Technical highlights

Invasive plant and animal research

2012-13

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Cover photo: Herbicide misting trials on prickly acacia near Barcaldine.

Contents

Introduction

This document provides a summary of the 2012-13 research program of the Invasive Plants and Animals Science group in Biosecurity Queensland. Our applied research program aims to better manage Queensland's worst weeds and pest animals, reducing their impacts on agriculture, the environment and the community.

Our work is undertaken at five centres across the state: Ecosciences Precinct (Dutton Park), Health and Food Sciences Precinct (Coopers Plains), Robert Wicks Pest Animal Research Centre (Toowoomba) and Tropical Weeds Research Centre (Charters Towers and South Johnstone). Our research station at Inglewood closed during 2012-13 due to limited use and the need to make budget savings. Budget reductions also resulted in the departure of a number of staff and they will be sorely missed. We nevertheless retain an experienced and skilful team of approximately 40 scientists and support staff committed to quality science to support pest management.

The research projects summarised in this document cover the development of effective control strategies and methods (e.g. biological control and herbicides), as well as improved knowledge of pest species' biology and assessment of pest impact. Notable achievements of the research program for 2012-13 are outlined below.

Invasive plant science

- Seed longevity is being determined for numerous wet and dry tropics weeds under different environmental conditions such as rainfall and soil type. This will influence the length of time needed on follow-up control before the seed bank is exhausted. This is particularly relevant to eradication programs such as the four tropical weeds. The viability of seeds after immersion in water is being assessed for several wet tropics weeds.
- Herbicide trials are underway for alligator weed, black willow, badhara bush, Senegal tea, navua sedge, mikania, bogmoss, calotrope, candyleaf, yellow bells, bellyache bush and prickly acacia.
- The role of fire is being investigated for the management of grader grass and lantana. For lantana, modelling suggests that a biennial frequency of high intensity burns can achieve site-specific control in about 15 years.
- A sound understanding of pest ecology is needed for effective management. Our ecologists have recently undertaken a population viability analysis for lantana and assessed efficacy of herbicide control for cat's claw creeper.
- Factors limiting growth and dispersal of cabomba have now been determined. As pH increases to 7.5, cabomba growth is suppressed, and this effect could be used to manage infestations, as well as identifying potential areas of successful establishment.
- Monitoring of the seed-bank before and after major flooding along a central Queensland creek surprisingly found that weeds did not proliferate any more than non-weedy species. The riparian seed bank recovered quickly from the event.
- We are developing surveillance methods for weeds in the early stages of invasion. This includes the use of environmental DNA to detect the riparian weeds *Mimosa pigra* and pond apple in water bodies.
- We maintain an active weed biocontrol program. Currently, we are testing the host specificity of agents for bellyache bush, prickly acacia, cat's claw creeper, *Cyclindropuntia* spp., lantana and chromolaena.
- We continue to monitor recent releases of agents for Madeira vine, cat's claw creeper, parkinsonia and lantana. Each agent is showing evidence of establishment at widely-distributed sites. In addition to establishment, we have begun assessing the efficacy of two biocontrol agents for parthenium in south-eastern Queensland under varying grazing intensity.
- Overseas explorations and collaborations have identified potential agents for bellyache bush, prickly acacia, mikania, clidemia, miconia and cat's claw creeper.

Pest animal management

- Concern over the risk of poisoning to non-target species instigated an assessment of controlling feral pigs in southern Queensland with meat baits containing 1080. Monitoring bait removal and populations of bird species at risk of poisoning, suggests little impact, supporting continuation of baiting.
- We are examining the effectiveness of commercial harvesting to control feral pig and feral goat populations in the Queensland semi-arid rangelands. This study is using data collected on annual aerial surveys for kangaroos since the early 1980s.
- We have also collaborated in reviews of techniques for monitoring feral pig abundance, their impacts and management. Furthermore, protocols have been developed for monitoring the effectiveness of pig control programs.
- We are now studying the distribution, impacts and ranging behaviour of chital deer in north Queensland. This is in response to their relatively recent spread and increase in abundance, despite having a restricted distribution for over 100 years. We have also run workshops on the management of peri-urban populations of four deer species, which are becoming increasingly problematic.
- Rabbits are recovering from the knockdown delivered by a combination of drought and rabbit haemorrhagic disease virus (RHDV) in many areas of Australia. Unfortunately, despite this threat, many landholders are reluctant to undertake preventative control. The impediments to control are being determined through a phone survey of landholders.
- Long-term studies on the ecology and management of rabbit populations in western and south-eastern Queensland are now drawing to a close. The following year will hopefully see a documentation of the latest results.
- A benign rabbit calicivirius has recently been described in south-eastern Australia and provides partial immunity to RHDV. The distribution of the virus in south-eastern Queensland is being mapped to identify areas where biocontrol will be less effective. This will supplement the rabbit program of the Invasive Animal CRC, which hopes to introduce a new strain of the RHDV to overcome the protection afforded by the non-pathogenic calicivirus.
- Wild dogs are a concern across the state. We are running research projects in agricultural and peri-urban areas to better understand wild dog ecology and determine the effectiveness of management action. In areas grazed by cattle, data suggest that regularly controlling wild dogs may not reduce calf loss in the long-term. This is controversial as it calls into question the recommended management practice. The data are only suggestive and so the efficacy of baiting on cattle properties will need further assessment. For sheep graziers, wild dog control is essential, but is proving to be difficult despite the availability of various techniques and strategies. A number of related factors are likely responsible for the increasing problem of wild dogs for sheep producers. These include the reduced value of wool, reduced extent of dog-proof fencing, fewer people working on properties, and increased cattle production in sheep grazing areas. How to achieve cost-effective control will be an important area of research in the coming years.

Research services

- 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.
- Minor use permits were obtained from the Australian Pesticides and Veterinary Medicines Authority, which are required for the weed species, herbicide, application method and situation or environment.

Funding, collaboration and research priorities

In the 2012–13 financial year, Biosecurity Queensland's Invasive Plant and Animal Science program received funding from a number of sources. Queensland Government base funds provided $2.6 million, contributions from the Land Protection Fund amounted to $1.8 million and funding under contracts with external partners totalled $0.9 million (see page 30). Notable funding bodies for the latter were the Australian Government, Meat and Livestock Australia and the Invasive Animal CRC.

Our research program for 2012–13 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. We are currently seeking input on research priorities from Queensland local governments, natural resource management bodies and other stakeholders through an online survey and plan to finalise priorities through regional workshops.

Further information

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 page 32). 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. Weed seed dynamics

Project dates

August 2007 – June 2020

Project team

Shane Campbell, Faiz Bebawi and Chris Crowley

Project summary

There are many declared weeds for which we know very little about their seed ecology and longevity. Information on these aspects 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 any replenishment. In this project, seed longevity of priority weeds including yellow oleander, mesquite, prickly acacia, chinee apple, parthenium, orange-flowering and pink-flowering lantana, Gamba grass, calotrope, leucaena, yellow bells, Captain Cook tree, neem and Stevia, is being investigated in two different soil types (black clay and river loam), under two grass cover conditions (grassed and non-grassed) and at four burial depths (0, 2.5, 10 and 20 cm). Two different seed lots of chinee apple, yellow oleander and calotrope have been buried a couple of years apart to test if exposure to different environmental conditions affects longevity of their seed banks. All three species have exhibited short seed longevity of generally less than 24 months. There has been some variation between seed lots indicating that prevailing environmental conditions have influenced longevity of the seed banks. Species with viable seeds present after four years of burial include prickly acacia, leucaena, lantana and parthenium.

Collaborators

Bob J. Mayer, Senior Biometrician (DAFF, Oonoonba)

2. Best practice management of wet tropics weeds

Project dates

January 2009 – June 2015

Project team

Melissa Setter, Stephen Setter, Wayne Vogler, Laura Roden and Barbara Madigan

Project summary

This research directly supports on-ground management by investigating seed longevity, time to reproductive maturity, dispersal mechanisms and control options for priority species.

Navua sedge (Cyperus aromaticus)

Sempra™ (halosulfuron 750 g/kg), used with the wetter Bonza™ at 1% concentration, is the most effective herbicide in field trials. A pot trial has determined the lowest effective application rate for Sempra™ and field validation of the pot trial results will occur during 2013-14. Grazing withholding periods are being determined by Nufarm, the supplier of Sempra™ in discussion with the APVMA.

Bogmoss (Myaca fluviatilis)

A time exposure trial is underway based on the results of previous screening and rates trials and aquatic herbicides from the USA. Submerged bog moss is being subjected to the herbicides triclopyr, endothal, imazamox, flumioxazin, carfentrazone, penoxsulam and diquat for times of 15 minutes, 45 minutes, 2.25 hours, 6.75 hours, 24 hours, 5 days, 30 days and 210 days, after which the plants will be rinsed and placed in containers in fresh water. Assessments will be made after 5 months in fresh water.

Seed persistence in water (several species)

We are testing the viability of navua, hymenachne, leuceana, and mikania seed after varying periods of immersion in fresh, brackish and saline water. No results are available as yet.

Collaborators

Cairns Regional Council, Cassowary Coast Regional Council, Far North Queensland Regional Organisation of Councils, Tablelands Regional Council

Key publications

Setter, S.D., Setter, M.J., Graham, M.F. & Vitelli, J.S. 2008, Buoyancy and germination of pond apple (*Annona glabra* L.) propagules in fresh and salt water', in RD van Klinken, VA Osten, FD Panetta & JC Scanlan (eds), *Proceedings of the 16th Australian Weeds Conference*, Queensland Weeds Society, Brisbane, Queensland, pp. 140–2.

Setter, S.D, Patane , K.A , Logan, P. and Sydes, D. 2011, Pond apple (*Annona glabra*) -investigating selective mechanical

control options. In *Proceedings of the 23rd Asian Pacific Weed Science Conference*. *Vol 1*. McFadyen, R.E. *et al.*, ed(s). Asian-Pacific Weed Science Society, Cairns.26-29 / Sept.

Setter, S.D, and Patane ,K.A. 2011. Dispersal of pond apple (*Annona glabra*) by rodents, agile wallabies and flying foxes. In *Proceedings of the 23rd Asian Pacific Weed Science Conference*. *Vol 1*. McFadyen, R.E. *et al.*, ed(s). Asian-Pacific Weed Science Society, Cairns.26-29 / Sept.

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

Project dates

June 2010 – May 2015

Project team

Shane Campbell, Laura Roden, Christopher Crowley and Wayne Vogler

Project summary

This project is part of a larger, collaborative MLA-funded research program aimed at improving our understanding of the distribution, rate of spread, ecology, invasiveness and control of calotrope. Biosecurity Queensland is focussing on improving control options, with Charles Darwin University and the Northern Territory Department of Land Resource Management researching the other aspects. Control research implemented to date includes:

- Testing cut stump, frill, basal bark and soil-applied herbicides to provide practical options for control of isolated plants.
- Screening and testing rates of foliar herbicides to provide more options.
- In conjunction with Dow AgroSciences, evaluation of aerial application of Graslan* (tebuthiuron) for broadscale control in appropriate areas.
- Testing the susceptibility of calotrope to mechanical control through cutting experiments and evaluation of demonstration sites.

Monitoring over the past 18 months has demonstrated the effectiveness of aerial applications of Graslan* for control of large infestations on clay soils. Further testing is underway to determine the lowest rate capable of constantly killing calotrope while minimising damage to pasture. Monitoring and identification of the causal agent of a dieback phenomenon affecting calotrope in the Gulf of Carpentaria has also commenced in collaboration with the University of Queensland.

Collaborators

MLA, Charles Darwin University, Department of Land Resource Management, Northern Territory, University of Queensland, Dow AgroSciences, Landholders Peter and Ann Woollett and John Nelson

Key publications

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

Grace, B.S. 2006. The biology of Australian weeds 45. *Calotropis procera* (Aiton) W.T. Aiton. *Plant Protection Quarterly* 21(4): 152–160.

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

Project dates

July 2007 – June 2014

Project team

K. Dhileepan, Mariano Treviño (till Nov 2012) and Liz Snow (from Jan 2013)

Project summary

The Jatropha rust *Phakopsora arthuriana* (synonym *Phakopsora jatrophicola*) was evaluated as a potential biological control agent for bellyache bush (bellyache bush) at CABI (UK). Jatropha rust strains from Brazil, Mexico, Trinidad and Nicaragua were screened against various bellyache bush populations in Australia (Darwin purple, Katherine green, Kununurra green, and Queensland bronze, purple and green varieties). All the Australian bellyache bush varieties were susceptible to all four rust strains, but the strain from Trinidad showed higher virulence on all varieties. On the basis of comparative virulence, the strain from Trinidad was selected for full host-specificity testing. Full host-range testing was conducted for the Trinidadian accession against 38 of the 39 non-target test plant species. Thirty-four non-target test plant species were rated as either immune or resistant (no disease development and sporulation). Three of the remaining four non-target species belonging to the genus *Jatropha* supported uredinial sporulation of the rust and were rated as fully susceptible (*J. multifida* - sporulation comparable to *J. gossypiifolia*), moderately susceptible (*J. curcas* - regularly restricted sporulation) or weakly susceptible (*J. integerrima* - infrequently restricted sporulation). The rust also sporulated on two closely-related non-target species, *Aleurites moluccana* (weakly susceptible) and *Beyeria viscosa* (moderately susceptible). In a field situation, the rust would not pose any risk to non-target species rated as immune or resistant. Both *J. integerrima* and *A. moluccana* (rated as weakly susceptible) are unlikely to be found in the natural field host range of *P. arthuriana* and so come under attack. Based on the restricted number and size of uredinia produced and limited sporulation, *J. curcas*, *B. viscosa* and *A. moluccana* cannot be regarded as at risk of substantial damage.

Native range surveys were conducted for potential biological control agents for bellyache bush in Peru (42 sites), Bolivia (15 sites) and Paraguay (16 sites) during April 2013. A leaf-mining microlepidopteran (Gracillariidae) and a leaf-rust were widespread in Peru and Bolivia. In Bolivia, shoot-tip dieback due to galling by a cecidomyiid and a fruit-feeding scutellerid were also recorded. In Paraguay, shoot-tip dieback caused by the cecidomyiid *Prodiplosis* sp. near *longifila* and leaf-feeding lepidopteran larvae (Notodontidae) were collected.

Collaborators

Marion Seier (CABI Europe–UK, United Kingdom), Tanya Scharaschkin (Queensland University of Technology), Stefan Neser (Plant Protection Research Institute, South Africa)Damian Rumiz (Noel Kempff Mercado Museo de Historia Natural, Santa Cruz, Bolivia), Diana Silva Davila, Luis Ernesto Gonzles and Pavel Sanchez (Museo de Historia Natural, Lima, Peru), Carlos Aguilar Julio (National Museum of Natural History, Paraguay)

Key publications

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.

Bebawi, FF, Lockett, CJ, Davis, KM & Lukitsch, BV 2007, 'Damage potential of an introduced biological control agent *Agonosoma trilineatum* (F.) on bellyache bush (*Jatropha gossypiifolia* L.)', *Biological Control* 41(3): 415–22.

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.

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

Project dates

January 2007 – June 2014

Project team

K. Dhileepan, Di Taylor, Catherine Lockett (till Jan 2013) and David Perovic (till Dec 2013)

A. Balu, S. Murugesan, M. Senthilkumar (Institute of Forest Genetics and Tree Breeding, Coimbatore, India)

Project summary

A scale insect (*Anomalococcus indicus*), a leaf-webber (*Phycita* sp. 'A'), and a leaf weevil (*Dereodus denticollis*) were imported into a quarantine facility in Brisbane, Australia for host specificity testing as potential biological control agents for prickly acacia (*Vachellia nilotica* ssp. *indica*). For the leaf-webber, no-choice host specificity tests have been completed for 27 test plant species. The leaf-webber larvae fed and developed through to adults on 17 native species. In no-choice continuation (demographic) trials, the leaf-webber could complete up to three generations on the non-target species *A. baileyana* and up to two generations on the non-target species *A. mearnsii*. In choice oviposition trials, leaf-webber moths showed a significant preference for prickly acacia over the non-target test plants, in contrast to their behaviour under no-choice conditions. In view of the potential non-target risk, a decision was made to not seek approval for its release and the leaf-webber colony in quarantine was terminated in January 2013.

For the scale insect (*A. indicus*), no-choice host-specificity tests have been completed for 40 test plant species and are in progress for 14 test plant species. Mature gravid females have developed on10 non-target test plant species, but a significantly larger number of females developed on only two test plant species (*A. falcata* and *Neptunia major*). Significantly fewer mature females developed on all non-target test plant species than on *V. nilotica*. Choice host-specificity tests for several of the non-target test plant species on which the scale completed development and no-choice tests to compare the development and survival of nymphs on two of the native non-target species (*Neptunia major* and *Acacia falcata*) and prickly acacia have been initiated.

A leaf-feeding weevil (*Dereodus denticollis*) and a second leaf-webbing species (Phycita sp. 'B') were imported from India for colony establishment.

Collaborators

Roger Shivas, Principal Plant Pathologist (DEEDI), Marion Seier (CABI Europe–UK, United Kingdom), A. Balu (Institute of Forest Genetics and Tree Breeding, India), Stefan Neser (Plant Protection Research Institute, South Africa), Arne Witt (CABI Africa–Nairobi, Kenya)

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.

Dhileepan, K, Senaratne, KADW & Raghu, S 2006, 'A systematic approach to biological control agent exploration and prioritisation for prickly acacia (*Acacia nilotica* ssp. *indica*)', *Australian Journal of Entomology* 45(4): 303–07.

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

Project dates

September 2002 – June 2014

Project team

K. Dhileepan, Mariano Treviño (till Nov 2012) and Liz Snow (from Jan 2013)

Project summary

Cat's claw creeper *Dolichandra unguis-cati* (syn. *Macfadyena unguis-cati*), a Weed of National Significance, is an approved target for biological control. The leaf-mining jewel beetle, *Hylaeogena jureceki*, a native of tropical South America, was approved for field release in Australia in May 2012. Mass-rearing and field releases began in August 2012. Since then, over 23,000 adults have been released across 36 sites in south-eastern Queensland, including during winter months. Signs of larval mines and pupal cells were evident at many of the release sites. Though the mechanism of survival of the insect during winter moths is not known, winter surveys suggest that the insect may over-winter as adults. At one Brisbane site, *H. jureceki* has successfully survived over two winters, suggesting that the insect is likely to become widely established.

Starter colonies of *H. jureceki* have been supplied to various landcare and community groups in Queensland (e.g. Gympie & District Landcare Group and Yeppoon Regional Council) and New South Wales to take up rearing and release efforts locally.

A collaborative research project is being pursued with the Universidade Federal de Viçosa in Brazil (Dr Rober Barreto) to evaluate the potential of cat's claw creeper rusts (*Uropyxis rickiana* and *Prospodium macfadyenae*) as biological control agents for the long-pod and short-pod forms of cat's claw creeper in Australia. Seeds of long and short-pod forms of cat's claw creeper have been sent to Brazil to screen for susceptibility to the two rusts native to Brazil.

Collaborators

Stefan Neser and Anthony King (Plant Protection Research Institute, South Africa, Tanya Scharaschkin (Queensland University of Technology), Robert Barreto (Universidade Federal de Viçosa, Brazil)

Key publications

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

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

Dhileepan, K, Bayliss, D & Treviño, M 2010, 'Thermal tolerance and potential distribution of *Carvalhotingis visenda* (Hemiptera: Tingidae), a biological control agent for cat's claw creeper, *Macfadyena unguis-cati* (Bignoniaceae)', *Bulletin of Entomological Research* 100(2): 159–66.

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

Project dates

May 2007 – June 2014

Project team

K. Dhileepan, Kelli Pukallus and Mariano Treviño (till Nov 2012)

Project summary

Surveys for parthenium and its biological control agents in south-eastern Queensland recorded the stem-galling moth (*Epiblema strenuana*), the leaf-feeding beetle (*Zygogramma bicolorata*) and the winter-rust (*Puccinia abrupta* var. *partheniicola*). However, there was no evidence of summer rust (*Puccinia xanthii* var. *parthenii-hysterophorae*) and other biological control insects.

In north Queensland, surveys were conducted at three sites (Felspar, Cardigan Station and Bivouac Junction) during May-June 2013. At all sites, incidence of the stem-galling moth (3.3-7%) and summer rust (0.4-22%) remained low. The seed-feeding weevil (*Smicronyx lutulentus*), the stem-boring weevil (*Listronotus setosipennis*), the leaf-mining moth (*Bucculatrix parthenica*), the root-feeding clear-wing moth (*Carmenta* nr. *ithacae*) and the sap-feeding planthopper (*Stobaera concinna*) were the other agents recorded at these sites. The root-feeding Carmenta moth was also recovered from a non-release site (Caerphilly) near Plain Creek.

Collaborators

Steve Adkins (School of Land, Crop and Food Sciences, The University of Queensland)

Key publications

Dhileepan, K & Strathie, L 2009, '*Parthenium hysterophorus* L. (Asteraceae)', in R Muniappan, GVP Reddy & A Raman (eds), *Biological control of tropical weeds using arthropods*, Cambridge University Press, Cambridge, pp. 272–316.

Dhileepan, K 2007, 'Biological control of parthenium (*Parthenium hysterophorus*) in Australian rangeland translates to improved grass production', *Weed Science* 55(5): 497–501.

8. Gauging field efficacy of biocontrol agents on *Parthenium hysterophorus*

Project dates

Jan 2013 – Jun 2013

Project team

Olusegun Osunkoya, Christine Perrett and K. Dhileepan

Project summary

Biocontrol of *Parthenium hysterophorus*, a Weed of National Significance, has been in progress since the mid-1980s. However there is a lack of quantitative knowledge of the life-history stages of the weed, including the linkages between its above- and below-ground growth dynamics with and without biocontrol agents. This project aims to collect such demographic information. These data, when combined with simulation models under various site and landscape scenarios, will assist greatly in better control and management of the weed.

In the last six months we have scoped and have now selected two parthenium infestation sites on grazing properties in SE QLD (Kilcoy and Helidon-Spa; a third one is being sourced for). We will establish and monitor permanent plots in order to document hitherto missing detail demography (growth, survival and fecundity and seed bank) of parthenium with and without known 1-2 biocontrol agents (possibly the root-feeding *Carmenta* moth, the stem-galling *Conotrachelus* weevil, and the summer rust *Puccinia melampodii*). The interaction effects of the weed (± bioagents) with two fodder grass species (e.g. buffel and blue grasses) and under varying grazing intensity (control and two levels of clippings) will also be explored. Preliminary findings suggest that Parthenium seeds formed ~ 20% of the soil-seed bank at these infestation sites and that the rust and that the stem-galling weevil are abundant at the Helidon-Spa and Kilcoy sites, respectively

Collaborators

Steve Adkins, School of Agriculture & Food Sciences, Queensland University

9. Biological control of *Cylindropuntia* spp.

Project dates

October 2009 – June 2014

Project team

Bill Palmer (to 30 November 2012), Michael Day (from 1 December 2012), Joe Vitelli and Peter Jones

Project summary

The cactus *Cylindropuntia* spp., native to tropical America, include *Cylindropuntia rosea* (Hudson pear) and *C. tunicata,* both of which are Class 1 weeds in Qld, and *C. fulgida* and *C. imbricata,* which are Class 2 weeds. All are problems of pastures, decreasing productivity. Two biotypes (one from Mexico and one from South Africa) of the mealybug *Dactylopius tomentosus* were imported into quarantine to test their host specificity. A third biotype previously released in Australia (1925) to control *C. imbricata*, was also assessed against all *Cylindropuntia* spp. Results showed that all three biotypes attacked only *Cylindropuntia* spp. and no other species were affected. However, the Mexican *D. tomentosus* biotype was not compatible with the majority of the *Cylindropuntia* spp. and was consequently destroyed. The South Australian biotype has subsequently been re-distributed on the susceptible *Cylindropuntia* spp. in NSW and Qld. An application seeking the approval to field release the South African strain is being prepared. Four new biotypes of *D. tomentosus* were recently collected from the USA and are currently undergoing host specificity trials. Analyses of the DNA of *Cylindropuntia* spp. in Australia and plant material from South Africa, Mexico and Spain were not definitive and more detailed genetic work is required to resolve the taxonomy of this genus.

Collaborators

New South Wales Government Department of Primary Industries, University of Western Sydney, University of Michoacan, Mexico, Aridamerica AC, Mexico, Helmuth Zimmermann (Helmuth Zimmermann & Associates, South Africa)

Key publications

Holtkamp, RH 2012. *Cylindropuntia imbricata* (Haw.) F. M. Knuth - rope pear *Cylindropuntia rosea* (DC.) Backeb. - Hudson pear. In: *Biological Control of Weeds in Australia*. Julien, M , McFadyen, R and Cullen, JM eds. CSIRO Publishing, Melbourne. pp. 198-202.

Mathenge, CW, Holford, P, Hoffmann, JH, Zimmermann, HG, Spooner-Hart, R & Beattie, GAC 2009. Distinguishing suitable biotypes of *Dactylopius tomentosus* (Hemiptera: Dactylopiidae) for biological control of *Cylindropuntia fulgida* var. *fulgida* (Caryophyllales: Cactaceae) in South Africa. *Bulletin of Entomological Research*. 99(6): 619-27.

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.

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

Project dates

January 2000 – June 2013

Project team

Bill Palmer (to 30 Nov 2012), Michael Day (from 01 Dec 2012) and Wilmot Senaratne

Project summary

Because of non-target impacts, Biosecurity Queensland are requesting that biocontrol agents for mother-of-millions are released through the *Biological Control Act 1987* (*BCA 1987*). The Queensland Biological Control Authority will need to declare mother-of-millions as a target under the *BCA 1987*. In addition, the authority will need to declare the weevil *Osphilia tenuipes* as an agent for the control of mother-of-millions. The public and landholders will be given an opportunity to provide either their written support or objection to the proposed declaration. If the declaration is supported, the release of this insect will then be considered by the Australian Government under the *Quarantine Act 1908* and the *Environmental Protection and Biodiversity Conservation Act 1999*. The cultures of *Osphilia tenuipes* and *Alcidodes sedi* are costly to maintain in quarantine and so have been destroyed as the approval process may take several more years. Researchers in Africa have indicated that the agents can be collected.

Collaborators

Bob Parker and Marcelle O'Brien, Senior Biosecurity Officers, Invasive Plants and Animals (Biosecurity Queensland), Michelle Rafter, PhD student (The University of Queensland)

Key publications

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: *Proceedings of the 15th Australian Weeds Conference*. Preston, C , Watts, JH & Crossman, ND eds. Weed Management Society of South Australia, Adelaide. pp. 549–52.

Witt, ABR 2004. Initial screening of the stem-boring weevil *Osphilia tenuipes*, a candidate agent for the biological control of *Bryophyllum delagoense* in Australia. *Biocontrol*. 49(2): 197–209

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

11. Biological control of *Lantana camara*

Project dates

Ongoing

Project team

Michael Day, Natasha Riding (ESP) and Kelli Pukallus (TWRC)

Project summary

Lantana is a major weed of coastal and subcoastal eastern Australia, infesting national parks and forestry areas, where it reduces biodiversity. It also infests grazing lands where it outcompetes preferred species, reducing productivity. Lantana is also toxic to stock. Due to the size of infestations, conventional control is generally not feasible. Biocontrol commenced in 1914, with 32 agents introduced and 18 of which have established. Lantana is not under adequate control, so new and more damaging agents are being sought. Rearing of the herring-bone leaf-mining fly *Ophiomyia camarae* has ceased at the Tropical Weeds Research Centre, Charters Towers and field-monitoring is being conducted to determine areas of establishment. The fly is widely found from Rockhampton to Cooktown and is causing seasonal defoliation. Small populations are also present near Bundaberg, at Elliott Heads and Innes Park. Field releases of the budmite *Aceria lantanae* have commenced, but there have been no signs of establishment as yet. A report on the host-specificity testing of the pathogen *Puccinia lantanae* has been received from CABI Europe-UK. Further testing is recommended prior to submission of an application to AQIS for its release.

Collaborators

ARC-PPRI, South Africa, CABI Europe–UK, United Kingdom, Centre for Origin Research, United States, CSIRO Plant Industry, CSIRO Ecosystem Sciences, DERM, Office of Environment and Heritage, New South Wales, New South Wales Government Department of Primary Industries, The University of Queensland, Local governments in Queensland and New South Wales

Key publications

Day, M 2012. *Lantana camara* L. – lantana. In: *Biological Control of Weeds in Australia*. Julien, M, McFadyen, R & Cullen, J eds. CSIRO Publishing, Melbourne. pp. 334-46.

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

Zalucki, MP, Day, MD & Playford, J 2007. Will biological control of *Lantana camara* ever succeed? Patterns, processes & prospects. *Biological Control*. 42(3): 251–61.

12. Biological control of *Chromolaena odorata*

Project dates

Ongoing

Project team

Michael Day and Natasha Riding

Project summary

Chromolaena odorata (chromolaena) was first detected in Australia in 1994, near Bingil Bay, northern Queensland. It is a Class 1 weed in Queensland and was the target of a national cost-share eradication program. As eradication is no longer considered to be feasible, biological control options are being investigated, to help reduce the weed's impact and slow its spread.

The gall fly *Cecidochares connexa* was thoroughly tested, prior to being released into Indonesia, Micronesia, Papua New Guinea and Timor Leste, where it is helping control chromolaena. It was imported into quarantine at the Ecosciences Precinct and host-specificity testing commenced against plant species in the tribe Eupatorieae that had not been previously tested. Twenty species were tested thoroughly in no-choice and choice trials, with galls developing readily on, and adults emerging from *C. odorata*. Some galls developed on the weed *Praxelis clematidea* but adult emergence was very low. The results confirmed host specificity and showed that *P. clematidea* is a poor host and will not support populations of the gall fly. An application seeking approval to release *C. connexa* is being prepared.

Collaborators

National Agricultural Research Institute, Papua New Guinea

Key publications

Day, M & McFadyen, R 2012. *Chromolaena odorata* (L.) King and Robinson – chromolaena. In: *Biological Control of Weeds in Australia*. Julien, M, McFadyen, R & Cullen, J eds. CSIRO Publishing, Melbourne. pp. 162-169.

Day, MD, Bofeng, I & Nabo, I 2013. Successful biological control of *Chromolaena odorata* (Asteraceae) by the gall fly *Cecidochares connexa* (Diptera: Tephritidae) in Papua New Guinea. In: *Proceedings of the XIII International Symposium on Biological Control of Weeds*. Wu, Y, Johnson, T, Sing, S, Raghu, S, Wheeler, G, Pratt, P, Warner, K, Center, T, Goolsby, J & Reardon, R eds. Forest Health Technology Enterprise Team, Morgantown, WV. pp. 400-408.

13. Biological control of parkinsonia (*Parkinsonia aculeata)*

Project dates

March 2013 – March 2015

Project team

Kelli Pukallus and Judy Clark

Project summary

In conjunction with CSIRO, mass rearing and release of *Eueupithecia cisplatensis* is being undertaken for control of parkinsonia within Queensland.

Parkinsonia, a Weed of National Significance, is an introduced thorny tree from the Americas, which forms dense thickets and negatively impacts the environment. It has spread throughout central and northern Queensland. Three biological control agents have previously been released with varying results. This project endeavours to fill the void in leaf-feeding agents on Parkinsonia.

Host testing was completed in 2011 and approval granted for rearing and field releases *of E. cisplantensis* in 2012. The voracious leaf-feeding geometrid caterpillar from Argentina, defoliates the plant, restricting flowering and seed production.

TWRC received egg boxes in March 2013 from CSIRO's Brisbane colony. Releases commenced in April 2013 at eight paired sites in northern Queensland. The releases comprised various numbers and developmental stages of larvae or pupae. A comparison of their establishment success will allow a best-release technique to be determined.

Thus far, 1038 pupa and larva from 350 females have been released (equates to 20 000-15 000 larvae). Releases will continue in 2013/14, encompassing central and western Queensland. Combined with a high fecundity rate, mass rearing has been relatively easy and it is hoped establishment in the field will be seen soon.

Collaborators

Tim Heard and Gio Fichera (CSIRO Brisbane)

14. Improving weed management in Papua New Guinea

Project dates

January 2013 – June 2015

Project team

Michael Day

Project summary

An AusAID-funded project to increase the capacity of weed management in PNG commenced in January 2013. A workshop with participants from several organisations in PNG, including the National Agricultural Research Institute, was held in Kerevat, East New Britain, PNG in March 2013 to discuss agreed project activities and how best to implement them. Databases for each of the target weeds were established to capture information on distribution of weeds and their biocontrol agents. Posters and brochures were prepared and are being circulated throughout the country. An application to import two seed-feeding weevils to control *Mimosa pigra* was submitted and applications to import other biocontrol agents will be prepared and submitted to the appropriate organisations. Approved agents will be imported, reared and released and monitored as per agreed principles. Databases will be maintained for reporting and mapping purposes. Training in various aspects of weed management will be provided to participants as required. Improving weed management in PNG and other neighbouring countries should decrease the risks of weeds entering Queensland.

This project also provides information on the management and ecology of emerging weeds in Queensland, allowing earlier, more effective management here. The success of chromolaena biocontrol is one example.

Collaborators

AusAID, National Agricultural Research Institute, Papua New Guinea, Cocoa and Coconut Research Institute, Papua New Guinea, Papua New Guinea Oil Palm Research Association, National Agricultural Quarantine Inspection Authority, OK Tedi

Key publications

Day, MD, Kawi, A, Tunabuna, A, Fidelis, J, Swamy, B, Ratutuni, J, Saul-Maora, J, Dewhurst, CF & Orapa, W 2012. The distribution and socio-economic impacts of *Mikania micrantha* (Asteraceae) in Papua New Guinea and Fiji and prospects for its biocontrol. *Pakistan Journal of Weed Science Research*. 18: 169-179.

15. Improving weed management in Vanuatu

Project dates

October 2011 – October 2014

Project leader

Michael Day

Project summary

An AusAID-funded project to increase the capacity of weed management in Vanuatu commenced in October 2011. A poster showing all major weeds was prepared and distributed throughout Vanuatu. A brochure on parthenium has also been produced and distributed. A database to record locations of all the major weeds and their agents has been established and updated as field surveys have been conducted. The mikania rust *Puccinia spegazzinii* has been released on 11 islands and establishment has been confirmed on three islands. *Neochetina bruchi*, a biocontrol agent for water hyacinth, was imported in April 2013 and field releases have commenced. Import permits for parthenium and cat's claw creeper agents are being prepared.

Many of these weeds are in v arious stages of establishment in Australia. Lessons learnt from Vanuatu can be applied in Australia. For example, the mikania rust is an option for Australia if the weed becomes established here.

Collaborators

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

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

Project dates

July 2008 – December 2012

Project team

Olusegun Osunkoya, Christine Perrett and Cameron Clark

Project summary

Research work on lantana ecology has now concluded at four sites in Yarraman/Blackbutt. These sites span natural and managed lands. We have used the three year spatial and demographic (fecundity, survival and growth) data collected during these periods to develop population viability analysis to assist in pinpointing the weakest stage/s in the weed's life cycle, which can then form part of control strategies

Seed-bank size varied appreciably across sites and in response to rainfall and control measures. It was higher (~1000 seeds/ m^2) when annual rainfall was 15-30% below the long-term yearly average. Fire reduced seed bank populations, but not the proportion germinating (6-8%). Nearly a quarter of fresh seeds remain germinable after three years of soil burial. For small seedlings (‹10 cm high), survival and growth were surprisingly correlated; thus the observed positive association between these two traits, coupled with a persistent seed-bank population contribute to the invasiveness of the plant.

Lantana invasiveness is driven more by plant growth (65% contribution) than by seed production (19%) or plant survival (16%). However, from a control perspective, it is difficult to determine a single weak point in the life cycle of the weed that might be exploited to reduce growth below a sustaining rate. Also, the triennial fire regime often applied to manage lantana infestations appeared insufficient in site-specific (local) control of the weed. However, simulations showed that, except in a farm infestation, periodic burning could work within 4 - 10 years for control of the weed, but fire frequency should increase to at least once every two 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, Brisbane.

Key publications

Osunkoya OO, Perrett C, Fernando C, Clark C & Raghu S (2013). Modelling growth and site specific control of the invasive *Lantana camara* L (Verbanaceae) under differing fire regimes. *Population Ecology*, 55: 291-303

Osunkoya OO, Perrett C, Fernando C, & Clark C (2013) Patterns of seed bank and size asymmetry of plant growth across varying sites in the invasive *Lantana camara* L. (Verbanaceae) *Plant Ecology,* 214: 725-736

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.

17. Evaluation of restoration effort in riparian landscapes infested with cats claw creeper vine

Project dates

July 2012 – June 2013

Project team

Olusegun Osunkoya, Christine Perrett and Cameron Clark

Project summary

In March 2012, SEQ Water initiated a series of control efforts (via landcare groups and contractors) to combat infestations of the invasive cats claw creeper (CCC) vine along many creek inlets to its North Pine and Wivenhoe Dams. This involved cutting down the climbing stems of the vine, swabbing both ends of the cut portions with approved herbicide/s as well as application of herbicide/s on the infestation on the ground. We initiated evaluation of the efficacy of such a technique on long-term reduction of biomass of the weed and expected return of native flora. Permanent plots in treated and untreated infestations (paired) in riparian and non-riparian landscapes were established (July-Oct 2012) to document changes that are likely to occur through time in above (standing vegetation) and below ground flora (seed-bank). Initial results suggest that seed bank abundance and diversity is higher in CCC-invaded sites than in sites with CCC recently treated with herbicide and sites free of CCC (control). We will need to take further soil samples over time to determine the true long-term effect of this mode of control of the weed on resident flora.

Collaborators

Daniel Garcia, SEQ water

Key publications

Perrett C, Osunkoya OO & C, Clark (2012) Cat's Claw creeper vine, *Macfadyena unguis-cati* (Bignoniaceae) invasion impacts: comparative leaf nutrient content and effects on soil physico-chemical properties. Australian Journal of Botany, 60: 539 - 548

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: 2289 – 2302

Osunkoya OO, Bayliss D, Panetta D & Vivian-Smith G (2010). Leaf trait coordination in relation to carbon gain and resource use efficiency in invasive and native woody vine species. Annals of Botany, 106: 371 – 380.

18. Ecology, impact and control of environmental weeds

Project dates

July 2011 – July 2013

Project team

Olusegun Osunkoya and Christine Perrett

Project summary

Flooding, such as the major event of Jan 2011, has a profound impact on riparian zones through the removal of vegetation, resulting in habitats with bare substrate that are conducive to rampant weed growth in a non-competitive environment.

This study documented changes in the soil seed bank along riparian corridors following the major flood event in January 2011 in south-eastern Queensland. The study site was the Moolayember creek near Roma, central Queensland, which experienced an extreme flood event and where baseline ecological data on riparian seed bank populations had previously been collected in the summer and autumn months of 2007, 2008 and 2009. Ten and 15 months after the major flood event, we located and collected soil samples from three locations along the creek, each 2 km apart in spring/summer (November- December 2011) and in early autumn (March 2012). Thereafter, the collected soil samples were exposed to adequate warmth and moisture under glasshouse conditions, and emerged seedlings were taxonomically identified. Flooding significantly increased seed bank abundance, but decreased its species richness and diversity. However, the flood impact was less than that of a temporal (yearly) effect, but greater than that of seasonal variation. Seeds of trees and shrubs, as distinctive life form groups, were few in the soil, and were negatively affected by the flood; those of forbs (herbs) and graminoids (grasses) were numerous and proliferate after the flood. Seed banks of terrestrial or annual plants were more sensitive to flooding than those of their wetland or perennial counterparts, respectively. As an ecological group, seed banks of weedy and/or exotic species were no more affected (though mostly increasing in abundance) by the flood than those of native and/or non-invasive species. Overall, the studied riparian zone showed evidence of a quick recovery within its seed bank overtime, and therefore it can be considered to be resilient to an extreme flood event.

Collaborators

Steve Adkins, School of Agriculture & Food Sciences, Queensland University, Sheldon Navie, Technigro Australia

19. Cabomba (*Cabomba caroliniana*) ecology

Project dates

October 2010 – July 2013

Project team

Tobias Bickel and Christine Perrett

Project summary

The submersed aquatic weed *Cabomba caroliniana* (cabomba) is widely naturalised in Australia and is a serious environmental weed displacing native aquatic plants. Cabomba also causes multiple socio-economic impacts, interfering with use of freshwater resources. The current knowledge gap on cabomba ecology severely hampers management efforts.

Cabomba is predominantly found in coastal soft water lakes that provide favourable conditions for prolific growth. The pH of the water is a limiting factor, with cabomba preferring acidic to neutral water (optimum at pH 6.5). At pH 6.5, cabomba readily outcompetes other aquatic plants. However, a pH of 7.5 suppresses cabomba growth and shifts it to a level similar to that of other macrophytes. Therefore, manipulation of the pH curbs cabomba's competitive superiority and is a potential management tool.

Because cabomba spreads through unintentional overland transport, survival ability determines the potential dispersal distance. Cabomba fragments are highly resistant to desiccation. External factors, such as wind speed and clumping, affect the desiccation rate and therefore viability of fragments on arrival. The minimum survival time for fragments is 1 - 2h, but survival times for clumps exceed 50h. Therefore, unintentional overland dispersal of cabomba poses a high risk and can potentially span large geographical distances.

Collaborators

Brisbane City Council, CSIRO, SEQwater, National Aquatic Weed Management Group, Noosa and District Landcare, Department of Primary Industries, Victoria, University of New England, NSW

Key publications

Bickel, T O. 2012. Ecology of the submersed aquatic weed Cabomba caroliniana in Australia. In: *18th Australasian Weeds Conference Proceedings 2012*. Eldershaw V, ed. Weed Society of Victoria, Melbourne. p. 21-24.Melbourne. October/2012.

20. Control and ecology of *Stevia ovata*

Project dates

July 2012 – June 2015

Project team

Melissa Setter, Stephen Setter, Richard Boyne, Christopher Crowley and Simon Brooks

Project summary

This invasive weed is known to be present at only one location in north Queensland but because it is deemed to be such a threat to the area, it has been declared under the local laws of the Tablelands Regional Council. A *Stevia ovata* stakeholder group comprising local government, state government, and community members, has requested research into herbicide control of *Stevia ovata* along with some basic biology studies to quantify seed bank longevity and age to reproductive maturity.

Trials have therefore been initiated including:

- determination of germination requirements (e.g. temperature and light),
- seed persistence in soil and in fresh, brackish and saline water
- age to reproductive maturity
- herbicide screening trials

An initial screening trial of several herbicides was completed during 2012/13 and the most promising of these have now been included in a rate response trial.

Collaborators

Far North Queensland Regional Organisation of Councils

Tablelands Regional Council

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

Project dates

July 2006 – June 2015

Project team

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 ecology and management studies presented previously.

The research incorporates burning at three times (late dry, early wet, and late 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.

The late dry and early wet season fires along with the herbicide treatment were implemented during 2012-13. In April, the entire site was accidentally burnt during hazard reduction burning on Undara National Park resulting in no late wet fires or biomass recording. Hence it was decided not to implement any treatments during 2013-14 and final biomass measurements following the 2013-14 wet season. This will conclude the field component of the project, with data analysis remaining. Despite the loss of the site to fire, the results continue to indicate that dominance of grader grass is maintained by frequent ecosystem disturbance, thus disturbance should be minimised.

Collaborators

National Parks, Recreation, Sport and Racing: Undara Volcanic National Park

Key publications

Vogler, WD & Green, W 2011, 'Spray topping: a potential tool for managing grader grass (*Themeda quadrivalvis*)', in J Hodgon *et al.* (eds), *Proceedings of the 11th Queensland Weed Symposium, Queensland Weed Society,* Brisbane.

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

Vogler, WD & Owen, NA 2008, 'Grader grass (*Themeda quadrivalvis*): changing savannah ecosystems', in RD van Klinken, VA Osten, FD Panetta & JC Scanlan(eds), *Proceedings of the 16th Australian Weeds Conference*, Queensland Weeds Society, Brisbane, p. 213.

22. Ecology and management of *Mimosa pigra*

Project dates

July 2008 – June 2014

Project team

Joseph Vitelli and Barbara Madigan (up to December 2012)

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 remains underwater after heavy rains filled the dam in early 2010. However, prior to inundation it was estimated that seed bank exhaustion would occur by 2017.

Monitoring of plant and animal populations is typically achieved through visual detection. For rare species and for species in aquatic environments, this can be difficult and costly. This is often the case for exotic species at the early stages of invasion, yet early detection and delimitation is critical to the success of eradication and containment programs. Detecting aquatic species from their DNA in water samples is a developing technique. A new aspect of this project aims to develop a methodology for the detection of environmental DNA (eDNA) of invasive weeds in aquatic systems. The initial test species will be *M. pigra* and *Annona glabra* (pond apple), two wetland pest plants. Using eDNA to detect invasive species in aquatic systems could increase surveillance accuracy, decrease costs of surveys and increase sampling efficiency.

Collaborators

Dr Jane Oakey, Principal Molecular Biologist (Biosecurity Queensland), Brad Pease, Molecular Biologist (Biosecurity Queensland), Kay Bailey, National WONS Coordinator for *M. pigra* and athel pine, and Christopher Collins, Bert Lukitsch, Ian Cowie, Ben Stuckey, Em Pedler and Ben Matthias (NRETAS, Northern Teritory), 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, Madigan, BA & Worsley, KJ 2006, '*Mimosa pigra* in Queensland', in C Preston, JH Watts and ND Crossman (eds), *Proceedings of the 15th Australian Weeds Conference*, Weed Management Society of South Australia, Adelaide, pp. 251–4.

Vitelli, J.S., Oakey, J., Madigan, B.A., Driver, L., Chamberlain, A.A., and Heard, T.A. 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: Proceedings of the 11th Queensland Weed Symposium. J. Hodgon, ed. The Weed Society of Queensland Inc., Mackay, 31July – 3 August 2011, Weed management: Back to basic. pp. 65-68.

23. Ecology and control of national weed eradication targets

Project dates

July 2008 – June 2014

Project team

Simon Brooks, Kirsty Gough, Judy Clark, Stephen Setter, Richard Boyne, Shane Campbell and Melissa Setter

Project summary

This project aims to determine the key biological parameters of the four tropical weeds influencing the field operations of their nationally cost-shared eradication programs, such as seed bank persistence and age to maturity, as well as control measures and dispersal potential of the weeds.

This year, for *Mikania micrantha*, a field trial of a foliar herbicide and a pot trial to determine age to maturity were established. There was continued monitoring of buried packets of melastome seeds in the wet tropics and Siam weed achenes in the dry tropics to determine their longevity. Also continuing is a glasshouse trial of *Limnocharis flava* seed persistence under varying periods of immersion and assessments of seed longevity and seedling population dynamics of *Clidemia hirta* in the field and observations on the growth to maturity of invasive melastomes. Immersion, salinity and wash down additive treatments were continued or completed on seeds of several species.

Papers are being drafted on controlling *Chromoleana odorata*, including trials of low volume herbicide applications via a 'splatter gun' and the effects of repeat burning on seed banks.

Collaborators

Biosecurity Queensland officers based at South Johnstone and Mossman—provided assistance with locating and accessing trial areas

CSIRO Ecosystem Sciences, Atherton

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.

24. Class 1 weed control packages

Project dates

July 2008 – June 2014

Project team

Joseph Vitelli, Barbara Madigan (till Dec 2012) 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 contains no regrowth 20 months after treatment.

Despite chemical and mechanical treatments in 2009, badhara bush assessments at Cawarral in November 2012 yielded 91 (height ranging from 0.1 – 4m) and 277 (ranging in height from 0.1 to 2.6m) plants reshooting at 2 sites, whilst the Stanage Bay site had five reshooting plants (height 0.5 – 1.2m). No plants were found to be flowering or podding. Though extensive surveys of the area for badhara bush have been undertaken in previous years, a new badhara bush infestation was found 1 kilometre from the Stanage Bay site. This infestation occupies an area of over 300m^2 and contained 110 stems ranging in diameter from 0.5 to 36 cm.

A basal bark trial using triclopyr in diesel on black willow was initiated at Harvey Bay in December 2011. No regrowth was observed 18 months post treatment.

A Senegal tea foliar herbicide trial involving glyphosate, metsulfuron, imazapyr, triclopyr and endothal found that all were all effective at controlling 100% of the treated plants.

Collaborators

Dr Jane Oakey, Principal Molecular Biologist (Biosecurity Queensland), Brad Pease, Molecular, Biologist (Biosecurity Queensland), Biosecurity Queensland field staff, Brisbane City Council, Capricorn Pest Management Group, Logan City Council, Seqwater, Brett Cawthray, (Gladstone Regional Council), Scott Day, Duaringa Rural Lands Officer (Central Highlands Regional Council), Juliet Musgrave Fraser Coast Regional Council

25. Herbicide application

Project dates

July 2009 – June 2016

Project team

Wayne Vogler, John McKenzie, Dannielle Brazier and Laura Roden

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 (splatter method) of herbicides on priority weeds with research finalised on bellyache bush and a pot trial currently underway on prickly acacia. For bellyache bush, a minor use permit (PER13707) has now been granted by the APVMA for the application of metsulfuron methyl using the splatter method.

We have also been testing a new herbicide for DuPont as a potential control option for several weeds using the stem injection technique. Weeds tested included calotrope, chinee apple and prickly acacia. The trials have finished and the results have been submitted to DuPont for their consideration.

The use of misters as a potential control option for prickly acacia regrowth continues to be investigated in the Mitchell grass downs region of Queensland. A second trial was established at Barcaldine to further test and refine herbicide application rates within defined weather parameters. The trial has shown that misting has potential as an application technique however further testing is required to determine the parameters and herbicide application rates.

Collaborators

Desert Channels Queensland

Key publications

Brazier, D., McKenzie, J., Owen, A., Campbell, S., Vitelli, J., Reid, A. and Mayer, R. 2010. Evaluating herbicides for the control of the invasive weed florestina (*Florestina tripteris* DC. Prod.). In: Proceedings of the 17th Australasian Weeds Conference. Sue M. Zydenbos, ed. The New Zealand Plant Protection Society (Inc) and the Council of Australasian Weed Societies Inc., Christchurch, New Zealand pp. 421-3.

McKenzie, J., Brazier, D., Vitelli, J., Owen, A., and Mayer, R. 2010. Stem injection: a control technique often overlooked for exotic woody weeds. In: Proceedings of the 17th Australasian Weeds Conference. Sue M. Zydenbos, ed. The New Zealand Plant Protection Society (Inc) and the Council of Australasian Weed Societies Inc., Christchurch, New Zealand pp. 459-61.

An alligator weed herbicide trial at the Ecosciences Precinct.

Alligator weed flea beetle *(Agasicles hygrophila)*.

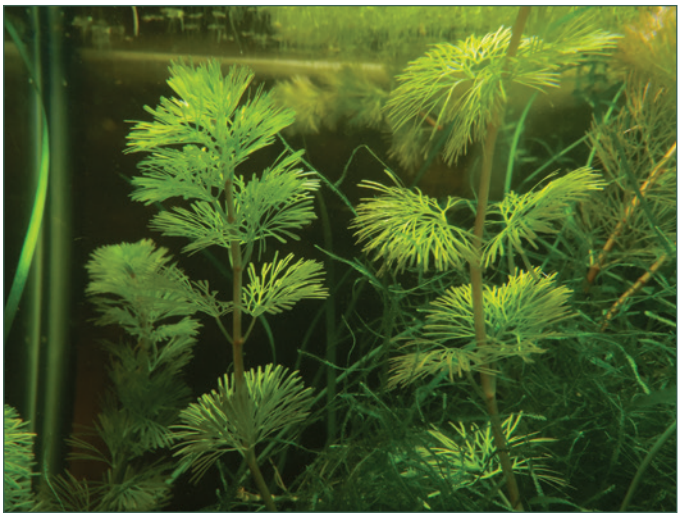
The leaf-mining jewel beetle *(Hylaeogena jureceki)* targets cat's claw creeper *(Dolichandra unguis-cati)*.

The leaf webber (*Phycita* sp. A), a potential biocontrol agent for prickly acacia, which is undergoing host-specificity testing in quarantine at the Ecosciences Precinct

Sylverio Bule releasing mikania rust on Tanna Island, Vanuatu.

Collecting potential biocontrol agents on prickly acacia in India.

Jatropha rust, a potential biocontrol agent for bellyache bush, in South America.



Aquatic weed *Cabomba coroliniana* (Cabomba).

Native range surveys for potential biocontrol agents for bellyache bush in South America.

Dactylopius damage on the Queensland cactus *Cylindropuntia fulgida* var. *mamillata*

The leaf weevil (*Dereodus denticollis*), a potential biocontrol agent for prickly acacia, which is undergoing host-specificity testing in quarantine at the Ecosciences Precinct.

Soil sampling amongst *Parthenium hysterophorus* (Parthenium) at a field site near Helidon, Queensland.

Wild dogs attracted to a canid pest ejector, which can provide target-specific control.

A stag chital deer with a GPS collar attached. Five deer have been collared as part of a pilot study looking at chital deer movements on Spyglass Research Station, north of Charters Towers.

Peter Elsworth collecting tissue samples from a rabbit trapped at Highfields as part of a survey to determine the distribution of the non-pathogenic RCV-A1 in South East Queensland.

Over the last decade, Biosecurity Queensland has captured and released dozens of wild dogs and several maremma guardian dogs fitted with satellite tracking collars to understand how wild dogs and maremmas interact.

Two fat-tailed dunnarts (*Sminthopsis crassicaudata*). These native mammals tripled in number at Bulloo Downs following the ripping of rabbit warrens. This highlighted the benefit to native animals that can occur with the control of rabbits.

A wild dog cluster fence, enclosing approximately 35 properties so that graziers can better manage pests and pastures and prevent reinvasion.

Grader grass fire research at Undara National Park.

Stephen Setter inspecting a potential site for a *Stevia* herbicide trial.

Female *Eueupithecia cisplatensis*, a biocontrol agent for parkinsonia.

Herbicide trial on *Stevia ovata* (candy leaf)

Eueupithecia cisplatensis pupil release on parkinsonia, Kelli Pukallus

Melissa Setter collecting bog moss for herbicide trials.

26. *Tecoma stans* herbicide trial

Project dates

April 2010 – August 2012

Project team

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, compromising the rehabilitation objectives of the operation.

In the past, herbicide and controlled burning have been used in an attempt to eradicate *T. stans* with limited success. Therefore, a research project was undertaken to develop a management plan to control this weed.

A herbicide trial has identified glyphosate (Roundup® 360) and metsulfuron methyl (Brushoff®) 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 indicate the seed bank is exhausted within six months. Plants from 0.3 m tall can be reproductive, although most plants need to reach almost 1 m in height prior to being reproductive.

The final report has been completed and demonstrates that eradication is feasible as long as there is commitment to following the actions outlined in the management plan.

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

Project dates

July 2012 – June 2013

Project team

Matt Gentle and James Speed

Project summary

Meat baits are widely used in western and northern Queensland to control the impacts of feral pigs. Examination of data on species sensitivity to 1080 suggests that the use of meat baits for feral pig control (i.e. 72 mg 1080 in 500 g meat) may be harmful to a range of non-target animals. However, we need to investigate whether this *theoretical* risk translates into an *actual* impact in the field. This project assessed the population-level impact on non-target consumers, specifically corvids and raptors, from meat baiting for feral pig control. Bird abundance was monitored before and after three baiting campaigns on treatment (baited) and control (non-baited) sites in south-western Queensland. Comparison of pre- and post-baiting densities indicate no consistent, significant changes in bird species abundance on the baited site (Culgoa National Park) relative to the unbaited control sites.

During two baiting campaigns, 40 baits were monitored to determine the species visiting and consuming bait. While some baits were moved (particularly by varanids, ravens/crows and raptors), few were sampled (partly eaten) and none were entirely consumed by non-target species.

While it remains important to continue research to further reduce any likelihood of non-target deaths, the results from this study suggest minimal, if any, impact on the susceptible bird species monitored. This supports the continued use of meat baits in such environments.

Collaborators

Queensland National Parks and Wildlife Service

28. Best practice management of feral pigs (*Sus scrofa*)

Project dates

July 2012 – June 2013

Project team

Matt Gentle, Tony Pople and Jim Mitchell

Project summary

This project aims to collate, analyse and publish information from feral pig research to improve feral pig management. The first component of this study examined the role of feral pig harvesting as a control technique. Commercial harvesting of feral pigs is often encouraged as it carries little or no cost and is widely perceived to control populations. This study used simple harvest models to examine commercial harvest offtake on twenty-six sites throughout Queensland. Commercial harvest rates were generally low (‹20%), with high harvest rates capable of substantial reductions (›50%) in long-term population size being isolated occurrences and not maintained across sites and years. Our results demonstrate that, at current harvest rates, commercial harvesting is ineffective for the landscape-scale control of feral pig populations.

Given the critical importance of monitoring in pest animal management, the second component of this project reviewed the available wild suid (pig) monitoring techniques. This review was a collaborative effort between European, American and Australian researchers, and assessed the available literature on monitoring wild suids worldwide. This review will guide potential users to identify optimal monitoring option/s for their objectives, circumstances and resources.

The final component reviewed the impacts and management of feral pigs in Australia. Understanding feral pig impacts is vital to develop improved strategies to reduce damage. We collaborated with Australian researchers to provide a summary of the current knowledge of feral pig impacts and management techniques. This will be an important publication to guide future research.

Collaborators

Ric Engeman (National Wildlife Research Center, Colorado, United States), Giovanna Massei (Animal Health Veterinary Laboratory Agency, United Kingdom), Mikael Sage (Wildlife, Environment and Expertises, France), Andrew Bengsen (NSW Department of Primary Industries), Hayley Pearson (University of Sydney), Glen Saunders (NSW Department of Primary Industries)

Key publications

Engeman RM, Massei G, Sage M, Gentle MN (2013) Monitoring wild pig populations: a review of methods. *Environmental Science and Pollution Research* **20**(11), 8077-8091.

Gentle M, Pople A (2013) Effectiveness of commercial harvesting in controlling feral-pig populations. *Wildlife Research* **40**(6), 459-469.

Bengsen AJ, Gentle MN, Mitchell JL, Pearson HE, Saunders GR (in press) Impacts and management of wild pigs *Sus scrofa* in Australia. *Mammal Review*.

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

Project dates

July 2009 – June 2012

Project team

Jim Mitchell and Kyle Risdale

Project summary

Feral pigs continue to cause environmental and economic impacts in northern Queensland. Previous research within this project has focussed on improving control options (particularly baiting) and quantifying the impacts of feral pigs. During 2012/13 we contributed to a large project funded by the Australian Government and coordinated by Terrestrial Ecosystem Services Pty. Ltd. It is aimed at developing monitoring protocols to assess the effectiveness of large-scale pest animal control programs undertaken to protect key vegetation habitats. Our role was to develop a monitoring tool for feral pigs which was completed and tested by the end of June 2013. Similar tools have been developed for rabbits, feral goats and camels.

30. Chital deer movements

Project dates

April 2013 – December 2014

Project team

Michael Brennan and Tony Pople

Project summary

Chital deer are increasingly being viewed as a serious pest animal in north Queensland. They have been established in the Charters Towers area since the late 1800s, but surprisingly their distribution has not expanded greatly. Availability of water and suitable habitat, and predation by wild dogs are possible factors restricting their spread. Despite being long established, very little information is known about the basic ecology of this exotic species. Information on ranging behaviour, particularly habitat use, drinking frequency and ranging area, will help in developing management plans for the species.

An opportunity exists to use four GPS (global positioning system) collars that are currently surplus to the needs of a separate study on red deer in southern Qld. Staff from that study have expertise in the capture, handling and collaring of deer in the field. These experienced field staff will be used in this project to capture and collar four adult chital deer. This project on chital deer is seen as a pilot study on chital deer movements. Funding will be sought in future years to increase sample size and scope of the study.

The project was to start in April 2013, but was delayed due to the unavailability of a darting crew and the field site, Spyglass research station near Charters Towers. In August 2013, five animals were captured and collared.

Collaborators

Tracy Jensen (Burdekin Shire Council), Lauren O'Bryan, Jonathan Lee (Biosecurity Queensland), Steven Anderson (DAFF, Spyglass Research Station), Neal Finch (DEHP), Peter Murray, Matt Amos, Glen Harry, Keith Staines (UQ Gatton), Sporting Shooters Association, Australian Deer Association

31. Strategic management of rabbits (*Oryctolagus cuniculus*) in south-western Queensland

Project dates

July 2006 – June 2015

Project team

David Berman (to December 2012), Joe Scanlan (from January 2013), Michael Brennan and Peter Elsworth

Project summary

Following three consecutive years of good rainfall in south-western Queensland, monitoring of rabbit populations at Bulloo Downs has shown the benefit of ripping warrens in drought refuge areas. Destroying warrens in the areas where rabbits were thought to normally survive drought achieved a reduction in rabbits of over 99%. Rabbit numbers have been suppressed for three good seasons at Bulloo Downs suggesting that rabbit control by destruction of drought refuge is a useful strategy. In a comparable area at Coongie Lakes in South Australia, rabbits maintained high density throughout the drought in the drought refuge area within 1 km of permanent water. This area of high density has now spread out to at least 15 km from the drought refuge. Rabbit numbers at Bulloo Downs have remained low, only spreading from one source area that was not considered a drought refuge site when the ripping was done. It has been nearly ten years since the completion of the ripping and rabbit numbers are still suppressed, highlighting the long-term benefit of this control. With drought again affecting this region, rabbits still do not have access to drought refuge areas and numbers will be reduced further.

Collaborators

South West NRM Ltd, SA Department of Environment, Water and Natural Resources

NSW DPI

Key publications

Berman, D., Brennan, M. and 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.

32. Distribution of the benign calicivirus RCV-A1 in south-eastern Queensland

Project dates

January 2013 – December 2013

Project team

Peter Elsworth, Michael Brennan and Joe Scanlan (from January 2013)

Project summary

Monitoring efforts during the initial release phase of RHDV led to the hypothesis that there was at least one other rabbit calicivirus circulating in Australian rabbits. In 2009, this virus was isolated and named RCV-A1. Recent investigation into RCV-A1 has shown that it is non-pathogenic (i.e. does not cause a noticeable disease or death) and it provides partial, temporary protection against infection by RHDV. This has obvious implications for management of rabbits, especially where RHDV is used as the main control tool.

To date, RCV-A1 has been found in rabbit populations in cooler-wetter locations in south-eastern Australia, primarily NSW, Victoria and South Australia. The recent development of a serological test has made it possible to test historical samples. This has shown that RCV-A1 was present in Queensland at two sites (Mundubbera/Eidsvold and Whetstone) in 1995 and at Stanthorpe in 2006. Interestingly, the Whetstone site showed no evidence of RCV-A1 in 2007.

As RHDV is still used as a management tool in Queensland, it is important to know the extent to which RCV-A1 is present in the state. The aim of this project is to sample rabbit populations in southern, eastern and central Qld to assess the distribution and prevalence of RCV-A1. Initial sampling has begun, with analyses for the presence of RCV-A1 to be undertaken next financial year.

Collaborators

Tanja Strive, John Wright (CSIRO), Darling Downs Moreton Rabbit Board, Tony Hopkins (Feral Animal Control Service), Somerset RC, North Burnett RC, Sunshine Coast RC, Ecosure, Gold Coast Airport

Key publications

Strive, T., Elsworth, P., Liu, J., Wright, J.D., Kovaliski, J. and Capucci, L. 2013. The non-pathogenic Australian rabbit calicivirus RCV-A1 provides temporal and partial cross protection to lethal Rabbit Haemorrhagic Disease Virus infection which is not dependent on antibody titres. *Veterinary Research*. 44: 51 doi: 10.1186/1297-9716-44-51.

Elsworth, PG, Kovaliski, J and Cooke, BD. 2012. Rabbit haemorrhagic disease: are Australian rabbits (*Oryctolagus cuniculus*) evolving resistance to infection with Czech CAPM 351 RHDV? *Epidemiology and Infection*, 140 (11), 1972-1981.

Elsworth PG. 2013. *Development of genetic resistance to rabbit haemorrhagic disease in wild rabbits Oryctolagus* cuniculus. PhD Thesis. University of Canberra.

33. Benefits of rabbit control in south-eastern Queensland

Project dates

July 2006 – June 2014

Project team

David Berman (to December 2012), Joe Scanlan (from January 2013), Michael Brennan and Peter Elsworth.

Project summary

This project will provide information on the benefits of controlling rabbits and help to refine control strategies to reduce the cost of control. A study site at Cottonvale was established where the rabbit-proof DDMRB fence separates an area heavily used by rabbits ('dirty side') from an area that has never had high numbers of rabbits ('clean side'). The 'dirty side' was characterised by a high number of warrens and a high density of rabbits and foxes. Rabbit control by ripping warrens and burning log piles reduced rabbit numbers on the 'dirty side' of the fence and there has been a corresponding reduction in fox numbers.

Botanical yield and composition data collation have been completed. Pasture condition (in terms of perennial grasses) was very good at the end of the 2012/13 growing season, following several years of above average rainfall. The level of grazing pressure in the cattle-grazed area appears to have been well within the sustainable capacity of the pasture, leading to no deterioration of pasture condition. Further pasture modelling to estimate pasture growth (using the GRASP model) will be used to confirm this preliminary analysis.

Remote cameras were set up in April 2012 to monitor wildlife on both sides of barrier fence. Similar surveys have previously done. These data will be analysed to determine if there are any differences between the wildlife assemblages in the two areas.

Survival and reproduction of rabbits has been analysed (through use of radio-collared rabbits), showing the lower survival of rabbit where there were no warrens. These data will be used to parameterise an individual-based population model of rabbits in south-eastern Queensland (using the NetLOGO programming package).

Collaborators

Darling Downs Moreton Rabbit Board (DDMRB), QMDC

34. Impediments to and drivers of rabbit control

Project dates

July 2012 – December 2013

Project team

Petra Skoien, Joe Scanlan, Peter Elsworth, Michael Brennan and Matt Gentle

Project summary

Landholders are often reticent to undertake rabbit control. This is especially so when rabbits are in low numbers. This work aims to identify and understand barriers to rabbit management being undertaken by landholders in areas impacted by rabbits in southern Queensland.

A telephone survey was conducted (facilitated by the DAFF Customer Service Centre) of landholders in those shires that pay a precept specifically for rabbit management and research. These landholders were identified as being potentially in rabbit-impacted areas. These areas were determined from previous data on soil suitability and historic rabbit control. Landholders were asked a number of questions on their experience with rabbits, and the reasons why they do or do not undertake rabbit control and what would enable them to do more.

Detailed analyses of the survey results are underway.

The outcomes are expected to provide empirically-derived understanding of the barriers to and drivers of rabbit management to enable informed decisions to be made about the allocation of resources for research, extension and control of rabbits.

Collaborators

Harley West (Stanthorpe Landcare)

35. Wild dog best-practice management

Project dates

July 2012 – June 2015

Project leader

Lee Allen

Project summary

This project used data collected over three decades to synthesise understanding on aspects of wild dog ecology and management. Manipulative experiments comparing calf loss in baited and un-baited treatment areas show wild dog control is sometimes counter-productive (Allen 2013). Independent studies into the causes of calf loss (Burns, Fordyce et al. 2010) and dietary studies of wild dogs (Allen, Goullet et al. 2012) support this conclusion. We have undertaken a number of studies (cattle predation assessment, large-scale baiting evaluation, dispersal and movements study etc) that help to explain why this is so. These data have significant implications for wild dog management nationally.

Collaborators

Peter Fleming, Guy Ballard (NSW DPI), Simon Humphrys (Invasive Animal CRC), Ben Allen (Biosecurity Qld)

Key publications

Allen LR (2013) Wild dog control impacts on calf wastage in extensive beef cattle enterprises. *Animal Production Science* http://dx.doi.org/10.1071/AN12356

Allen L, Goullet M, Palmer R (2012) The diet of the dingo (*Canis lupus dingo* and hybrids) in north-eastern Australia: a supplement to the paper of Brook and Kutt (2011). *The Rangeland Journal* 34, 211-217.

Burns BM, Fordyce G, Holroyd RG (2010) A review of factors that impact on the capacity of beef cattle females to conceive, maintain a pregnancy and wean a calf – implications for reproductive efficiency in northern Australia. Animal Reproduction Science 122, 1–22.

36. Peri-urban wild dog management

Project dates

July 2012 – June 2015

Project team

Matt Gentle, Ben Allen, James Speed and Lee Allen

Project summary

Management of peri-urban wild dogs is often contentious and difficult to implement given the presence of a variety of stakeholders with wide-ranging, and often conflicting, ideologies. This conflict is compounded by a general lack of understanding about wild dog ecology and the effectiveness of management techniques in these environments. This project investigates wild dog ecology and management in peri-urban areas in order to identify improved management strategies.

A small number of wild dogs on the Sunshine and Gold Coast have been fitted with GPS collars. Preliminary results suggest that wild dogs in peri-urban areas live within small home ranges, adjacent to and interspersed with residential housing. Analyses of a preliminary sample of scats suggest that their diet is varied and consists mainly of mammals and birds. Peri-urban wild dogs can carry pathogens although their prevalence and significance to animal and human health is largely unknown. Dogs trapped as part of control campaigns are being sampled for pathogens of economic and human health significance. Almost 200 tissue samples have been collected for DNA analyses, to determine gene-flow and genetic heritage. This work will continue over the life of the project. Reports of wild dog impacts are being collated from local governments to determine the type and scale of damage. Testing of non-toxic ejectors and 1080 baiting is also planned to determine the utility of such techniques in peri-urban areas.

Collaborators

Invasive Animals CRC, NSW Department of Primary Industries, Meat and Livestock Australia Limited, Moreton Bay Regional Council; Somerset Regional Council, Logan City Council, Sunshine Coast Regional Council, Brisbane City Council, Gold Coast City Council

37. Chemical registration: providing tools for invasive pest control

Project dates

Ongoing

Project team

Joseph Vitelli and David Holdom (till Nov 2012)

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 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 are available to address these issues and that any studies conducted for regulatory purposes meet APVMA requirements and guidelines.

Collaborators

Biosecurity field staff, APVMA screening officers.

Key publications

Permits issued by APVMA to Biosecurity Queensland during FY2012-13:

Permit (PER10367) Metsulfuron-methyl / Pastures and Non-Crop Situations / Parthenium. Expires 30 Jun 2018.

Permit (PER10533) Glyphosate / Pasture, non-crop situations / *Macfadyena unguis-cati* (Cat's claw creeper). Expires 31 Jul 2018.

Permit (PER10540) 2,4-D Amine, Glyphosate and Metsulfuron / Pasture and Fallow (Floodplains) / Lippia. Expires 31 Jul 2018.

Permit (PER13812) Grazon & Access / Pastures, rights of way, commercial and industrial areas / Coral cactus. Expires 30 Nov 2017.

Permit (PER13707) Metsulfuron methyl / Native pastures, rights of way, commercial and industrial areas / Bellyache bush. Expires 30 Jun 2017.

Permit (PER10397) 2,4-D / Pastures and non-crop situations / *Bryophyllum pinnatum*. Expires 30 Jun 2018.

Permit (PER13684) Triclopyr, picloram (Access Herbicide and Tordon DSH) ; Fluroxpyr (Starane 200 Herbicide); Glyphosate (Roudup Biactive) & Imazapyr (Unimaz 250 SL Herbicide) / Various situations / Pond Apple. Expires 30 Jun 2015.

Permit (PER10892) Glyphosate / Aquatic areas in Queensland / *Salvinia molesta*. Expires 31 Aug 2016.

Permit (PER10557) Nufarm Arsenal Xpress Herbicide / Non-crop areas / Thunbergia. Expires 30 Sep 2018.

Permit (PER13189) Haloxyfop / Rinyirru (Lakefield) National Park (CYPAL) / Hymenachne. Expires 30 Jun 2015.

Permit (PER13406) Glyphosate / Terrestrial & Aquatic Areas (Qld) / Hymenachne spp.. Expires 30 Jun 2017.

Where other states hold permits for identical situations, APVMA encourages the inclusion of other states on those permits. This process is much faster than applications for a new permit, typically requiring days rather than months.

38. Pest management chemistry

Project dates

Ongoing

Project leader

Alyson Herbert

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

Forensic toxicology

Over the year, our laboratory performed investigations relating to possible animal poisonings: 46 sodium fluoroacetate, 19 strychnine, 11 anticoagulant and 2 phosphine. Most investigations related to domestic dogs and cats, as well as a number involving wild macropods.

Formulation chemistry

During the year our formulation facility produced 3270 L of 1080 36g/L pig bait solution in accordance with upcoming registration of the formulation with the APVMA.

Testing of post-preparation sodium fluoroacetate solutions and meat baits continued throughout the year. Additional testing of 33 sodium fluoroacetate formulations was undertaken for industry.

External funding

Research and development contracts

Project/research area	Funding body	Funds ($)
Weed biocontrol in the Solomons and Vanuatu	AusAID	60 000
Weed biocontrol in Papua New Guinea	AusAID	42 000
Controlling calotrope in northern Australia	Meat and Livestock Australia	124 000
Biological control of bellyache bush	Meat and Livestock Australia	23 000
Biological control of prickly acacia	Meat and Livestock Australia	309 000
Biological control of Hudson pear	Department of Industry and Investment (New South Wales)	75 000
Biological control of Mikania	Australian Centre for International Research	1 000
Biological control of lantana camara	NSW LT/LG	7 000
Weed biocontrol taskforce	NSW Government	1 000
Herbicide control options for priority weeds	DuPont	22 000
Effective herbicide control	Anglo coal	17 000
Pond apple DNA sampling	Reef catchments	10 000
Canid bait project	Invasive Animals Cooperative Research Centre	5 000
Peri-urban wild dog control	Invasive Animals Cooperative Research Centre	150 000
Interactions between livestock guardian dogs and wild dogs	Department of Agriculture, Forestry and Fisheries (federal)	1 000
Improving feral pig management	Queensland Murray–Darling Committee	5 000
Feral pig best practice research	Terrestrial Ecosystem Services	34 000
Total		**886 000**

Land Protection Fund

Project/research area	Funds ($)
Weed seed dynamics	44 000
Herbicide application research	103 000
Biological control of bellyache bush	49 000
Biological control of prickly acacia	112 000
Biological control of mother-of-millions	38 000
Biological control of cat's claw creeper	106 000
Biological control of madeira vine	156 000
Biological control of lantana	96 000
Rearing and release of weed biological control agents	91 000
Biocontrol evaluation	122 000
Ecology and control of wet tropics weeds	79 000
Environmental weed ecology research	11 000
Water weed ecology and management research	143 000
Feral pig best practice research in northern Queensland	14 000
Feral deer best practice research	47 000
Wild dog best practice research	111 000
Rabbit best practice research	312 000
Pesticide authorities	84 000
Pest management chemistry and chemical registration	84 000
Total	**1802 000**

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Publications & Presentations

Journal articles

Allen BL, Fleming PJS, Allen LR, Engeman RM, Ballard G, Leung LKP 2013. As clear as mud: A critical review of evidence for the ecological roles of Australian dingoes. *Biological Conservation* 159, 158-174.

Allen L, Goullet M, Palmer R (2012) The diet of the dingo (*Canis lupus dingo* and hybrids) in north-eastern Australia: a supplement to the paper of Brook and Kutt 2011. *The Rangeland Journal* 34, 211-217.

Bebawi, FF, Campbell, SD, and Mayer, RJ 2012. Persistence of bellyache bush (*Jatropha gossypifolia* L.) soil seed banks. *The Rangeland Journal*. 34: 429-438.

Bebawi, F.F., Vitelli, J.S., Campbell, S.D. and Mayer, R.J. 2011. Impact of control strategies on bellyache bush (*Jatropha gossypiifolia* L.) mortality, seedling recruitment, population dynamics, pasture yield and cost analysis. *Rangeland Journal* 33(3): 277-286.

Bengsen, A.J., Gentle, M.N., Mitchell, J.L., Pearson, H.E. and Saunders, G.R. (In press) Management and impacts of feral pigs in Australia. *Mammal Review*.

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Brooks, S.J. and Setter, S.D. 2012. Soil seed bank longevity information for weed eradication target species. *Pakistan Journal of Weed Science Research* 18: 73-83.

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Dhileepan, K. 2012. Bellyache bush a headache for the north. *Feedback* (MLA's members magazine – north edition), Nov/Dec 2012.

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Sundstrom, K. 2013. Eyeing data on man's pest friend, Satellite, 23 May.

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Posters

Bickel, T O & Perrett, C. 2013. *Ecology of Cabomba caroliniana and the implications for management*. 12th Queensland Weed Symposium. Hervey Bay. 15-18 July.

Olusegun Osunkoya 2013. Soil seed bank dynamics in response to an extreme flood event in a riparian habitat of subtropical central Queensland, Australia. 12th Queensland weed symposium. Hervey Bay, QLD July.

Toh, R., Dhileepan, K., Shivas, R.G., Adkins, S.W. and Hanan, J. 2013. Biological control under changing environments: visualising summer rust on parthenium weed canopies (poster). *7th International Conference on Functional-Structural Plant Models* (FSPM2013), 9-13 June, Saariselkä, Finland.

Forums & workshops

Allen B. 2012. Peri-urban wild dog research. South-east Queensland Pest Animal Forum. Redland Bay, 3 December.

Allen, Lee. 2013. Reef rescue grazing forum, *Dingo predation and cattle production*. Mackay. 13 March.

Allen, B. 2013. Peri-urban wild dog research. Mackay-Whitsunday Pest Animal Forum. Mackay, 13 March.

Allen, B. 2013. Peri-urban wild dog research. South-east Queensland Pest Animal Forum. Ipswich, 20 March.

Allen, B. 2013. Peri-urban wild dog research. Dry Tropics Pest Animal Forum. Bowen, 23 April.

Allen, B. 2013. Peri-urban wild dog research. Agforce predator control field day. Kingaroy, 1 May.

Allen, B. 2013. Peri-urban wild dog research. Far-north Queensland Pest Animal Forum. Mareeba, 21 May.

Bickel T O. 2013. *Ecology of the submersed aquatic weed Cabomba caroliniana in Australia*. Goulburn Broken Catchment Management Authority, Community groups, National Aquatic Weeds Management Group, and other stakeholders. Benella. 12-13 March.

Campbell, SD 2012, Calotrope research, Dry Tropics Pest Advisory Forum. Charters Towers. 20 September.

Campbell, SD 2012, Prickly acacia biological control and other research, Prickly Acacia Forum, Richmond. 6 December.

Campbell, SD 2012, Use of fire for weed management, Fire Management Information Day, Speculation Station, Homestead. 27 September.

Campbell, SD 2013, Calotrope, North West Graziers Forum, Cloncurry. 21 May.

Day, MD 2012. *Biocontrol of lantana*. Mary-Burnett Catchment Group. Ecosciences Precinct. 29 November.

Day, MD 2013. Biocontrol of *Chromolaena odorata* – an overseas experience. *Chromolaena odorata* Management Group. South Johnstone. 14 February.

Day, MD 2013. *Improving weed management in Papua New Guinea*. Vudal University. Kerevat, PNG. 19-21 March.

Day, MD 2013. Mikania micrantha: *weed ecology and control*. Taipei, Taiwan. 22 April.

Day, MD 2013. *Biological control of weeds*. Sri Lanka. 18, 24 and 28 June.

Day, MD 2013. *Biocontrol options for Sri Lanka*. Sri Lanka. 18, 24 and 28 June.

Dhileepan, K. 2013. Biological control of Queensland weeds: Research update. South East Queensland Pest Advisory Forum Meeting, Queens Park Environmental Education Centre, Ipswich, 20 March.

Gentle, M. 2012. Current Biosecurity Queensland pest animal research projects. South-east Queensland Pest Animal Forum. Redland Bay, 3 December.

Gentle, M. 2012. Current Biosecurity Queensland pest animal research projects. Southern Inland Qld Pest Animal Forum, Toowoomba, 10 December.

Gentle, M. 2013. Peri-urban wild dog project, Southern Inland Qld Pest Animal Forum. Toowoomba, 24 May.

Jones, P 2013. National Cactus Workshop. Hahndorf, South Australia. 23-24 May.

Olusegun Osunkoya 2013. Soil seed bank dynamics in response to an extreme flood event in a riparian habitat of subtropical central Queensland, Australia. SE QLD Pest Advisory Forum Meeting. Ipswich, May.

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

Pukallus, K 2012. *Overview of Biological Control Programs within TWRC*. Dry Tropics Pest Advisory Forum. TWRC, Charters Towers. 20 September.

Vitelli, J. 2012. Mimosa pigra research update. Mimosa pigra stakeholders group. Proserpine, 29 March.

Vogler W. 2012. *Use of Fire to Control Weeds*, Dry Tropics Pest Advisory Forum. Charters Towers. 20 September.

Vogler W. 2013. *Tropical Weeds Research Update*, Gulf Pest Taskforce. Croydon. 14 November.

Vogler W. 2013. *Navua Sedge Herbicides*, Pest Fest. Mareeba, 22 May.

Lectures & seminars

Bebawi, FF. 2012. Weeds around Charters Towers. UQ Gatton students. TWRC, Charters Towers. 11 July 2012.

Bickel T O. 2012. *Ecology of the submersed aquatic weed Cabomba caroliniana in Australia*. Ecosciences Precinct Scientists. Brisbane. November.

Brooks, SJ 2012. *Class 1 weeds*. UQ Gatton students. TWRC, Charters Towers. 11 July.

Day, MD 2013. Biological control of weeds. Vudal University. Kerevat, PNG. 19 March.

Day, MD 2013. Biological control of *Mikania micrantha* in Papua New Guinea. National Taiwan University. 24 April.

Day, MD 2012. Successful biocontrol of *Chromolaena odorata* by the gall fly *Cecidochares connexa* in Papua New Guinea. Ecosciences Precinct. 10 October.

Dhileepan, K. 2012. Biological control of prickly acacia and bellyache bush. Biosecurity Queensland-CSIRO Biological Invasion Joint Seminar Series, Ecosciences Precinct, 11th July.

Jones, P 2013. Host range testing results of two *Dactylopius tomentosus* biotypes and their potential as biocontrol agents of *Cylindropuntia* spp. in Australia. National Opuntoid and Cactus Committee, Hahndorf, South Australia.

Jones P 2013. Host range testing results of two *Dactylopius tomentosus* biotypes and their potential as biocontrol agents of *Cylindropuntia* spp. in Australia. Biological Invasion Seminar Series, Ecosciences Precinct. 5 June.

Madigan, B 2012. *Weed control methods*. UQ Gatton students. TWRC, Charters Towers. 11 July.

Mitchell, J 2012. *Feral pigs*, University of Queensland Students, TWRC, Charters Towers 11 July.

Olusegun Osunkoya 2012. Soil seed bank dynamics in response to an extreme flood event in a riparian habitat of subtropical central Queensland, Australia. Biological Invasion Seminar series @ Ecosciences Precinct, Dutton Park, Brisbane, QLD. 6th March 2012

Palmer, WA 2012. Release of Plectonycha correntina, a leaf beetle for the biological control of Madeira vine. Biological Invasion Seminar Series. Ecosciences Precinct. 11 September.

Palmer, WA 2012. Australia's weed biocontrol - where to now? Annual meeting of the Entomological Society of America. Knoxville, Tn, USA. 13 November.

Palmer, WA 2012. *Regulatory processes for biological control for Australia and New Zealand*. Annual meeting of the Entomological Society of America. Knoxville, Tn, USA. 14 November.

Palmer, WA 2012. *Future of biological control of weeds in Australia*. USDA and Texas A&M Blacklands Research Centre. Temple, Texas. 19 November.

Palmer, WA 2013. *From Cactoblastis to the Ecosciences Precinct*. Indooroopilly Garden Club. Indooroopilly. 1 May.

Pukallus, K. 2012. *Process of Biological Control and review of TWRC projects*. UQ Gatton students. TWRC, Charters Towers. 11 July.

Pukallus, K. 2013. *New Parkinsonia biological control agent, Eueupithecia cisplatensis*. QPWS staff. TWRC, Charters Towers. 14 May.

Vitelli, J. 2012. Herbicide resistance and Class 1 weed research. QRail Vegetation Control Officers, QRail Brisbane 08 August.

Vitelli, J. 2012. Herbicide resistance and Class 1 weed research. Far North Queensland Pest Advisory Forum, Mossman 23 August.

Vitelli, J. 2012. Expanding the aquatic herbicide list. Far North Queensland Pest Advisory Forum, Mossman 23 August.

Vitelli, J. 2012. Aquatic herbicide research involving carfentrazone. Kerry Webb Development Manager, FMC Australasia, ESP 2 April.

Vitelli, J. 2012. Developing monitoring protocols for minor use permit PER13189 – assessing off-target damage during the aerial application of haloxyfop within Rinyirru (Lakefield) National Park (CYPAL) for the control of hymenachne. John Clarkson Department of National Parks Recreation Sport and Racing, ESP 8 April.

Vitelli, J. 2012. Aquatic herbicide research involving flumioxazin and bispyribac-sodium. Chris van der Hoven Marketing Manager, Sumitomo Chemical, ESP 29 May.

Vitelli, J. 2012. Pond apple management. DAFF and SunshineCoast Regional Council staff. Maroochy, 11 July.

Scientist in School program (SIS)

Pukallus, K. 2012. *Insect lifecycles*. Millchester State Primary School, Year 2. Charters Towers. 9 August.

Pukallus, K. 2012. *Plant lifecycles and fruiting bodies*. Millchester State Primary School, Year 2. Charters Towers. 30 August.

Pukallus, K. 2012. Mighty Milly Minds Science Competition. Millchester State Primary School. Term 4.

Pukallus, K. 2012. International Girls Day. Presentation at Millchester State Primary School, Year 6 & 7. 14 November.

Pukallus, K. 2013. Science – Dichotomous Keys, classroom teaching. Millchester State Primary School, Year 7. February.

Pukallus, K. 2013. DAFF Plant Science Competition advisor. Millchester State Primary School. Term 1 & 2.

Riding, N., Snow. E.L. and Day, M.D. 2012. The viability, pathenogenicity and and potential impact of the lantana rust *Prospodium tuberculatum*. Ecosciences Precinct. Dutton Park. 11th September.

Senaratne, KADW 2013. Quarantine for weed biocontrol research at Ecosciences Precinct. Sri Lanka. 18, 24 and 28 June.

Snow, E.L. 2013. Weed biological control in Queensland. Habitat Brisbane (Brisbane City Council). Brisbane. 3 June.

Vogler W. 2013. Grader Grass, QPWS Regional Managers Meeting. Undara National Park. 18th April.

Field days

Campbell, SD 2012. Prickly acacia research update, Prickly Acacia Field day, Redlands, McKinlay. 17 August.

Campbell, SD 2013. General bellyache bush information, Splatter Gun Field Day, Charters Towers. 16 March.

McKenzie, J 2012. Control methods for woody weeds, Woody Weed Field day, Muttaburra. 28 September.

McKenzie, J 2013. Use of splatter guns on bellyache bush, Splatter Gun Field Day, Charters Towers. 16 March.Vogler W. 2013. Prickly Acacia Field Day. Desert Channels Queensland. Sesbania Station, Winton. 3rd May.

Snow, E.L. 2012. National Science Week display for Madeira vine biological control. Ecosciences Lab. Dutton Park. 14th August.

Snow, E.L., Taylor. D.B.J. 2012. National Science Week display for biological control of weeds. CSIRO Ecosciences Lab. Dutton Park. 16th August.

Media (radio/TV)

Campbell, SD 2012. Calotrope research, ABC Radio. 19 November.

Gentle, M. 2013. GPS tracking of wild dogs. Media Release, 17 May.

Gentle, M. 2013. WIN News, Sunshine Coast, 3 July.

Gentle, M. 2013. Seven News, Sunshine Coast, 4 July.

Dhileepan, K. 2012. Radio Interview, ABC North-West Qld - Biological control of prickly acacia update. 23 August.