Natural Resources, Mines and Water

Managing Queensland's natural resources ... for today and tomorrow

Technical highlights

Weed and pest animal research

2004–05

Queensland **the Smart State**

Queensland Government
Natural Resources, Mines and Water

Research conducted by Pest Management Research
Natural Resource Sciences
Queensland Department of Natural Resources, Mines and Watet

at

Alan Fletcher Research Station
Sherwood, Brisbane, Queensland

Robert Wicks Pest Animal Research Centre
Inglewood and Toowoomba, Queensland

Tropical Weeds Research Centre
Charters Towers and South Johnstone, Queensland

Important note

This report contains incomplete information and does not constitute an official medium for the publication of results. Information herein should not be quoted without the permission of the authors concerned.

Herbicide trial results reported here are provided for information only and do not constitute a formal recommendation. Before using or advising on the use of herbicides, please read the product label for rates and methods of application or contact the Plant Health Services, Department of Primary Industries and Fisheries, Queensland.

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A message from the Executive Director, Natural Resource Sciences

Pest Management Research makes a significant contribution towards the improved management of pest plants and pest animals throughout Queensland, and is integral to the research portfolio of the Department of Natural Resources, Mines and Water (NRMW).

By developing improved pest management practices, this research effort benefits the environment and helps Queensland's landholders, local governments, weed and pest management groups, and primary producers.

Notable achievements this year include an increased knowledge of the ecology of bellyache bush and parkinsonia for integrated control strategies; the continued release of biocontrol agents for bellyache bush, lantana and prickly acacia; progress towards the identification of suitable biocontrol agents for cat's claw creeper; an improved understanding of feral pig dietary preferences in the Wet Tropics Region; and studies confirming that wild dog baiting programs have no impact on spotted tailed quoll populations

Successful collaboration with other research providers, such as the Cooperative Research Centre (CRC) for Australian Weed Management, the Bureau of Rural Sciences, the Rainforest CRC, CSIRO, the Grain Research and Development Corporation, the Plant Protection Research Institute (South Africa), The University of Queensland and James Cook University, continues to be an important aspect of our research. I would particularly like to extend the department's thanks to our on-ground collaborators—the landholders, local government staff and community groups—without whom much of our field work would be impossible.

The majority of the funding for the research program was provided directly by the Queensland Government and through local government precepts. However, in 2004–2005, Pest Management Research attracted over $1.02 million, or 16% of the total research program budget, in external funding. This is excellent recognition of the achievements of the program and demonstrates the community's respect for the research being undertaken. Examples of external assistance include funding from the Australian Centre for International Research to aid research towards the offshore biocontrol of two weeds of national significance (chromolaena and mikania), and from the Commonwealth Bureau of Rural Sciences for control of wild dogs and feral pigs.

Finally, I acknowledge the significant effort involved in the 2004–05 strategic review of current and future issues, directions and priorities for pest management research. This review resulted in 12 recommendations including the restructure of work programs into four areas (pest animal management; integrated weed management; landscape restoration; and research services). The recommendations will be progressively implemented in 2005–06.

I commend the staff for their professional and technical skills and their commitment to Pest Management Research, and congratulate them on achieving major advances towards the sustainable use of the state's natural resources.

Chris Robson

Executive Director
Natural Resource Sciences

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Acronyms and abbreviations

ACIAR	Australian Centre for International Agricultural Research
AFRS	Alan Fletcher Research Station, Brisbane
APVMA	Australian Pesticides and Veterinary Medicines Authority
AQIS	Australian Quarantine Inspection Service
AWM	Australian Weed Management
BRS	Bureau of Rural Sciences
CCC	cat's claw creeper
CRC	cooperative research centre
CSIRO	Commonwealth Scientific and Industrial Research Organisation
CWTA	Centre for Wet Tropics Agriculture
DBIRD	Northern Territory Department of Business Industry and Resource Development
DEH	Department of Environment and Heritage
DNA	deoxyribonucleic acid
DPI&F	Department of Primary Industries and Fisheries, Queensland
EPA	Environmental Protection Agency
GIS	geographic information system
GPS	global positioning system
LD	lethal dose
LPO	Land Protection Officer, Natural Resources and Mines
MLA	Meat and Livestock Australia
MRL	maximum residue limit
NHT	Natural Heritage Trust
NR&M*	Department of Natural Resources, Mines and Water
NRSc	Natural Resource Sciences, Indooroopilly, Natural Resources, Mines and Water
NSW	New South Wales
NT	Northern Territory
PAEC	pest animal ethics committee
PAPP	para-aminopropriophenone
PFT	plant functional type
PNG	Papua New Guinea
Ppb	parts per billion
PPRI	Plant Protection Research Institute, Pretoria, South Africa
QPWS	Queensland Parks and Wildlife Service
RHD	rabbit haemorrhagic disease
RWPARC	Robert Wicks Pest Animal Research Centre, Inglewood and Toowoomba
SAFS	South African Field Station, Pretoria
TTD	trap tranquiliser device
TWRC	Tropical Weeds Research Centre, Charters Towers
UQ	The University of Queensland
VIAS	Victorian Institute of Animal Sciences
WHA	World Heritage Area
WONS	weeds of national significance

Units of measurement

g	gram
ug	microgram (one millionth of a gram, 10^{-6})
ng	nanogram (one billionth of a gram, 10^{-9})
mm	millimetre
cm	centimetre
m	metre
km	kilometre
L	litre
mL	millilitre
ha	hectare
°C	degrees Celsius
©	copyright
®	registered
™	trademark
pH	a measure of the concentration of hydrogen ions

* Since the information in this document was compiled, the Department of Natural Resources and Mines (NR&M) has become the Department of Natural Resources, Mines and Water (NRMW).

Pesticide trade names, active ingredients, and manufacturers

Name	Active ingredient(s)	Concentration	Manufacturer
Access*	triclopyr and picloram	240 g/L and 120 g/L	Dow AgroSciences
AF Rubber Vine Spray	2,4-D n-butyl ester	800 g/L	Nufarm
Winter Grass Killer	endothal	175 g/L	Envirogreen Pty Ltd
Amicide® 500	2,4-D dimethyl amine salt	500 g/L	Nufarm
Arsenal® 250A	imazapyr	250 g/L	BASF
Atrazine 500 SC	atrazine	500 g/L	4 Farmers Pty Ltd
Balance® 750 WG	isoxaflutole	750 g/kg	Bayer CropScience
BIN-DIE®	bromoxynil and MCPA	200 g/L	Amgrow
Brominicide 200	bromoxynil n-octanoylester	200 g/L	Nufarm Australia
Brush-Off®	metsulfuron methyl	600 g/kg	Du Pont
Confidor 200SC®	imidacloprid	200 g/L	Bayer
Daconate®	monosodium arsonate	800 g/L MSMA	Crop Care Australasia
Farmozine 500	atrazine	500 g/L	Farmoz Pty Ltd
Flame®	imazapic	500g/L	BASF
FMC carfentrazone	carfentrazone -ethyl	240 g/L	FMC Australasia Pty Ltd
Garlon® 3A	triclopyr amine	440 g/L	Dow Agrosciences
Garlon*600	triclopyr	600 g/L	Dow Agrosciences
Glean®	chlorsulfuron	750 g/kg	Du Pont
Gramoxone 250	paraquat	250 g/L	Syngenta Crop Protection Pty Ltd
Graslan*	tebuthiuron	200 g/kg	Dow AgroSciences
Grazon* DS	triclopyr and picloram	300 g/L and 100 g/L	Dow AgroSciences
Londax®DF®	bensulfuron	600 g/kg	Dupont
Reglone®	diquat dibromide monohydrate	100 g/L	Syngenta Crop Protection Pty Ltd
Ronstar® Granules	oxadiazon	20 g/kg	Bayer
Roundup®	glyphosate	360 g/L	Monsanto
Roundup® Biactive ™	glyphosate	360g/L	Nufarm
Rubber vine spray	2,4-D	800 g/L	Agricrop
Sempra® Herbicide	halosulfuron-methyl	750g/kg	Nufarm
Spinnaker® 700 WGD	imazethapyr	700 g/kg	BASF
Starane* 200	fluroxypyr	200 g/L	Dow AgroSciences
Tordon* Granules	picloram	20 g/kg	Dow AgroSciences
Tordon* 75-D	2,4-D and picloram	300 g/L and 75 g/L	Dow AgroSciences
Total Ag Leafex Defoliant	sodium chlorate	300 g/L	Total Ag Services
Uptake*	paraffinic oil and alkoxylated alchohol non-ionic surfactants	582 g/l and 249g/L	Dow AgroSciences
Velpar® L	hexazinone	250 g/L	Du Pont

Verdict* 520	haloxyfop	520 g/L	Dow AgroSciences
Vigilant®	picloram	43 g/L	The Horticulture and Food Research Institute of New Zealand
Weedmaster® Duo	glyphosate	360 g/L	Nufarm
Winter Weed Killer®	endothal	175 g/L	Amgrow Garden King

Manager's report

Achievements

The summary of achievements illustrates the significant progress made by our research teams during the year. It reflects the professional and technical expertise, the dedication of our staff, and the excellent assistance provided by our operational and administrative support teams.

Among the notable successes this year were the development of a better understanding of dietary preferences of feral pigs in the Wet Tropics, the high levels of prickly acacia damage in northern coastal areas by the biocontrol agent, *Chiasmia assimilis,* and advances in understanding the biology and integrated management of rangeland weeds such as bellyache bush and parkinsonia. Several of the Weeds CRC funded projects have enabled us to improve our understanding of the ecology of many bird-dispersed environmental weeds and to develop better science-based methodologies for selection of biocontrol agents.

The value of our research was recognised when our researchers presented invited as well as submitted papers and chaired sessions at national and international conferences during the year. Sixteen scientific papers were published in national and international, refereed scientific journals, and more than 40 conference papers were published by Pest Management Science research staff during the year.

Funding

The Queensland Government provided $3.82 million in base funds and the Land Protection Fund provided $1.48 million. External funds totalling $1.02 million were received and are listed in the table on page 4.

Review processes

A strategic review of Pest Management Research was undertaken during the year by an internal committee comprising representatives from both Natural Resource Sciences and Land Protection and in consultation with Pest Management Research staff at each station. The review recommended the restructure of work programs into four areas, namely Pest Animal Management, Integrated Weed Management, Landscape Restoration and Research Services.

A successful review of Science Quality in Weed Research was also undertaken. The review was internally commissioned by NRSc, but conducted by an independent external panel that comprised Max Whitten (ex CSIRO Entomology), John Goolsby (USDA), Noel Ainsworth (DPI Vic), and Richard Carter (NSW Agriculture).

Research priorities for 2004–05 were based on the list of ongoing projects and previously identified priority weeds and feral animals.

Conferences

During the year, research staff attended several important conferences, workshops and seminars. These occasions were beneficial in two ways: they enabled staff to present the work of our scientists at national and international forums, and they provided them with unique opportunities to share ideas and keep abreast of the latest information in the wide range of disciplines represented. Some of the conferences at which our work was presented were: the 14th Australian Weeds Conference (Wagga Wagga), the 13th Australasian Vertebrate Pest Conference (New Zealand), the Ecological Society of Australia conference (Adelaide), the XI International Mammalogical Congress (Japan) and the 8th Queensland Weeds Symposium (Townsville). Staff from Tropical Weeds Research Centre (TWRC) were closely involved in the organisation of the very successful 8th Queensland Weeds Symposium. Shane Campbell was the Conference Committee Chair and Wayne Vogler participated as editor of the proceedings.

Staff

The year saw a number of staff resignations, including the retirement of long-term weed technical officer, Bob Galagher. Two Weeds CRC funded scientists, Dr Graeme Hastwell and Dr S. Raghu completed their post-doctoral fellowships.

Collaboration

Collaboration with other research groups is important in maximising the effective use of our resources and integrating our work with other natural resource management research.

Pest Management Research is a major partner in the CRC for Australian Weed Management. Dane Panetta of the Alan Fletcher Research Station (AFRS) continued as program leader of Program 1 (Weed Incursion and Risk Management), in Program 3 (Landscape Management) Michael Day was a project leader within the biological control research area and Gabrielle Vivian-Smith was project leader for bird-dispersed weeds. Other TWRC and AFRS staff were involved in several other Weeds CRC research projects. Pest Management Research is also an equity partner in the Rainforest CRC, with projects on the ecology and management of rainforest weeds and on feral pig control, where Jim Mitchell is project leader for Project 6.2—Impact of Invasive Species on Biodiversity.

We also collaborate directly with a wide range of agencies including: CABI BioScience Institute of Biological Control, UK; Plant Protection Research Institute, South Africa; CSIRO (two Divisions); Queensland, Griffith and James Cook universities, the University of Sydney (Orange Agricultural College); University of KwaZulu-Natal, herbicide manufacturers; Landcare and various NRM groups; and other Queensland, NSW and Northern Territory and Australian Commonwealth Government departments.

Much of our research requires field trials on the properties of private landholders. Their continued support is essential for our work and is much appreciated.

Extension

Communication of results is an essential part of our research. Research results are communicated to the scientific community through publications and conference presentations, listed at the end of this book. Land Protection Extension Officers continue to be associated with the AFRS, TWRC and Robert Wicks Pest Animal Research Centre (RWPARC), and research staff assist extension staff in the production of fact sheets, leaflets and other brochures and displays. Research staff also provide information for pest status assessments and other reports by Land Protection and other national and international agencies. Staff communicate directly with landholders and land managers through talks and displays at field days and workshops, and to Landcare and Bushcare groups, and producer organisations.

I am pleased to present this report to the groups and individuals who are our clients, and to our collaborators and colleagues. If you have any comments or require further information, please contact me, or one of the research group's professional leaders.

Gabrielle Vivian-Smith
Principal Scientist
Pest Management Research

Summary of achievements for 2004–2005

Weed research

- A prickly acacia biocontrol agent, *Chiasmia assimilis*, has established on infestations in the Bowen and Home Hill areas where it is causing partial to total defoliation. Field releases of the more recent agent, *Cometaster pyrula* commenced.
- The first stage of a study investigating the feasibility of registering haloxyfop for the control of grasses growing in aquatic situations is encouraging. The study indicates that haloxyfop breakdown in simulated aquatic environments is rapid in both the creek water and aquatic organisms tested.
- The *Mimosa pigra* seed bank at Peter Faust Dam, Proserpine has declined ten-fold over four years. The trend suggests that the soil seed bank at this site may be depleted within 10 to 15 years, a significantly shorter period than reported from the Northern Territory.
- The rate of expansion of bellyache bush has been quantified at two sites in northern Queensland. Even during a series of dry years, bellyache bush has the capacity to rapidly spread outwards from initial infestations. Biocontrol efforts for bellyache bush continued with several releases of the seed feeding bug, *Agonosoma trilineatum*. Bio-evaluation studies, involving the mapping of infestations, continued in order to quantify baseline plant and seed densities.
- Ecological studies have led to an improved understanding of the life cycles of two of Queensland's worst rangeland shrubs (parkinsonia and bellyache bush). This information is now being used in agronomic trials aimed at developing integrated control strategies.
- Cat's claw creeper biocontrol progressed with the host-specificity testing of the leaf-sucking tingid, *Carvalhotingis visenda*. A subsequent agent, a leaf-tying pyralid moth, *Hyposomia pyrochroma*, was also imported into high security and is now being tested. A risk-benefit modelling framework for host-testing biological control agents was developed using cat's claw creeper as a model system. It will assist in decision making with regard to biocontrol agents.
- An externally funded ACIAR project continued with the release and establishment of the chromalaena gallfly (*Cecidochares connexa*) in 11 provinces of Papua New Guinea.
- Releases of two lantana agents, a bug, *Falconia intermedia*, and the rust, *Prospodium tuberculatum*, continued. Establishment of *Falconia* was reported at three sites. The rust established at 15 Queensland sites. Two further agents were also imported into Quarantine: the beetle, *Alagoasa extrema*, and the leaf-mining fly, *Ophiomyia camarae*. *Alagoasa extrema* lacked host specificity and was not considered for release. Testing for the other species was initiated. Investigations continued regarding the non-target attack of the agent, *Aconophora compressa*, providing a better understanding of the agent's biology.
- The release of the two mother-of-millions agents, *Osophilia tenuipes* and *Alcidodes sedi*, which feed on several closely related ornamental species, is being investigated in accordance with the requirements of the *Biological Control Act 1987*.
- A successful application was made to the Australian Weeds Committee to have the weedy sporobolus grasses declared as a biological control target. A potential agent, the smut, *Ustilago sporoboli-indici*, was successfully isolated in South Africa.
- An investigation of the ecology of bird-dispersed weeds examined several novel management approaches using case studies, including the impact of reduced fruit attractiveness and landscape factors influencing weed dispersal rates. Fruit morphology studies indicated that the more invasive species tended to have smaller fruits.
- Seed bank ecology studies indicated that the environmental weeds, white moth vine (*Araujia sericifera*) and Mickey Mouse bush (*Ochna serrulata*) both have non-persistent seed banks.
- A recording protocol was developed for use by field staff undertaking eradication programs. The data generated through its use will be used to develop methods to measure eradication success.

Pest animal research

- The natural mortality in spotted tailed quoll populations is high and there appears to be no population-level impact of wild dog baiting programs on quoll populations.

- Wild dog studies in western Queensland have highlighted the need to examine the movement of dispersing dogs to understand the recolonisation of baited areas.
- Artificial neural networks are being used to investigate mouse abundance as an additional tool to conventional modelling approaches.
- The Central Queensland rat has proved elusive, highlighting the difficulty of working with irruptive species.
- A study of the dietary preferences of feral pigs in the Wet Tropics bioregion indicated that, while their diets depended to an extent on their habitats, they are best described as generalist omnivores with a preference for plant material. The information generated by the study will be used to refine baiting strategies and formulation.

External funding 2004–2005

Project	Funds $	Funding body
Biocontrol of bellyache bush	20 000	CRC AWM
Biocontrol of cat's claw creeper	25 000	Northern Rivers Catchment Management Authority, NSW
Biocontrol of chromolaena in PNG	97 400	ACIAR
Biocontrol—mikania project development and biocontrol training	15 000	ACIAR
Biocontrol of lantana	42 300 30 000 40 000	CRC AWM, NSW Lantana taskforce Natural Heritage Trust
Biocontrol of lantana (north Queensland)	22 000	NHT2
Biocontrol of weedy sporobolus grasses African survey	65 500	MLA
Aconophora—Mangrove survey	20 000	Qld DPI &F
Ecology of bird-dispersed weeds	86 500	CRC AWM
Ecology of wet tropics weeds	31 000	Rainforest CRC
Lantana—seed bank and ecology	20 000	NHT2
Mimosa pigra research	44 000	Mackay Whitsunday NRM Group
Rational selection of biocontrol agents	78 500	CRC AWM
Weed functional groups	38,500	CRC AWM
Parkinsonia, GRT and Riparian weed research	5 500	CRC AWM
Weed Risk Assessment	5 000	CRC AWM
Water weeds management	38 600 3 500	NHT2 Noosa Shire
Weed incursion management strategies	66 700	CRC AWM
Investigation of PAPP toxin for wild dog control	18 000	Pest Animal Control CRC
Target-specific systems for feral pig toxins	6 000	Bureau of Rural Sciences
Effective baiting of feral pigs	1 000	Bureau of Rural Sciences
Best practice wild dog baiting	88 000	Bureau of Rural Sciences
Diet and trapping strategies of feral pigs in tropical rainforests	9 000	Rainforest CRC
Mouse and rat management	96 000	Grains Research and Development Corporation
Impact of 1080 of native quolls	12 000	Bureau of Rural Sciences
1080 bait degradation model development	1 000	Bureau of Rural Sciences

Chapter 1 Weed research biocontrol

Biocontrol of bellyache bush (*Jatropha gossypiifolia*)

Objective

To achieve biocontrol of bellyache bush by introducing, testing and releasing exotic insect species or pathogens

Staff

Catherine Lockett (Leader), James Mitchell (TWRC)

Methods

In 1997, CSIRO Entomology began to survey insects and pathogens of *Jatropha gossypiifolia* and its close relative *J. curcas* in tropical America and the Caribbean. As a result of this work, host specificity testing on one insect, the seed feeding scutellerid, *Agonosoma trilineatum*, was completed in 2002 and permission to release was received at the end of the year. A starter colony of insects was forwarded to the TWRC in March 2003 with additional consignments of insects arriving in April.

A strategy incorporating a trial of three different total release sizes (small, medium and large) was adopted for *Agonosoma* releases and began in 2003, continuing through to 2005. Sites selected for insect releases were within half a day's drive of the TWRC. Insect release sizes were to be based roughly on the minimum monthly colony production, with two sites Barkla and Almora, to receive a single release of 250 to 300 adults, two sites, Cardigan and Strathalbyn, to receive two to three consecutive or near consecutive releases of 250 to 300 adults to give a total of 750 to 1000 adults, and two sites, Mt Ravenswood and Southern View, to receive multiple consecutive or near consecutive releases of 250 to 300 adults to give a total of over 2000 adults.

Between May 2003 and July 2004, 19 releases were made at the 6 sites. A single release was made at a seventh site, Kings Creek. The target of 2000+ adults to be released at Southern View was not achieved due to limitations in the number of insects reared and a lack of seed at the site following dry conditions.

All sites were checked in 2004. There were no signs of insect establishment at six of the seven release sites. Small numbers of insects were found at Mt Ravenswood in January 2004, but not later in the season. Over 2600 adults were released at Mt Ravenswood over a seven-month period and the results indicated that a continuation of multiple releases might be needed to promote establishment.

Progress

Insects are currently being reared in plastic boxes in the laboratory and in gauze covered cages in the glasshouse. Cut foliage with seed capsules is collected once or twice weekly from field sites or from plants grown at the TWRC.

No insects were released between late July and early December 2004. Seed was scarce in the field and the *Agonosoma* colony remained relatively small during the period. The first release for the 2004–2005 summer was made at Kings Creek in December 2004. Subsequent releases were focused at Mt Ravenswood, with nine releases totalling 1660 adults, being made between January and the end of June 2005.

Field cages consisting of a gauze cover over a metal frame were used on three occasions at Mt Ravenswood. On each occasion 60 adults were added to the cage and the cage was removed after approximately two weeks. The cages were useful in ascertaining the placement of egg batches, which was nearer to the base of the plants than was anticipated; however, relatively few batches were laid. Survival of adults within the cages was variable.

Signs of field establishment were observed in February 2005 when approximately 20 nymphs were found on plants near the site of the free releases and first cage set-up. Evidence of feeding damage on seed capsules was also observed. However, subsequent inspections made in April, May and June found no further signs of the insects.

The rearing and release program continues.

Expected completion

Ongoing

Funding

Queensland Government

CRC Australian Weed Management

Logistic support

Northern Territory Department of Business, Industry and Resource Development CSIRO

Agonosoma trilineatum beetle

Bellyache bush

Biocontrol of cat's claw creeper (*Macfadyena unguis cati*)

Objective

To achieve biocontrol of cat's claw creeper using introduced insect species

Staff

K. Dhileepan (Leader), S. Raghu (till May 2005), Mariano Treviño, Elizabeth Snow and Wilmot Senaratne (AFRS)

Collaborators

Hester Williams and Stefan Neser (PPRI), Joe Scanlan (RWPARC), and Andrew Lowe (The University of Queensland)

Methods

Insect source

The cat's claw leaf-sucking tingid (*Carvalhotingis visenda)* (Drake & Hambleton) and the leaf-tying pyralid moth (*Hypocosmia pyrochroma*) (Jones) were sourced from laboratory colonies maintained at the Plant Protection Research Institute, Pretoria. The colonies were established from material collected by Dr Stefan Neser in Argentina and Brazil in April 2002.

Test plants

The test plant list has been developed following the centrifugal phylogenetic method. In the list, the Bignoniaceae are represented by one species of each native Australian genus as well as by introduced species. The families Acanthaceae, Gesneriaceae, Avicenniaceae, Myoporaceae, Oleaceae, Pedeliaceae, Scrophulariaceae, Verbenaceae, Rubiaceae and Solanaceae are also represented in the list.

Adult no-choice tests

Ten newly emerged adults will be transferred to each potted test plant, and survival and oviposition, if any, will be recorded at regular intervals. The test will be continued until all adults on all test plants die. Nymphal development, if any, will be monitored. In each batch, cat's claw will be included as a control and the test repeated five times. Adults excluded from test plants will also be included as a negative control.

Nymphal no-choice tests

Ten newly emerged nymphs will be transferred to potted test plants of the test species, including cat's claw as control. The test plants will be sampled at frequent intervals and the proportion of nymphs surviving and developing into adults will be recorded. The test will be repeated five times.

Adult multiple-choice tests

Twenty pairs of tingid adults will be released into a cage with various test plant species and the trial repeated five times. All test plants will be sampled at least three times during each week and the number of adults on each test plant will be recorded. After two weeks, any feeding and oviposition marks, and the number of adults on the test plant species will be recorded.

Biological studies

One pair of newly emerged tingids will be introduced to a single cat's claw plant. The tingids will be transferred to a new cat's claw plant each week after recording the number of egg batches laid over the week. The cat's claw plant with egg batches will be maintained in an insect-proof cage and the number of adults emerged from each plant (each week) will be recorded along with the sex ratio. The experiment will be repeated five times and the data collected will be used to construct a life-table. Growth (plant height and the number of leaves) of plants exposed to tingid and control plants will be compared to study the effects of tingid herbivory on cat's claw creeper.

No-choice demography studies

If the tingids feed, oviposit and complete nymphal development on any of the test plants in the no-choice tests, the emerging adults will be maintained on the same test plant species for the second generation. This study will continue for several generations to ascertain whether the non-target host can sustain the tingid population on its own. During the study the following parameters will be recorded at weekly or fortnightly intervals: number of adults, number of nymphs, number of egg batches, sex ratio, proportion of leaf area damaged, plant height, and the number of new leaves produced per plant. Simultaneously, no-choice demography trials will be initiated similar to the above study, but by using adults emerged from cat's claw. The trial will be repeated five times.

Choice demography studies

If the tingids feed, oviposit and complete nymphal development on any of the test plants in the no-choice tests, a choice demography study will be undertaken. In this study newly emerged tingids (20 pairs) will be released in an insect-proof cage with the target weed and the non-target plant(s) arranged randomly. This study will be repeated simultaneously in five cages and the number of adults, nymphs and egg batches in each test plant in the cage will be recorded at weekly or fortnightly intervals. The study will be continued for several months to ascertain spillover risk.

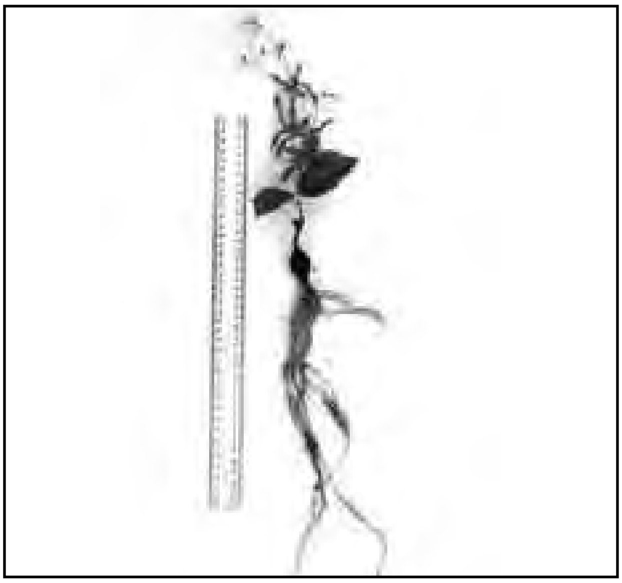
Non-target risk

The risk posed to non-target species will be evaluated from the data of the choice and no-choice tests and demography studies using a systems modelling approach incorporating climate suitability and field distribution records of target and non-target plants.

Progress

Leaf-sucking tingid (*Carvalhotingis visenda*)

The leaf-sucking tingid in quarantine was transferred from high security to medium security in December 2004. The rearing method for the tingid was standardised and the host specificity tests are in progress. The tingid did not oviposit on any of the 25 test plant species tested so far, and no nymphal development occurred on any of the 16 test plant species tested to date. The testing of other test plants is in progress. An application for approval of a host specificity test list for the leaf-sucking tingid was submitted to AQIS in January 2005.



Cat's claw creeper seedling showing tuberous root

Experimentalist M. Trevino working on biological control insects in high security area of quarantine

Leaf-tying pyralid moth (*Hyposomia pyrochroma*)

Permit to import a leaf-tying pyralid moth (*Hyposomia pyrochroma*) was obtained from AQIS and EA. The leaf-tying moth was imported into the high security quarantine in February 2005. After one generation, the moth was transferred into medium security quarantine in April 2005. The rearing method has been standardised and the no-choice larval feeding tests are in progress. The leaf-tying moth underwent winter diapause as pupae in the soil. Experiments were initiated in the temperature and photoperiod-controlled cabinets within the quarantine to understand the mechanism for the diapause initiation and methods to break the diapause. So far, more than 10 test plant species have been screened, and no larval feeding and development occurred on any of these test plants. Screening of other tests plants is in progress.

Expected completion

2006

Funding

Land Protection Fund

CRC Australian Weed Management

Northern Rivers Catchment Management Authority, NSW

Gold Coast City Council

Biocontrol of chromolaena (*Chromolaena odorata*) in Papua New Guinea

Objectives

Through the introduction and establishment of biocontrol agents for chromolaena in Papua New Guinea, this project aims to:

- reduce the impact of chromolaena to small block holders and plantation owners in areas where the weed is a problem
- reduce the seed load and thus the possibility of spread into northern Australia

- establish successful biocontrol methods that can be used in northern Australia if required
- promote biocontrol as a safe and successful weed control method
- train scientists in Papua New Guinea in biocontrol methods.

Staff

Michael Day (Leader) (AFRS)

Methods

Suitable agents are selected based on results of host specificity testing and field observations in other countries. Information on the agents' life history and host ranges are sent to the collaborators in Papua New Guinea, and import permits are requested. A nucleus colony of each agent is sent from the South African field station, to PNG, where a quarantine colony is established. The insects are reared through one generation before being transferred to rearing facilities.

Mass-rearing and field releases of the agents will take place throughout PNG where chromolaena is a problem. Releases of agents will be conducted with the aid of Provincial staff as part of their training in biocontrol activities. Programs will be set up for field monitoring plant density and spread, insect populations, and their impact on the plant.

Progress

This ACIAR-funded project has been extended from March 2005 until September 2006.

The gallfly, *Cecidochares connexa*, has been released in all of the 12 provinces in which chromolaena occurs and has established in 11 of these; the agent was only recently released in Bougainville. The insect is no longer being reared at Labu Research Station. However, galls are being collected from the field and distributed to chromolaena infestations where the agent is not already present. In Sandaun Province, the fly has spread up to 100 km from some release sites and is causing substantial damage to chromolaena. Near Vanimo, the fly has controlled chromolaena and food gardens have now been re-established. Successful control of the weed has also been observed around Namatanai in New Ireland, where food gardens and pastures have re-established. The fly is also widespread and causing significant damage in Morobe, Oro and East New Britain provinces.

The moth, *Pareuchaetes pseudoinsulata*, has been released in eight provinces but has established only in Morobe. The insect has established at 11 sites and is spreading up to 10 km away to a further nine sites. *P. pseudoinsulata* is causing significant damage on a seasonal basis, with plants becoming totally defoliated at some sites in the Markham Valley. Landowners are distributing the moth to new areas. The moth is no longer being reared at Labu because its establishment is labour intensive and difficult.

The leaf-mining fly, *Calycomyza eupatorivora*, has been imported several times. A colony was established at Labu Research Station but died out following minor flooding of the nursery area. New shipments are being planned for the coming months.

An application to import another agent—the weevil, *Lixus aemulus*—has been submitted to the Department of Environment and Conservation and is being considered.

Expected completion

September 2006

Funding

ACIAR

Releasing *C. connexa* in New Ireland, PNG (Photograph taken by M. Day)

***C. connexa* adult (Photograph provided by Desmier de Chenon)**

Biocontrol of lantana (*Lantana camara*)

Objectives

To import, evaluate host specificity, mass rear, field release and monitor biocontrol agents for lantana (*Lantana camara*)

Staff

Michael Day (Leader), Natasha Riding, Annerose Chamberlain, Tanya Grimshaw, Liz Snow, Peter Jones and Rose Broe (AFRS)

Methods

Entomologists in Mexico and South Africa are contracted to locate and study the biology of potential agents prior to their introduction into quarantine in Australia.

Agents are imported and their host specificity is examined. Agents approved for field-release are then mass reared and released in the field with the help of land protection officers (LPOs) and local council weed officers.

Plant Protection Research Institute (PPRI), South Africa has been contracted to study the biology, biotype preference and host specificity of several potential agents prior to their importation into Australia.

Progress

Aconophora compressa has established at a number of sites around Queensland. The insect is widespread throughout south-east Queensland from Nambour in the north, to Mt Glorious in the west, and Coolangatta in the south. *A. compressa* has also spread into northern NSW and is found south to Woodburn. In north Queensland, the insect is common around Atherton and populations are spreading around Mt Fox, north-west of Ingham.

L. camara leaf showing _O. camarae_ mine (Photograph provided by PPRI)

A. compressa has been released and has established in NSW, with assistance and funding from the New South Wales Lantana Taskforce. It is widespread on the central coast and has spread to the northern beaches of Sydney.

A. compressa is also attacking and damaging fiddlewood (*Citharexylum spinosum*) and, to a lesser extent, several varieties of *Duranta erecta*. When populations are high, some spill-over onto other species can occur causing superficial damage, but this is not sustained.

The mirid, *Falconia intermedia*, has established at three sites, all in north Queensland, despite an intensive rearing and release program throughout Queensland. The insect is increasing at two of these sites.

The lantana rust (*Prospodium tuberculatum*) is being produced and has been released throughout all favourable areas in Queensland and New South Wales. The agent appears to have established at 15 sites in Queensland. However, drought conditions throughout much of the state have hampered establishment. In New South Wales, where conditions have been a little more favourable, the rust has established at 40 sites. In all areas where the rust is present, infection levels are only low and confined to the release site.

The lantana trimorphic beetle (*Alagoasa extrema*) was imported into quarantine from Plant Protection Research Institute (PPRI), South Africa in October 2002. All biology and host specificity studies have been completed. Larvae completed development on 10 species: *Lantana camara*, *Avicennia marina* var. *australasica*, *Aloysia citriodora*, *Citharexylum spinosum*, *Lippia alba*, *Pandorea pandorana*, *Phyla nodiflora*, *Stachytarpheta cayennensis*, *Stachytarpheta mutabilis* and *Verbena gaudichaudii*, but per cent development on the non-target species was lower than on lantana. Subsequent generations could be supported on lantana and *A. citriodora*. The agent was not considered for release and the colony was destroyed.

The lantana herring-bone leaf-mining fly (*Ophiomyia camarae*) was imported into quarantine from PPRI in October 2004. A colony was successfully established and host testing on 11 species has commenced. No mines have been seen on any species other than lantana and *Lippia alba*. Testing is expected to be completed by December 2005.

The biology, biotype preference and host specificity of the budmite, *Aceria lantanae*, was studied under contract at PPRI. Host specificity testing has been completed and the agent appears host specific. A report on this work has been submitted by PPRI and an application to Australian Quarantine Inspection Service requesting the field release of the agent is being prepared.

Lantana specimens from many different sites in eastern Australia have been identified by Dr Roger Sanders, a lantana taxonomist, as either *L. urticifolia* or *L. urticifolia* X *L. camara* hybrids. This supports previous preliminary DNA studies that have suggested that lantana in Australia has a close affinity to *L. urticifolia*. A collaborative project with CSIRO Plant Industry to undertake genetic analysis of lantana from different regions is currently underway.

Expected completion

Ongoing

Funding

Land Protection Fund

NSW Lantana Taskforce

CRC Australian Weeds Management

Natural Heritage Trust

Experimentalist T. Grimshaw surveying *L.camara* for biocontrol agents

Biocontrol of Madeira vine (*Anredera cordifolia*) with insects

Objective

To achieve biocontrol of Madeira vine using introduced insect species

Staff

K. Dhileepan (AFRS)

Collaborators

Stefan Neser and Liame van der Westhuizen (PPRI)

Methods

Exploratory surveys were conducted by Stefan Neser and his team in southern Brazil and northern Argentina to identify potential biocontrol agents for Madeira vine. Suitable agents were imported into quarantine in South Africa for host specificity testing.

Progress

- Specimens of *Phenrica sp*. currently undergoing host-specificity tests in PPRI have been submitted to Nora Cabrera (Buenos Aires) and Catherine Duckett (USA). No identification has been received so far.
- Only *Anredera cordifolia* (Basellaceae), *Basella alba* var. *rubra* (Basellaceae) and *Talinum paniculatum* (Portulacaceae) were accepted by both adults and larvae, indicating a fairly narrow host range. This warrants further impact and risk analysis studies.
- Feeding by *Phenrica* sp. adults does not seem to have a marked impact on the test plants
- The second chrysomelid, *Plectonycha correntina* is being successfully cultured at PPRI, but both time and financial constraints are limiting further trials.

Expected completion

2006

Funding

Queensland Government

Madiera vine flower and leaf

Biocontrol of prickly acacia (*Acacia nilotica* ssp. *indica*)

Objective

To conduct explorations in India for potential biocontrol agents for prickly acacia

Staff

K. Dhileepan (AFRS)

Collaborators

Syed Ahmed (Arid Forest Research Institute, Jodhpur, India)

A. Balu (Institute of Forest Genetics and Tree Breeding, Coimbatore, India)

Shilesh Jadhav (Pandit Ravishankar University, Raipur, India)

B.S. Bhumannavar (Project Directorate of Biological Control, Bangalore, India)

Methods

- Local contacts have been established, potential collaborators identified and the project contract has been signed by both Indian and Australian governments.
- The project has been initiated in two regions in India with suitable climatic conditions (hot and dry arid regions) and sampling protocol has been drafted.
- Research staff have been appointed in collaborating agencies (i.e. Arid Forest Research, Jodhpur and Institute of Plant Genetics and Tree Breeding, Coimbatore) in India.
- Potential areas in India have been identified, using climate and plant genotype matching, and surveyed at regular intervals.
- Insects and plant pathogens occurring on prickly acacia have been catalogued and agents showing 'ecological' specificity to prickly acacia in the field will be tested further in the glasshouse for their 'physiological' host range.
- Exclusion trials using insecticides will be conducted in two places to quantify the impact of naive herbivores on the survival and growth of prickly acacia seedlings under field conditions.
- Potential agents have been imported to Australia for further host specificity tests.

Progress

A CLIMEX model has been developed to identify potential areas for exploration in India. The model identified north-west India (i.e. Rajasthan) as the most suitable area in India.

Funding proposals have been submitted to Meat and Livestock Australia (MLA) and Defeating the Weed Menace Program (DEH and DAFF).

An honours project titled 'Response of invasive prickly acacia (*Acacia nilotica* ssp. *indica*) to simulated herbivory: Implications for its biological control' has been submitted to The University of Queensland.

Expected completion

2006

Funding

Land Protection Fund

Biocontrol of mother-of-millions (*Bryophyllum* spp.)

Objective

To achieve biocontrol of the poisonous weed, mother-of-millions, by introducing and releasing exotic insect species or pathogens

Staff

Bill Palmer (Leader), Wilmot Senaratne (AFRS)

Methods

The amenability of the weed to a solution by biological control and the extent to which the weed problem affects Queensland stakeholders have been assessed. Faunistic surveys of *Bryophyllum delagoense,* and closely related species, will be undertaken in areas where the plant occurs naturally in Madagascar and southern Africa. These will identify potential biocontrol agents. The biology and host range of these identified agents will then be studied in both the South African field station and in the quarantine facility of the AFRS. Agents considered to be safe will then be mass reared and released throughout the range of the weed in Queensland. Releases will be monitored to determine establishment and any appreciable effect of the agent on the plant.

Progress

Surveys for potential biocontrol agents were undertaken in Madagascar and in southern Africa between 2000 and 2003. Of the insect species collected, four were selected as potential biocontrol agents: *Osphilia tenuipes* and *Alcidodes sedi* (Coleoptera: Curculionidae), *Eurytoma* sp. (Hymenoptera: Eurytomidae) and *Rhembastus* sp. (Coleoptera: Chrysomelidae).

The weevil, *Osphilia tenuipes,* was imported into the quarantine facility at AFRS in 2000 and host testing, using an approved host testing list, was conducted over the ensuing 18 months. The results indicated that the host range of *O. tenuipes* included all the *Bryophyllum* spp., some species in the very closely related genus, *Kalanchoe,* and *Echeveria* sp. Other exotic genera of the Crassulaceae, such as *Sedum,* might also be attacked occasionally. None of the native Crassulaceae, all *Crassula* spp., were attacked nor were any plants outside the Crassulaceae.

Alcidodes sedi was shipped to Australia in January 2003 and a laboratory culture established within the quarantine facility. Host specificity testing of an approved host test list and biology studies were completed. In no-choice tests it appears that *A. sedi* has a host range very similar to that of *O. tenuipes.* The insect can use most *Bryophyllum* spp. as hosts and also *Kalanchoe blossfeldiana* and *Echeveria* sp..

In South Africa, cultures of the remaining two possible agents, *Rhembastus* sp. and *Eurytoma* sp. did not generate sufficient material for any shipments to Australia. It is unlikely that these insects can be progressed without further trips to Madagascar. It is known from preliminary studies in South Africa that both insects will also attack *Kalanchoe blossfeldiana.*

Because *Osphilia tenuipes* and *Alcidodes sedi* can utilise *K. blossfeldiana* and *Echeveria* spp. as hosts, it would be necessary to release these, and most probably the other two insects, as declared agent organisms under the *Biological Control Act 1987*. Additionally, all *Bryophyllum* spp. would need to be declared target organisms under the Act. Approval under this Act requires the unanimous support of all appropriate federal and state departments and ministers. Processes for proceeding under this Act with the support of state and federal governments are being investigated.

Instances where thrips had caused considerable damage to mother-of-millions in the Milmerran district were reported. On investigation, the damage was found to be old and there were insufficient thrips present to provide samples for identification.

Damage caused by *O. tenuipes*

Expected completion

2004

Funding

Rural Lands Protection Trust Fund

NSW Department of Land and Water Conservation

Various shire councils

Biocontrol of weedy sporobolus grasses

Objectives

- To achieve biological control of the five weedy sporobolus grasses (*Sporobolus pyramidalis*, *S. natalensis*, *S. fertilis*, *S. africanus* and *S. jacquemontii*) infesting areas of Australia
- To determine the biology and host specificity of two organisms, the leaf smut *Ustilago sporoboli-indici* and the stem wasp *Tetramesa sp*., which have been identified as potential biological control agents
- To propose the release of *U. sporoboli-indici* and *Tetramesa sp*. in Australia should they prove to be host specific

Staff

Bill Palmer (Leader) and Wilmot Senaratne (AFRS)

Collaborators

Roger Day (QDPI&F), Bryan Simon (EPA), Mark Laing, Mike Morris and Kwasi Yobo (University of KwaZulu-Natal)

Methods

Application was made to have the weedy sporobolus grasses approved as targets for biological control by the Natural Resource Management Standing Committee.

A contract was negotiated with Professor Mark Laing of the University of KwaZulu-Natal to undertake biology and host specificity studies of the leaf smut *Ustilago sporoboli-indici*, which had previously been found to be infecting three species of the weedy sporobolus grasses in South Africa.

The studies on the smut will be divided into two phases. In the first phase the smut will be cultured and methods for infecting plants investigated. The smut will then be tested against Australian populations of all the weedy sporobolus grasses to determine whether they are susceptible, and against a small number of Australian native *Sporobolus spp*. The results of these studies will determine whether full host testing leading to release in Australia should proceed. All studies will be conducted overseas in South Africa.

The studies on the stem wasp will also be divided into two phases. In the first phase, which will be undertaken in South Africa, it will be necessary to determine whether the insect can be reared in the laboratory. If the insect can be successfully reared and shipped, it will be imported into quarantine facilities at the Alan Fletcher Research Station. Full host testing of the insect will then be undertaken in the second phase.

Progress

The application to have the weedy sporobolus grasses approved as targets for biological control was supported by the Australian Weeds Committee.

Approvals were obtained and seeds of the five weedy sporobolus grasses were shipped to South Africa so that the susceptibility of the Australian populations could be confirmed. On arrival the seeds were successfully germinated.

Study of the leaf smut *U. sporoboli-indici* commenced in January 2005 at the University of KwaZulu-Natal. Samples of the smut were collected from the field and isolated on artificial media in the laboratory.

Storage methods for the smut were evaluated. Agar blocks carrying smut mycelia were stored under double-sterilised distilled water. The viability of basidiospores stored on silica gel was also evaluated.

Studies on the stem wasp were not initiated, but discussions with a number of researchers in South Africa who could undertake the studies were held.

Expected completion

2008

Funding

Rural Lands Protection Trust Fund

Meat and Livestock Australia

Bioevaluation of bellyache bush (*Jatropha gossypiifolia*)

Objectives

- To obtain baseline plant population, seed production, soil seed bank and rate of spread data for bellyache bush prior to release of biocontrol agents
- To monitor the impact of biocontrol agents on the plant parameters listed in objective one

Staff

Wayne Vogler (Leader), Anita Keir, Amanda McCall (TWRC)

Background

Bellyache bush, a native of South America, probably escaped from horticultural cultivation over 20 years ago. In recent drought years it appears to have vigorously expanded its range across north and central Queensland. It is a major weed of the Burdekin River catchment and is starting to spread into the Fitzroy catchment. It is also distributed across the northern half of the Northern Territory and along the Great Northern Highway in tropical Western Australia. In Queensland, it is declared as a Class 2 weed. The jewel bug *Agonosoma trilineatum* is currently being released as a potential biocontrol agent. There is a need to evaluate the impacts of biocontrol agents so that the benefits can be promoted and biocontrol can be integrated into control strategies for bellyache bush.

The potential outcomes of the project are:

- quantification of the impact of bio-control agents on aspects of the reproduction and spread of bellyache bush
- information about the reproduction ecology of bellyache bush.

Methods

Two study sites were selected in Dalrymple shire in 2001. Replicated within 10 x 10 permanent exclosures, with six at each site the following information is being collected:

- Plant populations are assessed within five 1x1 m permanent quadrats within each exclosure.
- Seed production is estimated by placing ten 22 cm diameter seed traps in each exclosure.
- Soil seed banks are estimated annually by collecting litter and soil to 5 cm deep from twelve 324 cm^2 areas in each exclosure.

The rate of spread is estimated along five transects extending outwards from several clumps. Each site is then mapped annually using a Trimble GPS unit with accuracy to within 20 cm. Damage on the leaves, fruits and stems will be assessed at regular intervals and serial photography will occur over the life of the project.

Progress

The two sites where dense bellyache bush is present have been established. These are Southern View at Charters Towers and Mt Ravenswood at Ravenswood. Both sites have been mapped using the Trimble GPS. The study areas are 8.14 ha and 9.2 ha at Southern View and Mt Ravenswood respectively. Actual areas of bellyache bush are shown in Table 1.1 Significant increases in the total area infested with bellyache bush and the area of dense bellyache bush have occurred despite well below average rainfall over the last four years. The exception is at Southern View during the last year where the area of bellyache bush declined due to a single flood event, which killed plants in low lying areas.

- Damage to leaves, fruit and stems has been minimal, and indicates that there are few if any biological enemies of bellyache bush present in the north Queensland environment.
- Baseline plant densities have been measured at Southern View and Mt Ravenswood. Plant density has declined significantly during the first two years of the project mainly due to the effects of a natural soil-borne fungus. The effects of this fungus have been less significant during the last two years with some increase in plant density occurring due to the establishment of new plants (Table 1.2). A small decline occurred at Mt Ravenswood during the past year, mainly due to the death of young plants as a result of low rainfall.
- Viable soil seed banks under these dense infestations are shown in Table 1.3. The decline for the first two years can be attributed to relatively low seed production and seed decay. There has been a small increase in the soil seed bank from September 2003 to August 2004 due to a corresponding increase in seed production, particularly at Mt Ravenswood (Tables 1.3 and 1.4).

Table 1.1*   Area of bellyache bush infestation and dense bellyache bush within the infestation

Site	Area of bellyache bush (ha)				Area of dense bellyache bush (ha)			
	Nov 2001	**May 2003**	**May 2004**	**May 2005**	**Nov 2001**	**May 2003**	**May 2004**	**May 2005**
Southern View	1.98	2.54 (+28)	2.96 (+17)	2.57 (-13)	0.97	0.014 (-99)	0.044 (+214)	0.06 (+36)
Mt. Ravenswood	2.01	2.79 (+38)	3.54 (+27)	3.88 (+9)	0.834	0.793 (-5)	1.3 (+64)	1.72 (+32)

*Percentage change in area from previous year in brackets

- Seed production under these dense infestations is shown in Table 1.4. Seed production was considerably less during the 2002–2003 wet season due to below average rainfall and reductions in plant number and vigour caused by the soil borne fungus. Seed production remained low at Southern View during the 2003–2004 wet season due to continually low rainfall and low plant numbers. However, at Mt Ravenswood, seed production increased due to near average rainfall during the 2003–2004 wet season.
- Monitoring of the impact of the jewel bug (*Agonosoma*) has been delayed (due to it not establishing) in the field. This will begin when it is evident that field establishment has occurred.
- The soil-borne fungus has been identified as *Scytalidium dimidiatum*. Pathogenicity tests conducted by Allan Tomley did not result in infection of healthy plants. This fungus infects a range of economically important plant species such as mangoes and intentional spread is not recommended. The fungus is still present at both sites but its impact seems to have declined, possibly due to a run of low-rainfall years.
- The project is being wound back to monitoring the rate of spread only over the next two years due to *A. trilineatum* not establishing in the field.

Expected completion

Ongoing

Funding

Queensland Government

Table 1.2 Bellyache bush plant density

Site	Plants (No/m²) (No/ha)			
	September 2001	May 2003	May 2004	June 2005
Southern View	4.7 (47 000)	0.53 (5 300)	1.3 (13 000)	2.7 (27 000)
Mt. Ravenswood	20.3 (203 000)	4.83 (48 300)	9.0 (90 000)	8.2 (82 000)

Table 1.3* Viable soil seed bank (seeds/ha) of bellyache bush

Site	Seeds (million /ha)			
	September 2001	August 2002	September 2003	August 2004
Southern View	2.37	0.98 (-41)	0.027 (-97)	0.028 (+4)
Mt. Ravenswood	2.74	0.69 (-75)	0.12 (-83)	0.147 (+22)

*Percentage change from previous year in brackets.

Table 1.4 Seed production (seeds/ha) under dense infestations of bellyache bush

Site	Seeds/ha			
	June 01–May 02	June 02–May 03	June 03–May 04	June 04–May 05
Southern View	869 765	33 637	38 443	134 549
Mt. Ravenswood	2 181 621	860 155	3 433 891	2 671 765

Bioevaluation of rubber vine (*Cryptostegia grandiflora*)

Objectives

- To assess the impact of the established biocontrol agents, rust *Maravalia crypto*stegiae and moth *Euclasta gigantalis*, on establishment, growth and survival of rubber vine plants and associated plant communities under a range of conditions of climate, land type and management
- To establish and document a system of monitoring, which can be applied consistently over a lengthy period of time

Staff

Wayne Vogler (Leader), Catherine Setter, Anita Keir (TWRC)

Background

At two locations near Charters Towers (Ten Mile Creek and Anabranch), a permanent 50 m long, 4 m wide transect was established (1991) prior to the release of rubber vine biocontrol agents. Each transect is oriented along an environmental gradient provided by a slope running away from a creek and samples a range of rubber vine densities. The locations of all woody plants on transects were recorded and the diameters of stems at 20 cm above the ground were measured. Canopy cover, foliage cover and height of rubber vine plants were recorded. These transects provide base data prior to agent release against which impacts of the biocontrol agents can be assessed.

Methods

Monitoring of vegetation at several sites commenced in spring 1997 post biocontrol agent release. The sites are spread over the geographical range of rubber vine and represent a range of landforms, soil types and management regimes. At Ten Mile Creek and Anabranch, additional transects of the same design as those established in 1991 were set up. At Ten Mile Creek one is a replicate of the original transect, while the other two have been placed on a site carrying somewhat different vegetation. At Anabranch the one additional transect is a replicate of the 1991 transect.

The Ten Mile Creek site has five 8 x 8 m fenced exclusion zones established to exclude stock. Transects and exclusion zones assess the impacts of biocontrol agents with and without grazing and under a range of conditions. All woody vegetation on transects and in exclusion zones is mapped and tagged. Seedlings are also mapped. Specimens are collected for identification of all species evident on transects/exclusion zones.

The following variables are assessed during June/July each year:

- Stem diameter of woody perennials at 20 cm above the ground
- Height of the bulk of the rubber vine in each plot and maximum height of whips
- Flower and pod production of rubber vine
- Rust and moth infestation of rubber vine
- Soil seed banks (rubber vine)

Serial photographs are being taken at clearly defined photo-points once a year.

Progress

The poor wet season during 2004–2005 has resulted in limited rust infection across all sites except Delta Downs and Dalrymple National Park, where rust was abundant. Extensive defoliation occurred at all sites except Hughenden due to either rust infection (Delta Downs and Dalrymple National Park) or extremely low rainfall (Ten Mile Creek, Anabranch and Mt Hay). Some pods have been produced in the vicinity of research sites, except Annabranch, and on transects at Ten Mile Creek, where five pods were recorded despite the low rainfall.

There were significant plant deaths at Mt Hay and Annabranch, which were most likely due to the combined effects of previous rust infection and the low rainfall over the past few years. The remaining sites had only slight or no reduction in plant numbers during the past year (Table 1.5). No new seedlings were observed at any site except Hughenden where 30 small seedlings were observed. The presence of seedlings indicates that seed is being produced even though no pods were observed. Almost all of these seedlings will die before the next wet season if some rainfall does not occur during the winter months.
The lack of new seedlings at most sites is due to the depletion of the rubber vine soil seed bank (Table 1.6) resulting from very few seeds being produced and the short period of seed survival in soil. The re-occurrence of pods on or near transects is due to the low rust levels over the past few years, and indicates that, if the run of years with low rust infection continues, plant numbers could increase due to seedling recruitment. This has not been seen for more than five years. No *Euclasta* were observed at any site.

Expected completion

2007

Funding

Queensland Government

Table 1.5* Change in number of rubber vine plants on transects at eight sites

Sampling time	Site							
	Anabranch	Ten Mile Creek	Dalrymple	Mt. Hay	Delta Downs	Strathmore	Wrotham Park	Hughenden
Spring 1997	435	512	188	159	102	53	37	NA
Spring 1999	390 (-45)	413 (-99)	173 (-15)	169 (+10)	76 (-26)	54 (+1)	14 (-23)	NA
Spring 2000	275 (-115)	227 (-186)	152 (-21)	125 (-44)	51 (-25)	NA	NA	NA
Spring 2001	250 (-25)	193 (-34)	141 (-11)	93 (-32)	31 (-20)	NA	NA	NA
Winter 2002	214 (-36)	141 (-52)	116 (-25)	81 (-12)	23 (-8)	NA	NA	58
Winter 2003	195 (-19)	121 (-20)	102 (-14)	70 (-11)	22 (-1)	NA	NA	58 (0)
Winter 2004	108 (-88)	79 (-42)	101 (-1)	59 (-11)	19 (-3)	NA	NA	58 (0)
Winter 2005	35 (-73)	78 (-1)	99 (-2)	46 (-13)	16 (-3)	NA	NA	58 (0)

*Numbers in brackets indicate change in number of plants between years.

Table 1.6 Germinable soil seed bank (seeds/m²) of rubber vine at seven sites

Sampling time	Site						
	Anabranch	Ten Mile Creek	Mt. Hay	Delta Downs	Strathmore	Wrotham Park	Hughenden
Spring 1999	0	0.4	1.6	0	5.6	0	NA
Spring 2000	0	0	0	0.4	NA	NA	NA
Spring 2001	0	0	0	0	NA	NA	NA
Spring 2002	0	0	0	0	NA	NA	NA
Spring 2003	0	0	0	0	NA	NA	0
Spring 2004	0	0	0	0	NA	NA	0
Spring 2005	0	0	0	0	NA	NA	0

Investigations resulting from the non-target attack of lantana bug (*Aconophora compressa*)

Objective

To investigate various aspects of the non-target attack of *Aconophora compressa* including its host range, susceptibility to high temperature, biotic control factors and treatment by insecticide

Staff

Bill Palmer (Leader) Kunjithapatham Dhileepan, Michael Day, Mariano Trevino, Liz Snow (AFRS)

Collaborators

Judy King, Manon Griffiths, Pam Bowles, Wayne Thompson (DPI&F), Andrew Manners (CRC Australian Weed Management)

Methods

A. compressa is a membracid bug released for the biological control of lantana that has attacked a non-target host, fiddlewood (*Citharexylum spinosum*), and other plants. A comprehensive research program was implemented in 2003–4 to address the important issues. The program on *A. compressa* provided sound scientific information on the actual and potential impacts of the bug that could be conveyed to the community through associated communication and extension activities. The program on *A. compressa* was designed to assist on-ground management and address negative perceptions of the community. It assisted decision making, by providing NRMW with risk assessment tools, addressed public concerns and developed improved protocols for testing and releasing biocontrol agents.

Progress

In 2003–04, the DPI&FCall Centre and NRMW received many calls from locations in south-east Queensland, Malanda in north Queensland, northern NSW and Sydney concerning the non-target attack of various plants by *A. compressa*. Over 50 residents were visited at that time and these field observations indicated that five plant species supported adult development, albeit in low numbers for all but fiddlewood. The other four species were *Eremophila nivea*, *Jacaranda mimosifolia*, *Duranta erecta* and *Tecoma stans*.

Further investigative research indicated that both lantana and fiddlewood were good hosts. Ten species including *Duranta erecta* and *Jacaranda mimosifolia* were marginal hosts on which the insect can complete its life cycle but not build up to damaging populations. These also indicated that the insect was able to feed but not complete a life cycle on 10 other species (Table 1.7).

Relative abundance of *A. compressa* on lantana, jacaranda, fiddlewood, 'Sheena's gold' (a commercial variety of *Duranta repens*), 'Geisha girl' (a commercial variety of *Duranta repens*) and grey mangrove (*Avicennia marina*) was estimated in the field. *A. compressa* was most abundant on fiddlewood trees followed by the 'Geisha girl' and 'Sheena's gold'. Abundance on lantana ranked fourth behind the other plants. Abundance on jacaranda was very low.

Sites with grey mangrove were surveyed along the coast and river systems in 2003. The insect was found in low numbers on grey mangroves at various sites in the Brisbane, Logan, Albert and Pine Rivers and also along the Moreton Bay foreshore. Although there was evidence of feeding by the insect and also of oviposition and partial nymphal development, there was no indication of population build up and the infestations were typical of the 'overflow' populations observed on other plants. Further experimentation on host utilisation of mangroves is planned for 2005–06.

The effects of continuous high and alternating temperatures on the survival of *A. compressa* were studied in temperature cabinets. At constant temperature, field collected adults and nymphs survived less than 24 hours at 39°C. At 34°C and 36°C, 95% of adults died within 48 hours. Survival remained high at lower temperatures, with individuals surviving for eight and six months at 12°C and 16°C, respectively. At these temperatures, the nymphs survived longer than adults. At fluctuating temperature, adult and nymphal survival was less than two days at 39°C/24°C. At 36°C/22°C adult survival was approximately seven days, while nymphal survival was three days. The trends in both adult and nymphal survival at alternating temperatures are similar to those of constant temperatures, though survival is longer in the alternating temperature regime. The experiments in the laboratory support field observations that this insect is very sensitive to high temperatures, which can cause local extirpations.

Predation and parasitism of the lantana sap-sucking bug were investigated on fiddlewood trees in south-east Queensland. Of 46 predaceous arthropod species collected from fiddlewood, 26 consumed *A. compressa* adults or nymphs in Petri dish trials. The following bird species were reported to consume *A. compressa*: crow, pied currawong, magpie, fig bird, noisy miner, magpie lark, sparrow, willie wagtail, tawny grassbird, and spangled drongo. No parasitoids were found in a survey for egg parasitoids. Results suggest that there are predators, but not parasitoids of *A. compressa* on fiddlewood trees.

Trials of insecticides and application methods were commenced to provide chemical control options to the general public and the arboricultural and horticultural industries. Results from glasshouse and field trials indicated that Imidacloprid provided effective and extended control of this pest when applied as a foliar spray to shrubs and small trees. Imidacloprid was also found to be efficacious when used as a soil drench for larger trees. In August 2005, the Australian Pesticides and Veterinary Medicines Authority granted a Minor Use Permit for Imidacloprid to be used for the control of *Aconophora compressa,* either as a foliar spray or a soil injection.

Observations were made throughout 2004 and 2005 on the abundance of *A. compressa* on fiddlewood. Populations had previously crashed after heatwaves in February 2004, with only remnant populations surviving in cooler areas such as the bay side suburbs of Brisbane, Mt Tambourine and Byron Bay. Throughout 2004 and 2005 populations gradually recovered so that by June 2004, the insect was again widespread and sometimes in significant populations.

A Ph. D. study investigation into the behavioural basis for non-target selection and utilisation has been commenced.

Expected completion

2006

Funding

Rural Lands Protection Trust Fund

Queensland Department of Primary Industries and Fisheries

Dr Bill Palmer investigating *A. compressa* feeding evidence on fiddlewood

Table 1.7 Assessment of various plants as hosts for *A. compressa.*

Class 1 Hosts capable of sustaining populations over extended supporting population increase
Lantana camara (Verbenaceae)
Citharexylum spinosum (Verbenaceae)
Class 2 Hosts capable of supporting oviposition and complete immature development, but not supporting population increase
Aegiceras corniculatum (L.) Blanco (Myrsinaceae)
Baccharis halimifolia L. (Asteraceae)
Clerodendrum ugandense Prain. (Lamiaceae)
Duranta erecta L. (Verbenaceae)
Eremophila bignoniifolia (Benth.) F.Muell. (Myoporaceae)
Eremophila nivea Chinnock (Myoporaceae)
Jacaranda mimosifolia D. Don (Bignoniaceae)
Lippia alba (Mill.) Br. ex Britton & Wilson (Verbenaceae)
Tecoma stans (L.) Juss. ex Kunth (Bignoniaceae)
Vitex trifolia L. (Verbenaceae)
Class 3 Hosts capable of supporting limited feeding sufficient for survival of adults and partial development of nymphs
Avicennia marina (Forssk.) Vierh. (Avicenniaceae)
Clerodendrum costatum R. Br. (Lamiaceae)
Eremophila glabra (R.Br.) Ostenf. (Myoporaceae)
Eremophila maculata (Ker Gawl.) F.Muell. (Myoporaceae)
Myoporum acuminatum R. Br. (Myoporaceae)
Myoporum montanum R. Br. (Myoporaceae)
Pandorea jasminoides (Lindl.) K.Schum. (Bignoniaceae)
Pandorea pandorana (Andrews) Steenis. (Bignoniaceae)
Petrea volubilis L. (Bignoniaceae)
Prostanthera striatiflora F.Muell. (Lamiaceae)
Class 4 Plants not suitable for feeding or oviposition by the insect
Camellia japonica L. (Theaceae)
Gardenia spp. (Rubiaceae)
Grevillea sp. (Proteaceae)
Leea indica Merr. (Leeaceae)
Myoporum ellipticum R.Br. (Myoporaceae)
Myoporum parvifolium R.Br. (Myoporaceae)
Pentas sp. (Rubiaceae)
Prostanthera ovalifolia R. Br. (Lamiaceae)
Stachytarpheta cayennensis (Rich.) J.Vahl (Verbenaceae)
Stachytarpheta mutabilis (Jacq.) J.Vahl (Verbenaceae)

The suitability of native mangrove species as hosts for the lantana bug (*Aconophora compressa*)

Objectives

To determine whether the *A. compressa* can survive, lay eggs, complete nymphal development on native mangrove species, *Avicennia marina* and *Aegiceras corniculatum*.

Staff

K. Dhileepan (Leader) and Elizabeth Snow (AFRS)

Methods

Three sites along the Brisbane River containing lantana and both species of mangroves in the same area were used in the study. Newly emerged adults, field collected from both fiddlewood and lantana, were used in this study. At each site, four plants of each plant species (*L. camara, A. marina* and *A. corniculatum*) were randomly selected and on each plant six branches/shoot tips were selected and tagged. One pair of newly emerged adults was confined to each shoot tip by using a mesh-cloth bag. Among the six pairs of insects confined to shoots in each plant, three pairs were sourced from fiddlewood and three from lantana (3 pairs of insects x 2 insect sources x 4 trees x 3 test plant species x 3 sites). All plants were sampled at weekly intervals and the following data was collected:

- duration of adult survival
- pre-oviposition period
- number of egg batches
- number of nymphs
- proportion of nymphs reaching adult stage
- reproductive output.

Progress

The trial was initiated in June 2005. Three sites (Sherwood, Fig Tree Pocket and Rocklea) along the Brisbane River containing lantana and both species of mangroves in the same area were selected for the study. Nymphs collected from fiddlewood and lantana in the field were allowed to complete development on their respective host plants and the emerging adults were used in the study.

Expected completion

June 2006

Funding

Queensland Department of Primary Industries and Fisheries

Mass rearing and release of biocontrol agents for prickly acacia (*Acacia nilotica*)

Objective

To mass rear and release approved biocontrol agents

Staff

Catherine Lockett (Leader), Margie Robinson (TWRC)

Methods

After approval for release from quarantine, agents are mass reared at the TWRC and released throughout the range of the weed in Queensland. Ongoing monitoring determines establishment and any appreciable effect of the agent on the plant.

Progress

Mass rearing and release of *C. assimilis* ceased in September 2004 with the final release of insects at the Hughenden Town Common. This leaf-feeding geometrid was introduced into Australia from South Africa in 2002 and over 75 000 adults were released at both coastal and inland prickly acacia sites. Insects were seen at one coastal site within six months of the first release and establishment at all coastal release sites was confirmed within the first year.

In early March 2005, infestations of prickly acacia between Home Hill and Bowen were heavily attacked by *C. assimilis*. Landholders reported hundreds of small moths and caterpillars together with large areas of partial to total defoliation. The insect continued to cause damage at Inkerman into late June, with large numbers of adults present at the site.

Sampling of caterpillars and feeding damage commenced in March 2005 at Ashfield and has been conducted at six-weekly intervals since.

Field releases of the latest biocontrol agent *Cometaster pyrula* commenced in September 2004, and approximately 6000 larvae and 380 moths have been released at a coastal site, Ashfield. Larvae have persisted on bushes between site inspections but there have been no signs of adult emergence.

Expected completion

Ongoing

Funding

Queensland Government

Rational selection of biocontrol agents

Objective

To develop experimental approaches to aid in the selection of agents used in weed biological control, to improve the chances of releasing effective agents and reducing the probability of non-target damage

Staff

S. Raghu (Leader), K. Dhileepan,
Mariano Treviño (AFRS)

Methods

This project adopts a systematic approach towards agent selection through:

- defining what 'successful control' means, based on the weed's impact
- understanding the taxonomic status of the target weed
- understanding the weaknesses in the life cycle of the target weed
- understanding plant response to different types of damage (both simulated and actual herbivore damage)
- making agent selection decisions on the basis of the above knowledge
- doing host-specificity, agent-efficacy and non-target risk analyses under quarantine conditions
- treating predictions of agent efficacy as hypotheses to be tested in quarantine, and once agents have been field-released.

Progress

In July 2004, a workshop, involving most of the weed biological control scientists in Australia, was held in Brisbane. Its purpose was to discuss making agent selection decisions more explicit and testable through the use of the methods outlined above. The outcome of this workshop was the development of a best practice manual for selecting biological control agents that is to be published by the Weeds CRC in 2006.
In addition, a symposium on the same theme was held at the International Congress of Entomology in Brisbane in August 2004. The papers presented at this symposium have been published as a special issue of the journal *Biological control* (Vol. 34[3], Sept. 2005). The ideas presented in these publications will serve as guides for biological control practitioners in making agent selection decisions in the future.

A risk-benefit modelling framework for host testing of biological control agents is also being developed using *Macfadyena unguis-cati* as a model system. This tool will help scientists to make more informed decisions about particular agents, while simultaneously considering both the risks they pose and the benefits they can provide.

Expected completion

October 2005

Funding

CRC for Australian Weed Management

Queensland Government

Chapter 2 Weed research ecology

Ecology of bird-dispersed weeds

Objective

To define functional groups of bird-dispersed weeds that can be targeted by integrated weed management strategies

Staff

Gabrielle Vivian-Smith (Leader), Carl Gosper and Dane Panetta (AFRS)

Methods

Bird-dispersed weeds are a complex and difficult weed problem for land managers. There is little quantitative information regarding the dispersal process and rates and patterns of weed spread. Furthermore, management strategies specific to this unique mode of dispersal are only in the early stages of development.

This project takes a multi-species approach to develop functional groups of bird-dispersed weeds that can be targeted through integrated weed management. Five major focus areas for the study have been identified, each with differing methodologies:

- Determining existing knowledge and developing novel management approaches: bird observer questionnaire, literature review, and data base development
- Plant fruit traits: assessments of morphology, phenology, nutritional quality and display characteristics
- Dispersal patterns and distances: structured observations of feeding behaviour, bird diets, gape width and gut passage rate
- Recruitment dynamics and seed bank longevity of bird-dispersed weed species: controlled field, laboratory and tunnel experiments, including testing the effect of gut passage through birds on seed germination
- Testing novel bird-dispersed weed management approaches: effects of biocontrol agents, source strength of different weed populations and provision of replacement resources.

The project is located in south-east Queensland, where a wide variety of bird-dispersed environmental weeds exist.

Progress

Existing knowledge and novel management approaches

A review of literature on the ecology and patterns of spread of bird-dispersed weeds (paper in press, *Diversity and distributions*) was conducted. The information from this was applied to conceptualise novel research and management approaches at the landscape-scale that are specific to this unique mode of spread. These approaches target the mutualism between the plant and bird-dispersers, and are based on the assumption that the spread of these invasive plants is at least in part dispersal limited. The approaches include:

- research to quantify the effect of biocontrol agents on dispersal, particularly how changes in fruit production and/or quality affect fruit choice by frugivores, dispersal distributions of seed and post-dispersal processes
- redirecting or manipulating seed dispersal, such as the use of perch structures and/or vegetation density to attract frugivorous birds after they have been foraging on invasive plant fruits
- identifying and removing the major sources of seed spread, such as targeting core infestations, particular habitats and creating barrier zones
- identifying and providing alternative food resources for frugivores. These aim to replace fruits of invasive plants, with their use and effectiveness quantified.

Plant fruit traits

Research focuses on the types of weed fruits that birds find attractive and why they find them attractive. This involves detailed studies of weed fruit morphology, nutrient content and seasonality. Analysis of this large data set aims to identify functional groups of weeds based upon fruit characteristics. An award-winning poster of this work was presented at the Australian Weeds Conference 2004 and the Ecological Society of Australia Conference 2004.

Of the variety of fruit morphology traits measured, fruit width has the strongest relationship to plant invasiveness. Plants with smaller fruits tended to be more invasive than those with larger fruits (Figure 2.1). Invasive plants with smaller fruits have potentially more bird dispersers than those with larger fruits, which is the ecological link between fruit size and invasiveness.

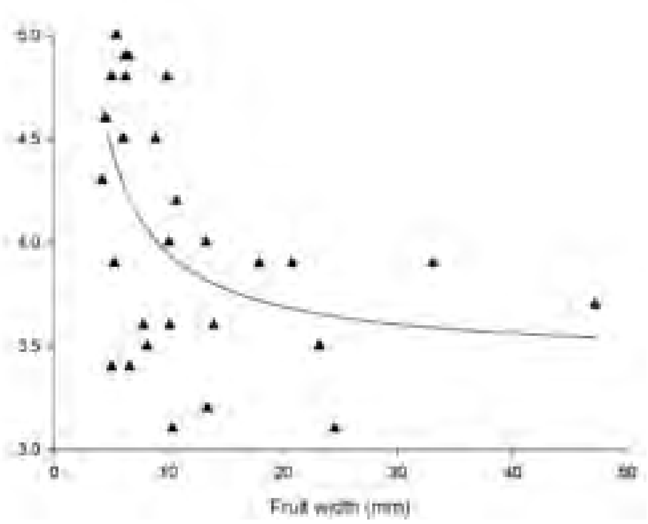


Figure 2.1 Fruit width of weed species in South East Queensland

Fruit width of weed species in South East Queensland relative to their invasiveness score (5 = highly invasive, 3 = less invasive). Regression curve $y = 3.43 + 5.13/x$ ($r2 = 0.26$, $F1,27 = 9.44$, $P = 0.005$)

Dispersal patterns and distances

Our detailed study of the diet of the figbird (*Sphecotheres viridis*; a common local frugivorous bird) is a component of the work that aims to incorporate avian traits that influence weed–bird interactions. We regularly sample faecal material deposited below figbird roosts and analyse the material to determine weed fruit content. Distances from the roost to the nearest conspecific plant for each species present in the figbird diet are measured to derive a minimum dispersal distance. This information will expand our knowledge of weed fruit consumption from the bird's perspective, and will document weed fruit choices, the dietary importance of weed fruits and seasonal variation in these factors for this highly frugivorous species.

Research has commenced into the dispersal of *Lantana camara*, one of Australia's worst weeds. We are recording the rate of bird visits to fruiting plants, and the rate and method of fruit handling and consumption. Future work aims to measure the time seeds take to pass through the gut of the birds. This will allow the generation of dispersal distribution models for *L. camara* in south-east Queensland.

Fruits of *Lantana camara* infested with the biological control agent *Ophiomyia lantanae*

Recruitment dynamics and seed bank longevity

Parallel studies investigate recruitment dynamics, including seed longevity, for seven bird-dispersed weeds. They form a component of the project that will contribute to developing follow-up control strategies for the management of these weed species. Species involved include *Asparagus africanus*, *A. aethiopicus*, *A. virgatus*, *L. camara* (both pink and pink-edged red biotypes), *Murraya paniculata*, *Ochna serrulata* and *Rivina humilis*.

Research into *Ochna serrulata* (Mickey Mouse plant) is now complete. The species was found to have a non-persistent seed bank, with very low (0.75%) seed viability after six months under field conditions. Recruitment was favoured by a combination of moist conditions and surface sowing, with no significant effects of seed processing (manual pulp removal or figbird gut passage) detected.

Research into the germination and emergence of *L. camara* has indicated that the two biotypes (pink-edged red and pink) tested show significant differences in seed size, germination patterns over time, and recruitment responses to the seed-damaging biocontrol agent *Ophiomyia lantanae*.

Testing novel bird-dispersed weed management approaches

We have conducted preliminary tests of two of our proposed novel management approaches for bird-dispersed weeds. First, we tested how the fruit-infesting biological control agent, *O. lantanae*, influenced bird use of *L. camara* fruits. *O. lantanae* leaves a visual feeding scar on infested fruits (see photograph), which birds would be able to detect. This study tested whether the agent was able to reduce dispersal of seeds by making the fruits less attractive to birds. A comparative study of fruit removal rates indicated that fruits infested with *O. lantanae* were preferred less by birds than undamaged fruits (Figure 2.2), demonstrating that biological control agents can reduce the attractiveness of fruits to birds.

Secondly, we tested to determine whether the removal rates of weed fruits varied with habitat, which, if so, would allow prioritisation of control efforts to habitats acting as the strongest weed seed sources. Rates of removal of *O. serrulata* fruits were measured in suburban and bushland habitats in south-east Queensland. More fruits were removed in bushland, suggesting that these sites should be priorities for control efforts. Although lower, removal rates from the suburban plants were still significant, indicating that gardens would also act as seed sources for re-invasion.

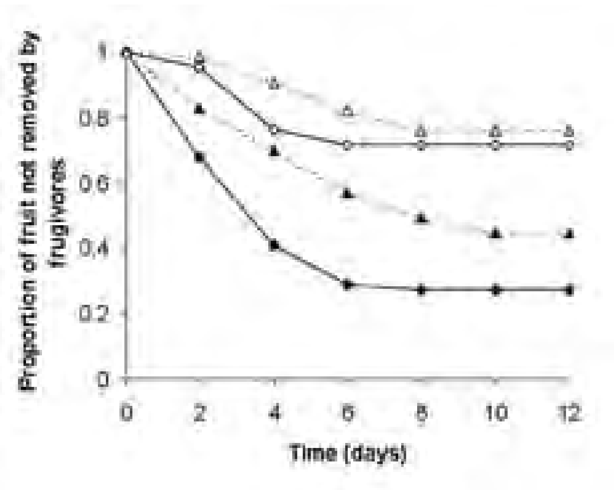


Figure 2.2 Survival curves for the removal of *L. Camara* fruits

Survival curves for the removal of *L. camara* fruits with and without *O. lantanae* damage at two populations (filled points = undamaged fruits, unfilled points = damaged fruits)

Superb fruit dove—fruit eating bird

Carl Gosper discussing Figbird diets with the media

Expected completion

March 2006

Funding

CRC for Australian Weed Management

Queensland Government

NHT2 Weeds of National Significance (partial, for Lantana component)

Ecology of Wet Tropics weeds

Objective

To develop an increased understanding of the ecology of key Wet Tropics weeds, in order to improve their management

Staff

Melissa Setter (Leader), Stephen Setter, and Brodie Akacich (CWTA), and Simon Brooks (TWRC)

Background

Weeds have the potential to degrade the high environmental, economic, and social values of the Wet Tropics area of north and far north Queensland. Sound ecological knowledge related to management of priority Wet Tropics weeds is inadequate.

Methods

Field, shadehouse, and laboratory experiments are being undertaken on several weed species, including pond apple (*Annona glabra*), sicklepod (*Senna obtusifolia*), hairy senna (*Senna hirsuta*), harungana (*Harungana madagascariensis*), hymenachne (*Hymenachne amplexicaulis*), chromolaena (*Chromolaena odorata*), and tobacco weed (*Elephantopus mollis*). Research studies include the following investigations.

Seed longevity

Seed bank depletion studies on pond apple, sicklepod, hairy senna, harungana, hymenachne, tobacco weed and Siam weed are being conducted to determine how long the seed bank of these species will remain viable at various depths of soil.

Pond apple age to reproduction

A field trial was established along a drainage system densely infested with pond apple to determine the survival rates and age to reproduction of pond apple seedlings before and after implementation of control programs. Data collected from this trial will be useful in the development of integrated management strategies for pond apple.

Pond apple insect damage

Insect damage has been observed on many pond apple seeds in the field in the Innisfail area. The insect species are collected, reared and identified. During the next fruiting season, observations on the geographic distribution of these insects on pond apple seed will be undertaken and their impact on seed viability quantified.

Pond apple seed development and germination techniques

The development of the pond apple embryo is being investigated, using periodical dissection and microscopic examination/photography. Possible germination techniques and triggers are also being investigated to develop a fast and reliable germination procedure for pond apple.

Pond apple seed buoyancy and viability in fresh and saline water

This experiment will be established on site at the CWTA using fish tanks to determine the buoyancy and viability of pond apple seeds in fresh and salt water. Data collected will augment information obtained from water current studies and allow the potential distribution of pond apple to be determined.

Hymenachne revegetation trial

A field experiment has been established in a riparian system to determine the effectiveness of revegetation and artificial shade structures when used in conjunction with chemical control. Approximately 1200 trees have been planted, shade structures erected and herbicide treatments applied.

Chromolaena eradication quantification effort

A field trial has been established near Innot Hot Springs to quantify the effort required to eradicate a small population of chromolaena, in terms of hours of labour required and litres of herbicide used. This trial is unique in that it will provide information from relatively dry areas compared to what is commonly obtained from wetter coastal strips.

Miconia (*Miconia calvescens*): time from flowering to fruit maturity

Three flowering miconia trees were monitored near Mossman to determine time from flowering to fruit maturity. Height and basal diameter of these trees were also recorded. Flowering panicles between 0 and 3 m above ground level were covered with strong, fine mesh bags to minimise any possibility of seed escape. Any panicles above 3 m were removed, as these were harder to monitor without damaging the tree. The panicles were monitored every 1–2 weeks until fruits began to mature.

Progress

Seed longevity studies

Five years later, seed bank rundown is ongoing for most species, with the exception of pond apple seed, which expired after two and a half years. Harungana seed viability is notably high after four years, particularly for buried seeds. Viability for seed on the soil surface averages 10%. In contrast, 80% of harungana seed, located at 2 cm and 10 cm depth, is still viable.

Pond apple age to reproduction and seedling mortality

Just over 500 pond apple seedlings of known age have been tagged in untreated (control) and treated transects (with the mature over-story and older seedlings removed). Approximately 80% mortality of pond apple was recorded 12 months after seedling emergence. None appear to be close to reproductive maturity.

Insect damage found on pond apple seeds

Pond apple insect damage

Several specimens of seed weevils have been isolated, reared and identified as *Coccotrypes carpophagus* (Hornung).

Pond apple seed development and germination techniques

Seeds have been dissected, examined and photographed for three months after collection. For seed kept in storage conditions, no development of the embryo has been observed. Seeds placed in a moist, warm environment (incubator or shadehouse pot), have developed, and germinated; however, this takes up to three months to occur. Various germination techniques and possible triggers have been applied in a pilot study. This research is ongoing.

Pond apple seed buoyancy and viability in fresh and saline water

Fish tanks have been set up, and the experiment is due to start soon.

Hymenachne revegetation trial

Biomass and soil seedbank sampling is ongoing, along with the continued application of some treatments. Hymenachne biomass appears less in all chemically treated plots as opposed to the control plots. As yet, there is no visually obvious difference in biomass between the shaded and unshaded plots.

Chromolaena: eradication quantification effort

Baseline data on all individuals (approx. 1000 adults) along with soil seedbank samples were collected in July 2003 and all plants sprayed with Grazon*DS as per standard control procedures. All efforts pertaining to initial control were recorded, including man-hours for control and survey/extended survey, chemical usage. Efficacy of kill/re-treatment is being recorded, and continuing seedbank data are being collected. Survey and control of newly found individuals is still occurring, adding to the initial cost of control. Treatment appears to be 100% effective; however, occasional plants are still being found (i.e. killing them is not the problem, finding them is)—this seems to indicate that higher resource input into initial surveying may be required.

Miconia: time from flowering to fruit maturity

The time from flowering to fruit maturation was approximately eight weeks. This is the first recording of such data in Australian conditions. The mesh bags were found to be strong and secure, and no seed escape was recorded or suspected. These trees will now be monitored monthly to find out when the next flowering event occurs.

Flower of *Miconia calvescens*

Expected completion

The project is ongoing, with different experiments expected to require between one and twelve years to complete.

Funding

Rainforest CRC

CRC for Australian Weed Management

Weeds of National Significance

Four Tropical Weeds Eradication Project

Queensland Government

Environmental weed ecology

Objective

To generate ecological research outcomes that better inform environmental weed management and biological control research

Staff

Gabrielle Vivian-Smith (Leader), Graeme Hastwell, Dane Panetta, David Hinchliffe (AFRS)

Methods

Experiments are designed to provide ecological information on propagule dispersal, seed bank dynamics and seed persistence of high impact weedy vines and other environmental weeds. Study species include cat's claw creeper (*Macfadyena unguis-cati*), balloon vine (*Cardiospermum grandiflorum*), moth vine (*Araujia sericifera*), Madeira vine (*Anredera cordifolia*), and Senegal tea (*Gymnocoronis spilanthoides*).

A major component of the project assesses the importance of riparian corridors for weed dispersal and will provide input to catchment-based weed management strategies. Dispersal studies of high impact weedy vines use seed traps, placed in-stream and along the riparian zone, to measure seed rain along creek corridors. Field and laboratory experiments evaluate the species' seed bank dynamics (germination requirements, emergence, seed persistence, and *in situ* seed bank densities).

In emergence and longevity studies, freshly harvested seeds are sown on the soil surface or buried. Emerging seedlings are monitored and the viability of remaining seeds is determined at intervals of 6–12 months for up to five years. Seed germination experiments in laboratory growth cabinets test responses to different light and temperature environments.

In a new component of this project a six-month study investigated approaches that could be used to evaluate the impact of potential biocontrol agents for control of cat's claw creeper. Levels of spatial and temporal variation experienced across a range of infestation sites were studied as well as collection of limited baseline data at infestation sites.

Progress

Cat's claw creeper *(Macfadyena unguis-cati)*

Ongoing studies have confirmed low and highly variable in situ seed bank densities for the species over the 24-month study period. Germination and emergence response studies for an initial 12-month period were presented and published in the proceedings of the Australian Weeds Conference (Vivian-Smith and Panetta 2004), with experimental studies of seed bank persistence for a second cohort of seeds confirming 0% seed viability after 24 months under field conditions. Data analysis and interpretation of the studies is ongoing. A report, summarising guidelines for bioevaluation of the impact of potential biocontrol agents for control of cat's claw creeper, was produced.

A fallen tree, killed by cat's claw creeper at one of the riparian study sites

Balloon vine (*Cardiospermum grandiflorum*)

The 24-month field study of seed deposition and seed bank densities in riparian corridors has been completed with data analysis underway. Seed bank densities and seed numbers deposited were greater than for cat's claw creeper. The species has a more persistent seed bank than the other three species in the study, with seeds continuing to remain viable after three years.

Moth vine (*Araujia sericifera*)

Studies of germination, seedling emergence, seed persistence and aspects of the dispersal ecology of the species are now complete, with the detailed results of the study now published (Vivian-Smith and Panetta 2005). The species recruitment characteristics showed strong similarities to rubber vine (also in the Asclepiadaceae). Although the vast majority of seeds persist for less than 24 months, a very small proportion of seeds demonstrated induced dormancy, remaining viable for longer periods. This suggests that in situations with very high seed inputs, a small, but potentially significant proportion (<1%) of the seed bank may show longer-term persistence. To verify this, field studies that determine the in situ seed bank densities typically found in infestations are required.

Madeira vine (*Anredera cordifolia*)

Experiments focusing on tuber dispersal, emergence and longevity of Madeira vine were completed in early 2005, with data analysis currently being conducted. A review paper, with external collaborators, on the biology of Madeira vine is underway. Field studies verified the production of viable seeds at four out of five populations in the Toowoomba area. Seeds retain components of the flower (perianth) and are difficult to distinguish from spent flowers. Rapid germination (up to 5.4% of individual flowers sampled) occurred under conditions of 15/25 °C alternating 12-hour thermo/photoperiod.

Senegal tea (*Gymnocoronis spilanthoides*)

Seed set (fecundity) and germination of seeds from two populations of the aquatic weed species in south-east Queensland were also investigated. Both populations produced viable seed in quantities sufficient to contribute to a seed bank. Seeds were much smaller than reported in the literature (0.5 mm in length, compared to 5 mm reported). Seed germination rates were high, reaching a maximum of 83% under conditions of 20/30 °C alternating 12-hour thermo/photoperiod. Virtually no seed germination occurred under continuously dark conditions, suggesting that field conditions promoting disturbance to the soil and exposure of seeds to light could promote recruitment of the species.

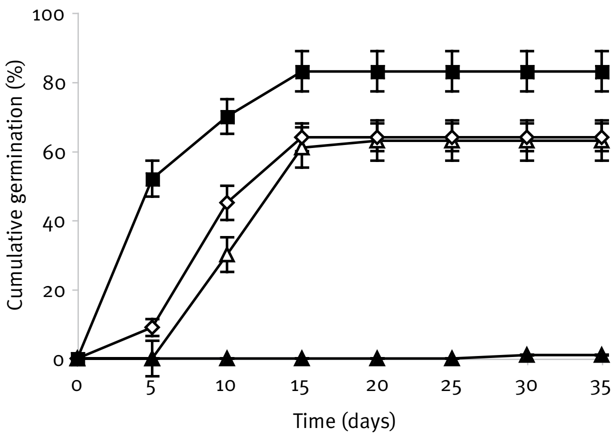


Figure 2.3 Mean cumulative germination of *Gymnocoronis spilanthoides* seeds

Mean cumulative germination (%) (± SE) of Gymnocoronis spilanthoides seeds under different light and temperature treatments (filled squares = light, 20/30 °C; open diamonds = light, 15/25 °C; open triangles = light, 10/20 °C; filled triangles = continuous darkness for all temperature treatments) over 35 days

Expected completion

The project is ongoing, with different experiments expected to require between one to three years to complete.

Funding

Queensland Government

Mimosa pigra research

Objectives

- To study the life cycle, growth rates, seedling emergence, seed bank and seed bank depletion of *Mimosa pigra* growing at the Peter Faust Dam, Proserpine, to aid in the mimosa eradication program
- To evaluate herbicides for control of melaleuca regrowth in *M. pigra* infested areas around Peter Faust Dam

Staff

Joseph Vitelli (Leader), Barbara Madigan, Kent Worsley (TWRC)

Methods

The area to be intensively studied for *M. pigra* at Peter Faust Dam is a peninsula known as Point 10 from the 65% water storage capacity level to the water's edge. This area includes the closed canopy mimosa infestations (known as the core areas) and large individual mimosa plants scattered across the peninsula. As the water level in the dam decreased from April 2001 (when mimosa was first recognised at the dam), massive and scattered seedling germination occurred.

Seedling emergence and seed bank

Seedling counts will be taken along a transect line running through the core infestation and in a grid pattern across the peninsula. Seedling counts will continue to be taken in new areas exposed by the receding water line. Soil cores for seed bank studies will be taken from different areas. Seeds recovered from the soil will be tested for viability. Soil cores will be taken at yearly intervals to study the soil seed bank depletion.

Life cycle and growth rates

Stem height, basal diameter, number of flower buds, and number of seed pods will be recorded at intervals for plants from three sections of the study area. Dry weight of harvested plants and seedling mortality will also be recorded. Soil from each of the areas will be analysed.

Fire and chemical control

Individual *M. pigra* plants will be treated with a flame burner at their base to study the effect of direct heat. A dense area of *M. pigra* with different fuel loads will also be burnt to study the effect of fire on a mimosa infestation. A cut stump treatment using metsulfuron methyl will also be applied to individual mimosa plants to study the efficacy of this treatment.

Herbicides and rates

Three melaleuca species (*Melaleuca leucadendra, M. quinquenervia and M. viridiflora*) growing at Peter Faust Dam will be grown in pots at TWRC. A range of herbicides and rates will be trialled to determine the best herbicide and rate for control of melaleuca regrowth in areas of the dam where *M. pigra* has been found. Fire and mechanical control methods will also be trialled on melaleuca.

Progress

Seedling emergence and seed bank

Near the end of 2004, the water level at Peter Faust Dam had receded to the lowest level since the dam was built, and has since stayed at a low level. The previous lowest water level had been in January 1997 at ~32%. A few seedlings continue to be found as the water level decreases; however, when the water level dropped below 32%, there was a significant decrease in the number of mimosa seedlings in the newly exposed areas along the transect line, compared with numbers above the 32% capacity level.

Soil cores have been taken annually in differing zones in the study area. Preliminary results show a decrease in the seed bank in the core area (~8200 seeds m^{-2} in 2002, ~3000 seeds m^{-2} in 2003; ~1400 seeds m^{-2} in 2004; ~800 seeds m^{-2} in 2005). Viability of these seeds was ~84% compared to ~98% for fresh seed.

Life cycle and growth rates

Thirty plants from three different areas in the research zone have been tagged and monthly measurements of height and basal diameter recorded. Flower and pod production are also monitored. All 30 tagged plants have produced flower buds, and close to 6.5 million seeds have been collected from these plants. *M. pigra* at Peter Faust Dam has been found to flower and set seed year round (Figure 2.4). Literature from the Northern Territory lists February to May and March to July as flowering and podding periods respectively.

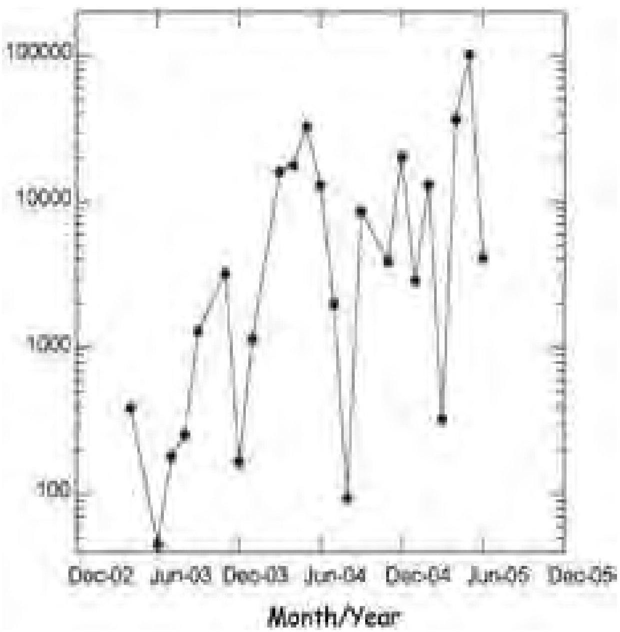


Figure 2.4 Mean number of mimosa pigra seeds collected per plant per month for the research zone at Peter Faust Dam

An area (10 m x 10 m) with dense mimosa seedlings (780 seedlings m^{-2}) was left and monitored for seven months during spring/summer. At the end of this period, average *M. pigra* density was 72 plants m^{-2} with 80% of the plants reaching reproductive maturity. All plants in this trial area were destroyed following assessment. A second area (90 seedlings m^{-2}) was left for nine months during autumn/winter. *M. pigra* density declined to 82 plants m^{-2}, with 64% of the plants having reached reproductive stage.

Fire and chemical control

Three stem size classes (5–25 mm, 25.1–45 mm, >45 mm) of *M. pigra* plants were treated at their base with a flame burner for one of two time periods (10 or 30 seconds). Table 2.1 shows mortality for this treatment.

Three size classes (5–25 mm, 25.1– 45 mm, >45 mm) of *M. pigra* plants were cut near ground level and immediately sprayed with metsulfuron methyl at 0.6 g L^{-1} plus wetting agent (0.1%v/v). Final assessments will be made and results analysed.

Table 2.1 Mortality of *M. pigra* plants following treatment at base with a flame burner

Stem class	5–25 mm	25.1–45 mm	>45 mm
30 seconds	4%	36%	56%
10 seconds	4%	5%	29%

Herbicides and rates

The recruitment of three melaleuca species (*Melaleuca leucadendra, M. quinquenervia and M. viridiflora*) at Peter Faust Dam is impacting on the eradication of *M. pigra* by hindering its visibility/detection and control. These three species were grown in pots at TWRC. Fourteen treatments were applied to the plants. Treatments were: triclopyr/picloram (Grazon* DS) at 900/300 and 450/150 g ha^{-1}; tebuthiuron (10% formulation) at 1500 g ha^{-1}; dicamba (Banvel® 200) at 1200 g ha^{-1}; triazinone (Velpar® L) at 1500 g ha^{-1}; 2,4-D/picloram (Tordon* 75-D) at 2250/562.5 g ha^{-1}; glyphosate (Weedmaster® Duo) at 3240 and 1620 g ha^{-1}; fluroxypyr (Starane* 200) at 600 g ha^{-1}; metsulfuron (Brush-Off®) at 72 and 36 g ha^{-1}; imazapyr (Arsenal® 250A) at 750 g ha^{-1} and a control. Final assessments were made and results are being analysed. A permit will be sought from the APVMA to register the most effective herbicide and rate that will effectively control the melaleuca species growing at the dam.

Expected completion

2010 subject to funding availability

Funding and logistic support

Queensland Government

Whitsunday Natural Resource Management Group

CRC Australian Weed Management

Weed functional groups

Objectives

- To improve our ability to predict which plants are likely to become serious weeds
- To further improve the Weed Risk Assessment process that is used to assess applications for importing plants into Australia
- To establish a protocol for deciding which recently naturalised plants should be given priority when planning control and eradication programs

Staff

Dane Panetta (Leader), Graeme Hastwell, Gabrielle Vivian-Smith, Jayd McCarthy (AFRS)

Progress

Analysis of the results of last year's plant functional type (PFT) experiment has been completed. Briefly, the PFT experiment quantified a series of plant traits (including above and below-ground growth, nutrient allocation and leaf characteristics) across 53 high and low-impact environmental weeds grown under controlled conditions.

Results

The analysis showed that the relationships between plant traits and weed impacts are complex, and that they differ between plant families. Although several traits that were correlated with weed impacts across all taxa were identified, cross-validation showed that those traits had very little predictive power (Table 2.2). Although this set of traits was able to correctly predict the impact status of some species, it performed very poorly for others (Figure 2.5). Overall, correct prediction rates (51.7%) were no better than random.

We further investigated the dataset by re-analysing data from species in Poaceae, Leguminoseae and Solanaceae, treating each family separately. Our expectation was that the re-analysis would identify identical sets of traits as being correlated with weed impacts, with the proviso that the lower number of replicates (8–11 species compared with the initial

53 species) may reduce the probability of identifying traits. However, the re-analysis identified several traits that were not identified in the analysis of the complete dataset (Table 2.2). Furthermore, no traits were common to all four trait sets. Predictive ability was improved, with most species being more accurately predicted by the family-level trait sets despite their being based on much smaller sample sizes (Figure 2.6).

Table 2.2 Plant traits correlated with environmental weed impacts

Data	ID Rate (%)	Trait
All species	51.7	Root weight
		Leaf area
		Number of leaves
		Root and stem carbon
		Root weight X number of leaves
Leguminoseae	55.5	Stem weight
		Root weight
Poaceae	62.6	Stem weight
		Leaf weight
		Root and stem carbon
Solanaceae	68.4	Root weight
		Leaf optical density
		Root weight X leaf optical density

Analyses were conducted on the entire data set (All species, 53 spp.) and for each of the three most numerous families among the species used in the experiment (Leguminoseae, 8 spp.*;* Poaceae, 11 spp.; Solanaceae, 9 spp.).

In addition, the estimates of the effects of individual traits often differed between families. For example, the slope estimates for root weight were 15.09 for Leguminoseae, and 145.25 for Solanaceae, while the estimates for stem weight were 19.66 for Leguminoseae, and 13.38 for Poaceae. Thus, changes in root weight had a much greater effect in determining impact among the Solanaceae than among the Leguminoseae, while changes in stem weight had the opposite effect on the Poaceae with respect to their effect on the Leguminoseae.

Discussion

Trait sets may differ between taxonomic groups for a number of reasons. In particular, weed impacts differ qualitatively, and it is likely that those impacts are phylogenetically correlated. Hence the traits associated with different types of impacts are also likely to differ between taxonomic groups.

Many of the traits associated with high competitive ability, such as leaf area and leaf weight, were absent from one or more of the trait sets. This suggests that interspecific competition may not be the primary determinant of weed invasion and impact that has commonly been assumed. We surmise that competitive response, i.e. the ability to withstand competition from neighbouring species, may be a larger factor, given that environmental weeds often invade established vegetation. This question warrants further research.

Our results indicate that it is unlikely that any universal trait set will be useful for predicting weed impact across all taxa. However, the improvement in predictive ability that occurs with trait sets from family-level data indicates that a more taxonomically-focused approach may still prove useful. Adopting trait-based prediction for weed risk assessment of species from plant families where there are conflicts between commercial applications and adverse environmental outcomes, such as *Leguminoseae* and *Poaceae*, may have considerable environmental and economic benefits.

Expected completion

2006

Funding

CRC for Australian Weed Management

Queensland Government

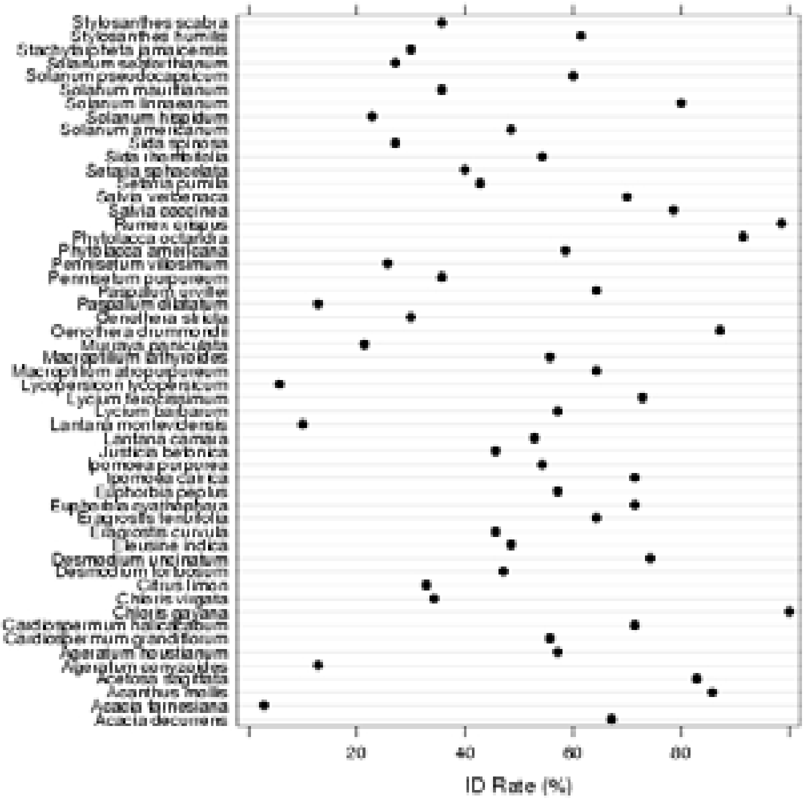


Figure 2.5 Impact status prediction rates

The rate at which all species trait set (Table 2.2) correctly predicts the impact status of samples for each species in the plant functional types experiment.

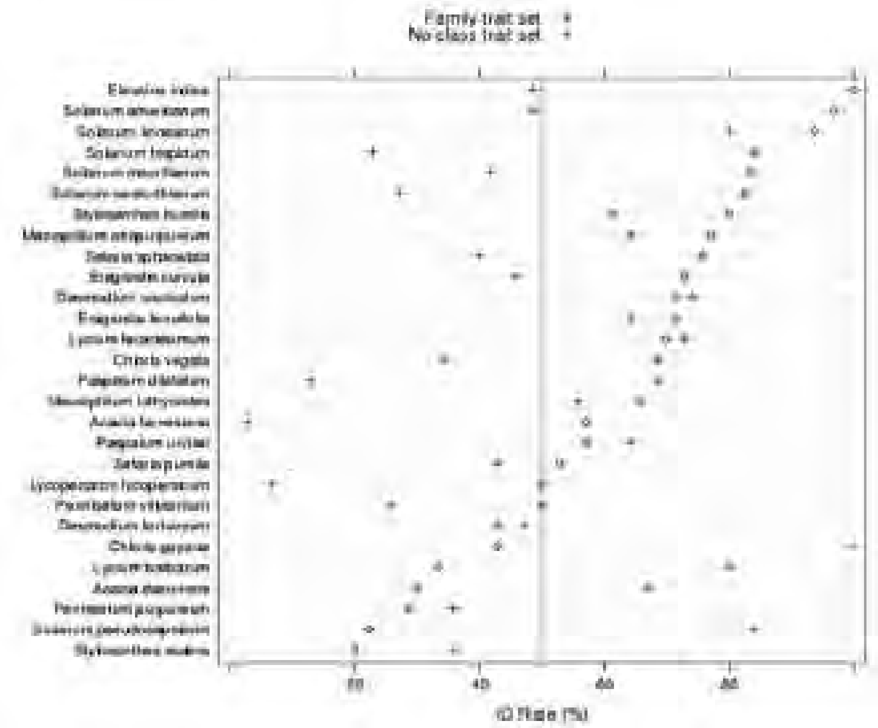


Figure 2.6 Impact prediction rates for all species

Impact prediction rates for all species (+) and family-level (°) i.e. Leguminoseae, Poaceae and Solanaceae trait sets. Vertical dotted line indicates the correct identification rate expected from tossing an unbiased coin.

Chapter 3 Management studies

Aerial control of bellyache bush (*Jatropha gossypiifolia*)

Objectives

- To evaluate a range of herbicides and rates for aerial control of bellyache bush, leading to aerial registration for control of bellyache bush
- To evaluate the efficacy of two herbicides for pre-emergent control of bellyache bush

Staff

Joseph Vitelli (Leader), Barbara Madigan (TWRC)

Method (aerial control trials)

Based on the results of a preliminary aerial field trial, four herbicides at four rates each were applied to mature potted bellyache bush plants in a randomised block design experiment. Each treatment consisted of 33 plants and was replicated three times. The plants were field collected and transplanted into 4-litre pots. The treatments used were triclopyr/picloram (Grazon* DS) at 450/150, 337.5/112.5, 225/75 and 112.5/37.5 g ha^{-1}; glyphosate (Roundup®) at 2160, 1620, 1080 and 540 g ha^{-1}; fluroxypyr (Starane* 200) at 600, 400, 200 and 100 g ha^{-1}; metsulfuron (Brush-Off®) at 72, 54, 36 and 18 g ha^{-1}; and a control. A surfactant (Uptake*) was added to each herbicide mix at 1 L ha^{-1}. The spray gantry at TWRC was used to simulate aerial application at 200 L ha^{-1}, complete double overpass. Height and basal diameter of plants were recorded. Plants were assessed at 28 days after treatment and further assessments will be made to measure percentage stem mortality.

Progress

- Metsulfuron was effective (>80% mortality) at all rates trialled, while only the highest rate of fluroxypyr (85.8%), triclopyr/picloram (95.5%) and glyphosate (98%) effectively controlled treated bellyache bush plants.
- The most effective herbicide and rate will be field evaluated at locations along the Burdekin and Palmer rivers.

Method (pre-emergent herbicide trials)

Pots containing 50 bellyache bush seeds and a measured weight of soil at a known soil moisture content were treated with two herbicides at various rates (metsulfuron [Brush-Off®] at 1152, 576, 288, 144, 72 and 36 g ha^{-1}; tebuthiuron [10% formulation] at 2000, 1000 and 500 g ha^{-1} and a control).

At selected days after application, each treatment was subjected to 21 simulated rainfall events to total 300 mm rainfall (Charters Towers average summer rainfall). Twice weekly, gravimetric soil moisture contents of pots were recorded, and emerging bellyache bush seedlings were recorded and marked. Mortality of emerged seedlings was noted.

All seedlings were then removed, and seeds retrieved from pots in each of the treatments will be tested for viability.

Progress

- Pots containing 50 bellyache bush seeds have been treated.
- Remaining seeds have been retrieved and tested for viability.
- Results are being analysed.

Expected completion

December 2007

Funding

Queensland Government

Evaluating the risk of off-target damage through the application of chemicals to control hymenachne (*Hymenachne amplexicaulis*)

Objectives

- To investigate the rate of breakdown and movement of haloxyfop applied within northern Queensland water systems, using aquarium tanks and enclosed and open water systems
- To establish residue levels of total haloxyfop in hymenachne and in non-target organisms, including fish, clams and crayfish

Staff

Joseph Vitelli (Leader), Barbara Madigan, Kent Worsley (TWRC), Lesley Ruddle (NRSc)

Methods

Laboratory studies

Two 100-litre glass aquarium tanks will contain either buffered sterile water (pH 7) or water and sediment from a creek system (~ pH 7) in northern Queensland. The tanks will be aerated and have aquarium lights on a 12-hour light/12-hour dark setting. Hymenachne, barramundi, freshwater mussels, redclaw, rainbow fish, fork-tailed catfish and purple gudgeons will be placed in each water tank. Water parameters (temperature, salinity, dissolved oxygen, pH, turbidity, conductivity) will be taken at commencement of treatment and at intervals during longer treatments. Verdict* equivalent to 400 g haloxyfop ha^{-1} will be sprayed on all hymenachne and the water surface. Ten minutes after treatment, 500 mL of tank water will be removed for analysis. At sampling times of 1, 3, 10, 31, 100, 316, 1000 and 3163 hours, water (from both field water and sterile water tanks) and sediment samples will be taken, and aquatic organisms will be harvested and analysed for haloxyfop-R methyl ester and haloxyfop acid.

This research is being conducted under an animal ethics permit, PAEC 040501. Only water samples will be taken from the sterile water tanks.

Field studies

Studies will be conducted in enclosed and open water systems located in northern Queensland. Water travel time will be monitored at each site prior to herbicide application.

Aquatic organisms for closed water systems research will be kept in floating cages. Samples and times will be as for the tank studies.

Progress

Laboratory studies: Creek water recorded significantly lower (53% less) haloxyfop-R methyl ester residue levels than distilled water within three hours of herbicide application. The disappearance of haloxyfop R-methyl ester was found to be rapid (<100 hours) in both creek water and aquatic organisms, whilst low levels (0.2 ppb) were still present in distilled water 3160 hours after herbicide application. No haloxyfop R-methyl ester residue levels were detected in redclaw or mussels throughout the study.

The total haloxyfop concentration in both distilled and creek water generally declined with time. Total haloxyfop residue levels for all biota (except redclaw) were significantly higher than residue levels in either distilled or creek water within one hour of herbicide application. Total haloxyfop levels peaked at three hours in barramundi, gudgeon, rainbow and mussels, and at 10 hours for redclaw and fork-tailed catfish. Residue levels in biota were up to 40 times higher than that in water for the same time period. Fork-tailed catfish accumulated haloxyfop in tissue within one hour, maintaining levels greater than 1000 ng g^{-1} for in excess of 1000 hours. Barrumundi was the only organism in which no haloxyfop was recorded after 1000 hours.

The aquarium study allowed haloxyfop breakdown data to be collected in a controlled environment and represented the 'worst case scenario' for the potential bioaccumulation of haloxyfop in aquatic organisms. Studies to quantify haloxyfop breakdown in field situations will commence in August 2005. This data will contribute towards the registration of haloxyfop for the control of grasses growing in aquatic situations, and assist in establishing withholding periods. The chemical breakdown studies will also assist the Australian Pesticides and Veterinary Medicines Authority in determining the situations where haloxyfop can be applied and the implications to certain aquaculture industries.

Expected completion

March 2006

Funding

Natural Heritage Trust

Queensland Government

Herbicide screening, refinement and registration for southern Queensland

Objectives

- To investigate and assess herbicides and other methods of controlling priority weeds
- To minimise pesticide dosages through improved application techniques and strategies in maintaining control of target species

Staff

Earl Sparkes (Leader), Paul Shortis, Trevor Armstrong, Michele Rogers (AFRS)

Methods

*The herbicide s*creening process incorporates the testing of the maximum number of formulations so that weed susceptibility is measurable. Screening may involve trying new herbicide application techniques. Replicated trials refine methods that were successful during the screening process. From these trials, the most effective herbicides, rates and methods of application are registered or off-label permits are sought from the APVMA. Pesticide dosages entering the environment are minimised through improved application techniques and strategies and in maintaining control of target species while avoiding off-target damage.

Progress

Umbrella tree (*Schefflera actinophylla*)

A third trial, further evaluating the effects of herbicides and control techniques, is undergoing final assessments on large and small plants on the Sunshine Coast. Initial assessments indicate imazapyr, metsulfuron-methyl and glyphosate as the most effective herbicides for stem injection. The most effective basal bark treatments include both a medium dose of 2,4-D n-butyl ester and higher rates of triclopyr + picloram ester, using dieseline as the carrier. Metsulfuron-methyl has shown promise as a foliar spray on plants less than one metre high.

Umbrella tree encroaching into remnant bushland in Noosa National Park

White moth vine (*Araujia sericifera*)

A replicated control trial was monitored at Ravensbourne, north-east of Toowoomba. It involved mechanical, cut stump, splatter gun, four foliar spray treatments and two basal bark treatments. Data reflecting the impact of trialled control strategies has been collected.

Climbing asparagus (*Asparagus africanus*)

A research paper has been completed showing basal bark spraying gives better control than foliar spraying.

Ochna *(Ochna serrulata*)

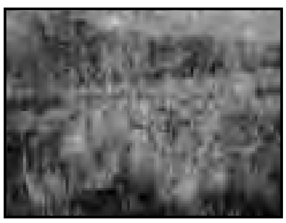
A paper presenting research findings into control methods was published in *Plant Protection Quarterly*.

Quilpie mesquite (*Prosopis velutina Woot)*

Mesquite is an invasive, prickly woody weed that is believed to have been introduced into southwest Queensland in the 1930s. Although it produces palatable pods and provides shade for grazing stock, it develops dense thickets, reducing pasture growth.

A comprehensive set of herbicide control options was developed that contributed to an integrated control strategy principally bridging on ongoing initiatives such as blade ploughing, biological control, control using vertebrates such as goats and improved pasture management including introduction of improved pasture species.

A mesquite plant prior to herbicide application



A mesquite plant six months after the application of clopyralid

Suckering/running bamboo (*Phyllostachys spp.)*

Following good rain through the summer months at the Canungra experiment site, glyphosate had the quickest knockdown but induced deformed shoots and promoted suckering. Root-absorbed flupropanate has controlled new plants and appears to suppress regeneration from suckers. Assessments are continuing.

African love grass (*Eragrostis curvula*)

Assessments monitoring seedling emergence after rain and residual herbicide effects were continued. Indications are that rainfall has been insufficient for establishment after any of the treatments.

Other applications for permits with the APVMA

- Environmental weeds permit Nº 7485 for Queensland was renewed and now incorporates the Madeira vine permit Nº 4860.
- Leucaena *(Leucaena leucocephala)* permit Nº 7489 was renewed until June 2007.
- Coral cactus (*Opuntia cylindrica* var. *cristata*) permit Nº 6369 was renewed until June 2008.
- African love grass (*Eragrostis curvula*) permit Nº 6765 was renewed until December 2008.
- An application for the renewal of the permit for the use of metsulfuron-methyl on giant sensitive bush (*Mimosa pigra*) has been forwarded to the APVMA.

Expected completion

June 2006

Funding

Queensland Government

Agronomist Trevor Armstrong using Quikspray's Anabranch Liquid Handling System to measure herbicide concentrates

Integrated management of bellyache bush (*Jatropha gossypifolia*) in northern Queensland

Objectives

- To develop an integrated management strategy for bellyache bush
- To evaluate the efficacy of combinations of fire, slashing, and Brush Off® (foliar spray) on mortality, seedling recruitment and survival of bellyache bush
- To better understand the ecology of bellyache bush and the implications for timing and effectiveness of control strategies
- To promote changes in management practices that will lead to sustainable levels of production

Staff

Faiz Bebawi (Leader), Joe Vitelli, Shane Campbell and Matthew Madigan (TWRC)

Methods

There are two areas of research associated with this project: integrated weed control and weed ecology of bellyache bush.

Integrated weed control

The impact of singular treatments (fire and slashing) on bellyache bush was examined at two north Queensland sites near Charters Towers (Sandy Creek and Larkspur). A five-year integrated management trial was initiated on riparian habitats adjacent to Sandy Creek and Southern Cross Creek at Almora Station near Charters Towers to determine the most effective combination of fire, slashing, stick-raking, and chemical treatments for controlling bellyache bush.

Weed ecology

A range of experiments were conducted to help fill knowledge gaps about bellyache bush seed ecology, flowering periodicity, competitive ability under different simulated grazing pressures, population dynamics, jewel bug impact on seed ecology of bellyache bush, and impact of integrated control treatments on pasture composition and yield.

Progress

Integrated weed control

Integrated control treatments (Almora Station)

A study on the efficacy of a combination of primary control techniques including slashing, stickraking, burning and spraying (foliar spray) followed by secondary control techniques including slashing, burning and spraying was initiated in April–May 2002. Results of the primary and secondary treatments are presented in Figure 3.1. The trial is ongoing.

Weed ecology

Seed longevity research (Larkspur)

A trial on seed longevity of bellyache bush was initiated on March 2001 at Larkspur where two types of bellyache bush seeds (intact and ant-discarded) were buried at six burial depths (0 cm on mulched ground, 0 cm on bare ground, 5, 10, 20 and 40 cm) under natural and rain-shelter conditions. Seeds exhumed after 36 months were viable (Figure 3.2). The trial is ongoing.

Seed bank longevity research (Riverview and Sandy Cree*k*)

A trial was conducted in December 2000 at two sites (Riverview—rocky habitat, and Sandy Creek—heavy clay habitat) to determine seed bank longevity of bellyache bush after complete removal of bellyache bush infestations from the sites. Thirty-nine months later, seedling emergence is still occurring at the sites where bellyache bush populations have been removed. The trial is ongoing.

How long does it take for bellyache bush to dominate a pasture?

A trial was established in September 2002 to determine the impact of five simulated grazing intensity regimes [no grazing (uncut pasture), low (cut at 40 cm height), medium (cut at 20 cm height), high grazing (cut at 10 cm height) and no pasture (pasture removed)] on four bellyache bush population densities [control (no bellyache bush), low (10 000–20 000 plants/ha), medium (20 000–60 000 plants/ha), and high density (60 000–120 000 plants/ha)]. Fourteen months after treatment application, bellyache bush at high density gained 2.6% of pasture area (Figure 3.3). The trial is ongoing.

Agronomic impact of the jewel bug (*Agonosoma trilineatun*)

A trial was established in February 2004 to determine the agronomic effects of three densities (control, low and high) of the jewel bug on capsule abortion, seed production, seed germination and viability of bellyache bush plants grown under mosquito netting at TWRC. Capsule abortion of immature and mature capsules at high insect density, was 80% and 12% respectively. After five months, seed production at high insect density was reduced by 87%. The trial is ongoing.

Expected completion

June 2006

Funding

Queensland Government

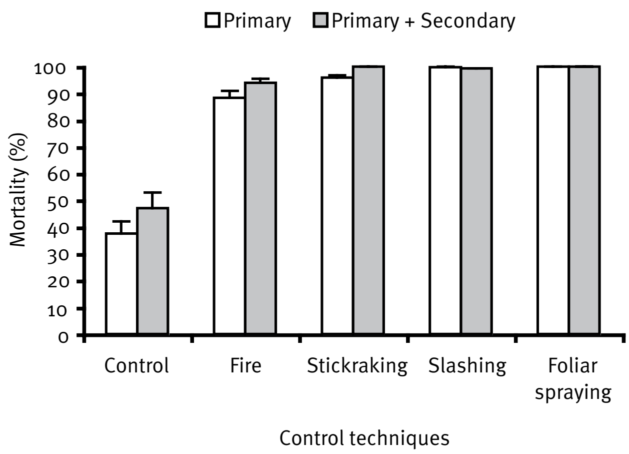


Figure 3.1 Mortality of bellyache bush

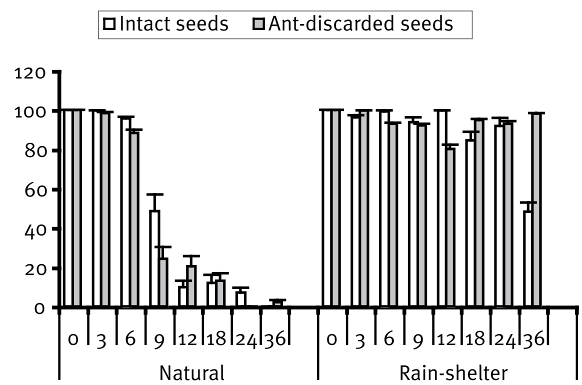


Figure 3.2 Viability of bellyache bush seeds

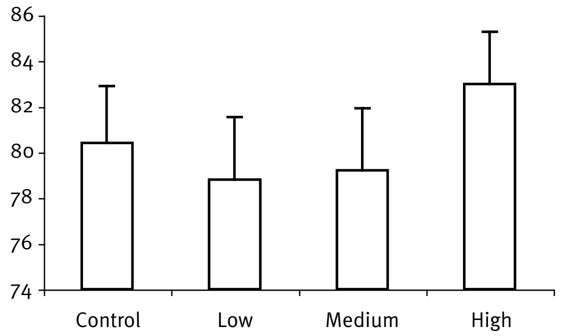


Figure 3.3 Free basal area of pasture affected by bellyache bush density

Integrated management of parkinsonia (*Parkinsonia aculeata*)

Objectives

- To evaluate the efficacy and cost of control methods to provide the technical basis for management packages
- To better understand the ecology of parkinsonia and the implications for timing and effectiveness of control strategies
- To promote changes in management practices that will lead to sustainable levels of production
- To report research findings to all stakeholders, through the media and publication of scientific articles

Staff

John McKenzie (Leader), Mike Pattison, Simon Hill, Shane Campbell (TWRC)

Methods

Development of integrated control strategies

A dense parkinsonia infestation located near Duaringa in central Queensland was selected to compare the efficacy of 11 treatments. These involved the use of ground (basal bark spraying of a 1:60 Access®/diesel mixture and spot spraying of Velpar®L) and aerially applied herbicides (Grazon* DS and Graslan*), and mechanical techniques (blade plough, Ellrott plough, stick-raking, dozing and double pulling). Burning was initially included in the experiment as a possible treatment, but was later removed because of the lack of sufficient fuel to carry a fire. Secondary treatments were imposed based on initial kill rates. Primary treatments that had kill rates greater than 85% were generally treated by basal barking, except for the residual chemical treatments. Graslan* treated plots were left untreated and only mature plants in the Velpar ® L plots were sprayed. This was done to stop seed being added to the seed bank, thereby enabling measurements on both the residual and soil seed bank run down. Plots that were stick raked were foliar sprayed with Grazon* DS. Plots that were initially double pulled, dozed and aerially treated with Grazon *DS were follow up treated using the Ellrott plough.

Ecological research

As part of a Weed CRC project, CSIRO has coordinated the establishment of five parkinsonia research sites scattered throughout the rangelands of Australia. These areas are considered to be representative of the diversity of environmental conditions where parkinsonia is currently found growing. TWRC staff collect ecological data on a monthly basis from a central Queensland site. Measurements undertaken on parkinsonia include growth and development, leaf and flower production, and seed bank longevity.

The effect of direction and season of burns on parkinsonia populations

This study is aimed at quantifying the efficacy of fire as a control technique for parkinsonia. The experiment comprises a split plot design with season of burn (end of wet season/early dry season, late dry season, early wet season and mid wet season) allocated to main plots and direction of burning allocated to sub plots (head fire and back fire).

The effect of camel grazing on parkinsonia

Camels are currently being used by a small group of landholders as a control option for parkinsonia. A field study was undertaken to quantify their impacts, with 20 mature parkinsonia plants selected from within both grazed and ungrazed paddocks on two properties. Seed production and plant biomass measurements were recorded on individual plants and 60 soil cores (4.5 cm x 5 cm)were also collected beneath the canopy of each tree.

Progress

Development of integrated control strategies

Preliminary findings indicate that the five most effective primary control methods (in terms of initial plant mortality) are blade ploughing using either front (93%) or back mounted machines (91%), basal bark spraying (97%), Graslan* DS (81%) and Velpar ® L(97%). Of these, the least expensive to implement were the broad scale blade ploughing (\$126 and \$156 ha^{-1} for front mounted and back mounted ploughs, respectively) and aerially applied Graslan*

($180 ha^{-1}) treatments. In contrast, individually applied Velpar® L and basal bark applications averaged $270 ha^{-1} and $412 ha^{-1}, respectively. Final recommendations will be deferred until post-treatment seedling regrowth and pasture responses have been quantified and the most appropriate secondary options determined.

Ecological research

Seed bank longevity

The key finding from the ecological research to date is that the seed bank of parkinsonia appears to be relatively short lived, with greater than 90% of the seed bank depleted within two years. This research is ongoing.

The effect of direction and season of burns on parkinsonia populations

Results to date suggest that all seasonal fires and direction of fires implemented caused significantly higher mortality than the untreated controls. However, there was no significant difference between seasons or direction of fires on parkinsonia plants and recruitment levels. Larger plants were found to be more susceptible to fire than juvenile plants.

The effect of camels on parkinsonia

The field research has been completed and the data are now being analysed.

Expected completion

June 2006

Funding

Queensland Government

NHT2 Weeds of National Significance

CRC Australian Weed Management

Weed eradication feasibility and program evaluation

Objectives

- To provide a scientifically-based rationale for decision making with regard to eradication of weed incursions
- To refine eradication methods by using ecological information
- To monitor selected eradication programs and document associated costs
- To develop criteria by which eradication progress can be assessed

Staff

Dane Panetta (Leader)(AFRS), Simon Brooks, Shane Campbell (TWRC), Stephen Setter (CWTA)

Collaborators

Data for eradication case studies are provided by NRMW Land Protection staff based at South Johnstone and several local government pest management officers.

Ecological studies of Class 1 weed eradication targets are conducted in conjunction with the Ecology of Wet Tropical Weeds project at South Johnstone.

Background

Early intervention is the most cost effective means for preventing weed incursions from reaching the stage of rapid expansion. Strategies designed to achieve this aim range from eradication, where the objective is to drive the incursion to extinction, to containment, which may vary from absolute to degrees of slowing spread. Recent and ongoing work to determine the feasibility of eradication and containment should contribute to formulating decision rules for determining management approaches. To make informed decisions, it is essential to gather case study data to provide a basis for determining to what degree management objectives are being achieved and assess progress towards eradication. The eradication of selected Class 1 weeds in north Queensland also presents opportunities to collect supporting weed ecology data under local conditions.

Methods

The project is collating data on eradication resources and progress, on a site and per visit basis for *Miconia racemosa*, *M. nervosa*, *M. calvescens*, *Limnocharis flava*, *Clidemia hirta*, *Mikania micrantha* and *Mimosa pigra* in Queensland. Data includes the geographical spread of sites, site discovery over time, labour resources, changes in infested areas and population over time and time since last emergence. Additional case studies will be added from elsewhere in Queensland and interstate.

To support the eradication efforts, investigations have commenced into the age to maturity, recruitment, and soil seed bank rundown for *M. calvescens* and *L. flava* under field conditions. Additional ecological data sources from established *M. pigra* and *Chromoleana odorata* sites have been identified. Some additional information about these species is presented in the Ecology of Wet Tropical Weeds and the *M. pigra* research projects.

A scoring system for the evaluation of progress towards the eradication objective is under development. The current system takes into account five-year trends in cumulative infested area, the detection ratio (infested area detected/area searched), and the average distance between new infestations and known infestations. It also includes an extinction score, which is a composite of the percentage of infestations in the monitoring phase (no plants detected for at least 12 months) and the percentage of infestations eradicated.

Progress

This project has contributed to a recording protocol for operational field staff to document resource inputs and management of north Queensland weed infestations targeted for eradication. In conjunction with the eradication program conducted by NRM, there are considerable inputs from several local governments into monitoring of *Clidemia hirta*, *Mikania micrantha*, *L. flava* and *Miconia* spp. eradication sites. This project is a vehicle to recognise the inputs of local governments and other agencies in the eradication of selected weed species. Past and current occurrences of selected species have mostly been verified, catalogued and mapped.

The tagging of newly emerged *Limnocharis flava* seedlings has shown most seedlings flower after a minimum of two to three months growth. However, two seedlings have flowered after 35 days. On the basis of the minimum value, it is recommended that monitoring for *Limnocharis* emergence takes place monthly at eradication sites. Near Tully, greater emergence of *Limnocharis* seedlings has been recorded in the warmer months between September and April.

The regeneration, growth rates, population structure and eradication resources at a *Miconia calvescens* site near El Arish have also been documented.

A prototype scoring system for the evaluation of progress towards the eradication objective has been applied to an earlier successful eradication program targeting bitterweed (*Helenium amarum* L.) in south-eastern Queensland and to the ongoing program targeting branched broomrape (*Orobanche ramose L.*) in South Australia (Figure 3.4). It is notable that the branched broomrape program has commenced with a higher score than the bitterweed program did. The extended plateau in the time course of the progress score for the latter species was due to repeated episodes of seed production, despite a relatively high frequency of site visits. This 'reproductive escape' led to a very long active control phase.

Expected completion

June 2008

Funding

CRC for Australian Weed Management

Queensland Government

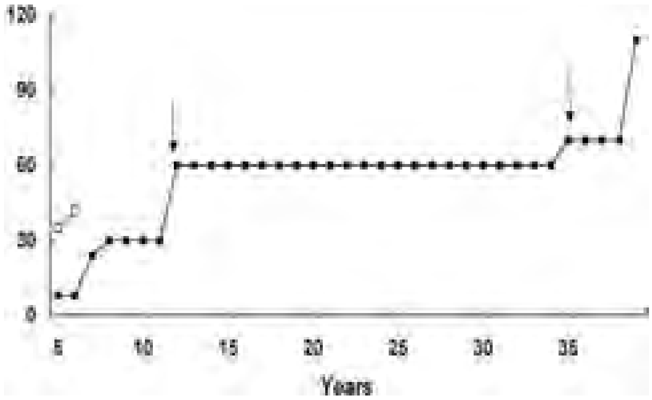


Figure 3.4* Eradication progress scores for bitterweed (solid symbols) and branched broomrape (open symbols)

For bitterweed, the left and right arrows refer to the eradication of a small satellite infestation and entry of the main infestation into the monitoring stage, respectively.

Water weed management, WONS and Class 1 plant pests

Objective

To develop eradication strategies for cabomba (*Cabomba caroliniana*), senegal tea plant (*Gymnocoronis spilanthoides*), hygrophila (*Hygrophila costata*) and alligator weed (*Alternanthera philoxeroides*)

Staff

Tom Anderson (Leader), Michele Rogers (AFRS)

Methods

Evaluation of potential improvements in eradication methods is undertaken. The major issues have been identified as:

- finding an alternative chemical to 2,4D for cabomba control
- improving efficacy by developing new chemical delivery systems
- managing residues by containment curtains
- improving chemical biodegradability.

Table 3.1 Effect of herbicides on cabomba survivor dry weight and phytotoxic response

Product	Active ingredient	Phytotoxic rating 1=alive, 5= dead	Survivor dry weight (g)
Control		1.0[A]	0.30
FMC Carfentrazone	*Carfentrazone*	4.8	0.00
Agricrop Rubber Vine Spray	2,4-D ester	3.4	0.02
Garlon *600	Triclopyr ester	3.4	0.04
Brominicide 200	*Bromoxynil*	4.4	0.00
Ronstar®	*Oxadiazon*	4.4	0.02
Bin-Die	Bromoxynil/ MCPA	3.8	0.02
Reglone®	Diquat	2.4	0.10
Vigilant®	Picloram K	1.8	0.27
Garlon®3A	Triclopyr amine	1.6	0.29
Tordon *Granules	Picloram amine	1.5	0.34
Winter Grass Killer	Endothal	1.4	0.38
Weedmaster® Duo	Glyphosate	1.4	0.21
Arsenal®250A	Imazapyr	1.2	0.21
Velpar®L	Hexazinone	1.2	0.25
Casaron G	Dichlobenil	1	0.27
Londax®DF	Bensulfuron	1	0.32
Kupramine®	Copper amine	1	0.32
Saltwater 40%		4	0.06
Bleach 1%	Chlorine	4.8	0.01
Organic interceptor 1%	Pine oil	4.6	0.10
Brunnings Urea 1%	Urea	5.0	0.00

Note: Products are in order of efficacy; bold refers to suitability for use in an aquatic environment. Active ingredients in italics are insoluble. All products applied at a rate of 10 ppm active ingredient. [A] Values are an average of five replications.

Replicated glasshouse screening trials followed by field efficacy studies are used to gather efficacy data. The project is a partnership between Environment Australia community environmental groups, local government and affected landowners.

Progress

Twenty-three products were tested in a screening trial. Two were relatively new aquatic products, FMC Carfentrazone and Garlon 3A. Agricrop Rubber Vine Spray was used as the benchmark product, as this is the only product currently registered against cabomba. Arsenal (imazapyr) was included because of its fast breakdown in water. Salt water, bleach and pine oil were tested as they are often suggested as control methods. Urea was included, as it has given good control of hornwort, *Ceratophyllum demersum*, a species closely related to cabomba.

Ten products showed effectiveness, based upon phytotoxicity scores; these were Hammer®EC, Agricrop Rubber Vine Spray, Garlon*600, Brominicide 200, Ronstar®, Chemspray Bin-Die, Bleach, Organic interceptor contact weed spray, seawater and Brunnings Urea. Of these ten, three are worthy of further consideration: FMC Carfentrazone, Agricrop Rubber Vine Spray and Garlon*600.

Other herbicides, Ronstar®, Brominicide 200 and Bin-Die performed better or as well as Agricrop Rubber Vine Spray, but would never be acceptable for aquatic applications because of fish toxicity.

Cabomba appeared to tolerate saltwater with 40% or (15 $mScm^{-3}$) being lethal. Cabomba was quite tolerant of bleach at 0.1 and 0.5%, but 1.0% was lethal. A bleach application rate of 0.1% would be unrealistic in practice. Organic interceptor contact weed spray, a pine oil herbicide had similar effects as bleach; high concentrations were needed to cause mortality. Brunnings Urea at 0.5 and 1% killed cabomba and may have some use where traditional herbicides cannot be used. Urea at these rates would be expensive and environmental considerations may prevent its use. FMC Carfentrazone is particularly interesting as it already has aquatic registrations in the USA and is registered on rice in Australia. A short half-life in water makes it attractive. Field-testing on naturally growing cabomba will determine the efficacy of Hammer and Garlon 600.

Laboratory tests are underway for a herbicide delivery agent. Products that may be useful are Rainsaver® gel crystals, silicone/raincoat, lanoline/solution; grease, fluro proofing agent/Aqua proof, Teflon/Star bright, Floetrol/acrylic extender, waxes, mud/grout clays and zeolite sand.

Commercially available cultured bacteria that breakdown herbicide residues have been obtained for testing.

Field trials have been set out, with FMC Carfentrazone working well.

Expected completion

Ongoing

Funding

Environment Australia NHT

Queensland Government

Land Protection Fund

Logistic support

Lake Macdonald Catchment Care Group

Noosa Council

Pine Rivers Shire Council

Wet Tropics weeds project—chemical trials

Objectives

- To develop herbicide control measures for various weeds of the Wet Tropics and to improve technology for their management, containment or eradication

Specific objectives for the 2004 to 2005 year were as follows:

- To evaluate chemical screening of various herbicides for the control of praxelis (*Praxelis clematidea*) growing in the field
- To evaluate three herbicides applied as foliar sprays for the control of Siam weed (*Chromolaena odorata*) growing in the Townsville/Thuringowa region
- To evaluate the seasonal application of Sempra® for the control of mature navua sedge (*Cyperus aromaticus*) growing in the field
- To determine the number and frequency of glyphosate applications required to deplete a navua sedge soil seed bank
- To determine the longevity of navua sedge seeds buried at different depths over time
- To monitor and collect baseline data on navua sedge growth rates and seed production

Staff

Peter van Haaren (Leader) (CWTA), Joseph Vitelli and Barbara Madigan (TWRC)

Methods

Weed control

Praxelis (*Praxelis clematidea*)

Six foliar herbicides at two rates were applied to praxelis in a randomised complete block design experiment in April 2004. Each treatment was replicated three times.

Chromolaena (*Chromolaena odorata*)

Chemical control

Variable results using Grazon*DS as a foliar herbicide for the control of chromolaena have been reported by several field operatives. The efficacy of three herbicides (Grazon*DS, Starane*200 and Brush-Off) applied to chromolaena growing in the Townsville/Thuringowa region was evaluated. Each treatment consisted of 50 plants per plot, and was replicated 3 times. The height, diameter and number of stems per plant were recorded prior to herbicide application. Plant mortality and seedling recruitment was determined six months post-application.

Navua Sedge (*Cyperus aromaticus*)

There are two main areas of research associated with navua sedge: chemical control and weed ecology.

Chemical control

To date halosulfuron-methyl (Sempra®—a herbicide registered for the control of sedges) has controlled navua sedge poorly in initial screening trials, with season being blamed for poor herbicide performance. A seasonality trial will determine the effectiveness of halosulfuron-methyl when applied at different times of the year for the control of navua sedge. Halosulfuron-methyl was applied at two rates (130 g per hectare and 520 g per hectare) monthly, commencing in July 2004, with each treatment replicated three times. Biomass reduction, mortality and density counts of navua sedge were recorded at each assessment period.

A frequency trial to determine navua sedge seed bank depletion and seedling control with the chemical glyphosate was commenced in early July 2004. This involved three treatments:

- once only application of glyphosate
- application repeated every 6 to 8 weeks
- application repeated every third month.

Each treatment was repeated three times. Navua sedge density counts were taken before, during, and post application.

Weed ecology

Seeds of field-grown navua sedge were collected from plants growing along roadsides and degraded pastures near Babinda in far north Queensland in November 2001. After collection, unfilled seeds were removed from the sample and filled seeds stored at low humidity at 5±2 °C until initiation of longevity and germination experiments 1 to 2 months later. The longevity experiment consisted of a split-plot design, with sampling time as the main plot (0, 3, 6, 12, 24, 36, 60, 120 and 180 months), and burial depth as the sub-plot (Laboratory stored, 0, 2 and 10 cm). The seed packets were buried using a randomised grid design in a field site at South Johnstone in far north Queensland. Each treatment was replicated four times. The existing ground cover (grass) was initially removed manually, and then allowed to grow over the site.

The growth rate, time to reproductive maturity, and seed production of 10 potted navua sedge seedlings were monitored for 12 months at Innisfail.

Progress

Weed control

Praxelis (*Praxelis clematidea*)

A 100% kill of praxelis was achieved with metsulfuron-methyl, monosodium methylarsonate and the higher rates of triclorpyr/picloram and 2,4-D/picloram. Praxelis density at the start of the trial averaged a million plants per hectare. Seedling recruitment was highest in the monosodium methylarsonate plots and least in metsulfuron-methyl plots 90 days after treatment. All plots except for metsulfuron-methyl, produced seedlings that flowered within 21 days after emergence. The trial has been completed.

Chromolaena (*Chromolaena odorata*)

Mortality of chromolaena following foliar spraying ranged between 70 and 100%, depending on the herbicide used. Significant differences in mortality of chromolaena were detected between metsulfuron-methyl (77%), fluroxypyr (99%), and triclopyr/picloram (93%).

Navua sedge (*Cyperus aromaticus*)

Preliminary results indicate that time of year may not be the critical factor for successful control, but rather soil moisture. Herbicide efficacy increased when halosulfuron-methyl was applied to stressed navua sedge plants. A glasshouse experiment involving halosulfuron-methyl being applied to plants grown at different soil moistures will commence in Charters Towers in 2005 and 2006. The field trial has been completed.

The frequency of glyphosate applications required to control emerging navua sedge plants before they set seed indicates that this strategy would not be economically viable in the long term. Glyphosate, though effective at controlling navua sedge plants when used in isolation, without other control options (for example pasture competition) will prove ineffective due to the large and persistent navua sedge soil seed bank.

Weed ecology

Seed longevity of navua sedge

Viability of buried seeds is still high (>62%) after three years (Figure 3.5).

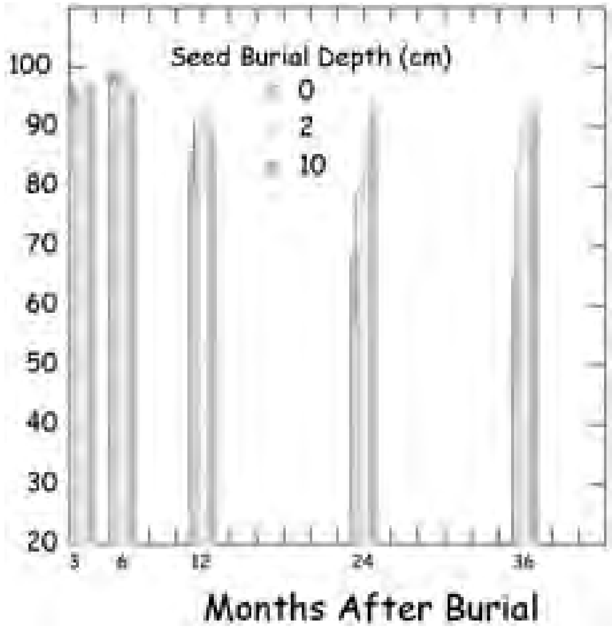


Figure 3.5 Viability of navua sedge seed as affected by three burial depth at 3, 6, 12, 24 and 36 months

Growth rate, time to reproductive maturity, and seed production of navua sedge

Plant height averaged 50 cm after 110 days and reached ~80 cm 385 days after emergence. The number of stems at final assessment averaged 278 stems/plant with 108 stems bearing inflorescences. The ratio of flowering to non-flowering stems was 1 : 2.6. The time to first flower averaged 52 ± 1.1 days, with seeds taking an additional 30 days to ripen on the flower head. This trial has been completed.

Expected completion

Ongoing

Funding

Queensland Government

Chapter 4 Chemical research projects

Effective 1080 meat baiting for feral pigs

Objectives

- To assess the amount of 1080 in meat baits required to kill feral pigs
- To investigate the longevity of 1080 and substrate for pig meat baits
- To undertake a field assessment of the efficacy of feral pig baiting using a quantitative biomarker to assess multiple bait uptake by feral pigs

Staff

Matt Gentle (Leader), Peter Elsworth (RWPARC), Jim Mitchell, Bill Dorney (TWRC), Bob Parker (AFRS)

Background

Baiting of feral pigs with 1080 meat baits is undertaken for broadscale reductions and is recommended in the event of an exotic disease outbreak. Much of the variation in the success (31–81% population reduction) of current baiting practices may be due to variations in bait uptake due to bait density, bait location or seasonal conditions. But the overall low level of reduction may be a result of pigs consuming insufficient bait to receive a lethal dose. It is therefore essential to have a greater understanding of how many baits are consumed by feral pigs at a particular bait and pig density. This information, when combined with the lethal dose required, will indicate whether the poor levels of reduction are due to insufficient toxin or failure of feral pigs to consume bait. Additionally, it is not known how long 72 mg 1080 meat baits will remain toxic; this needs to be understood to ensure that baits that are removed by pigs still contain lethal amounts and to ensure that meat baits do not offer a long-term hazard to non-target animals, such as farm dogs.

Methods

Methodology will follow that of a toxicity trial using penned animals to allow comparison with previous trials. However, there may be differences in the susceptibility of penned feral pigs compared to free-ranging feral pigs, so additional experiments will be undertaken to assess the effect of factors such as a varied diet and pig activity on the toxicity of 1080.

To estimate the longevity of baits, 72 mg 1080 baits will be presented in the field for specific periods before being collected and assayed for 1080 concentration. This will be done within a sample of Queensland environments that represent areas where aerial baiting is occurring. In each case, baits will be covered with a cage to protect them from uptake and consumption by animals.

Estimating bait uptake in free-ranging pigs will be undertaken by aerially baiting with non-toxic meat baits containing iophenoxic acid (IPA), a quantitative biomarker. Bait density will most likely be 12 baits/pig/km^2 to fall in with current practices but this may change in view of the results of the toxicity trials. Once aerial baiting has been completed, a shot sample of the population will be undertaken shortly following bait distribution. A blood sample will be removed from each individual, providing estimates of the proportion of the population that consume bait, and the quantity of bait that is consumed.

Progress

Toxicity trials have been conducted on 28 adult feral pigs. Pigs consumed doses of 1080 in meat bait ranging between 2.5 and 3.5 mg/kg bodyweight. The results to date have confirmed that the dose of 1080 to kill most feral pigs (defined here as 90%) appears to be greater than 3.0 mg/kg bodyweight. These results have confirmed our suspicions that feral pigs require a relatively large amount of 1080 for a lethal dose.

Feral pig about to be re-captured during the paddock toxicity trials at RWPARC, Inglewood

Bait degradation trials have been initiated at Cunnamulla, south-western Queensland and South Johnstone and Lakeland Downs, northern Queensland. Samples will continue to be collected.

In September 2005, aerial baiting trials are planned for Inverleigh, near Normanton, north Queensland.

This is being undertaken under Animal Ethics Approval No. 040803.

Expected completion

December 2006

Funding

Queensland Government

Bureau of Rural Sciences National Feral Animal Control Program

Non-target impacts of canid-baiting on quolls

Objective

To monitor and quantify the impacts of canid-baiting campaigns on quoll populations

Staff

Peter Cremasco (Leader), Tony King (RWPARC), Bob Parker (AFRS)

Methods

Areas of potential quoll habitat that are baited with 1080 to control foxes/wild dogs will be surveyed to find suitably dense populations of spot-tailed quolls (*Dasyurus maculatus*). Quolls will be trapped in cage traps, and then micro-chipped and radio-collared. Individuals within the population will be monitored during and after regular spring and autumn wild dog baiting campaigns, and their fate assessed throughout the program. The fate of wild dog baits will be assessed during the baiting program. Predator indices from before and after baiting will be compared to assess the effectiveness of the baiting program.

Progress

Two spring (2002 and 2003) and two autumn (2004 and 2005) monitoring periods have been conducted. During those four years, 76 individual quolls have been monitored. Two quolls have been confirmed as having ingested a 1080-bait and died. During that time, a further five quolls are known to have died from non-1080 related causes. 1080 cannot be ruled out in the death of a sixth quoll. About half of the population under study appear to die each year due to natural causes. Despite this, the studied population appears to be stable and robust, with no decline in overall population density over the four years of monitoring.

Funding was secured in early 2005, from the BRS National Feral Animal Control Program, to continue the work through to December 2006. An experimentalist, Tony King, has been appointed to the project.

Surveys continue to be conducted in the Warwick, Granite Belt and Mundubbera areas for other populations of quolls to monitor.

Extensive liaison has occurred with other Queensland researchers, as well as interstate research bodies, in an effort to standardise experimental design and maximise the usefulness of collected data.

Expected completion

December 2006

Funding

Queensland Government

Bureau of Rural Sciences

Dario Rivera (volunteer) handling a quoll while doing research at Cherrabah

Tissue residue and degradation of fluoroacetate from poisoned feral pigs

Objectives

- To determine the fluoroacetate residue levels found in poisoned feral pig carcasses
- To determine the persistence of carcasses
- To investigate which species consume carcasses and assess the potential of these species to be susceptible from consuming carcasses

Staff

Matt Gentle (Leader), Peter Elsworth (RWPARC), Bob Parker (AFRS)

Background

Sodium fluoroacetate (1080) is a widely used toxin for control of vertebrate pests in Australia. Given that a large dose of 1080 may be required to kill feral pigs, a high concentration of fluoroacetate residue may be found in the tissues of a poisoned animal. The levels of fluoroacetate found in carcasses should be investigated to assess if fluoroacetate pig-baiting campaigns constitute a significant secondary poisoning risk threat to non-target species, to ensure the responsible and sustainable use of fluoroacetate.

Methods

Samples were collected during routine poisoning campaigns. Landholders free-fed areas with non-toxic grain for up to one week; 1080-impregnated fermented wheat (288 mg 1080/kg wheat) was substituted following regular consumption of the free-feed. The following morning, carcasses were located and the following samples collected: liver, kidney, stomach, stomach contents, small intestine, large intestine, muscle and eye. Samples were frozen (–100ᴰC) until analysis with gas chromatography. The level of fluoroacetate determination for this method was 0.005 ug/g.

The risk of secondary poisoning to non-target species was assessed through comparing the fluoroacetate residue concentration in specific tissues with the lethal dose for a number of likely non-target consumers. The lethal 1080 dose for these animals was calculated from published LD_{50} values and expected adult bodyweights. The susceptibility of each species was based on the weight of tissue to be consumed to obtain this dose, based on the maximum amount of fluoroacetate residue in various pig tissues.

Between September and December 2004 the longevity of non-poisoned feral pig carcasses was assessed in semi-cleared grazing country at Inglewood, south-western Queensland. Their longevity was investigated through general descriptions of their state of decomposition and recording carcass weights. The species visiting and consuming carcasses were identified via remote digital or video cameras, or by track plots.

Results

The tissues of six pigs poisoned from 1080 grain-baiting operations were assayed. Residues were found in all samples. The distribution of residue within each individual was largely consistent; the highest concentrations were in the stomach contents, followed by the stomach, intestines, eyeball, muscle, and liver/ kidney respectively. The actual concentrations of sodium fluoroacetate in the various tissues were highly variable, ranging between 0.0031 to 87.3 ug/g in muscle and stomach contents respectively (Figure 4.1).

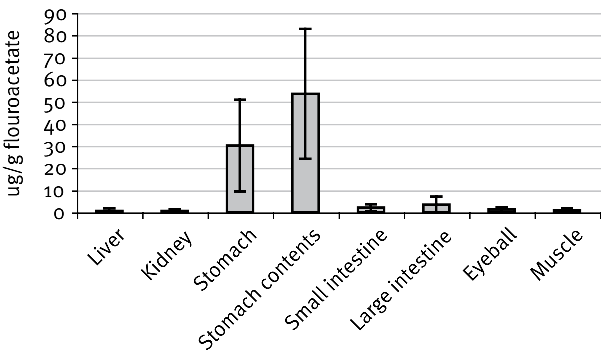


Figure 4.1 Fluoroacetate in tissues from lethally poisoned pigs

The mean concentration of fluoroacetate (ug/g) in tissues from lethally poisoned pigs. Error bars indicate standard deviation.

Based on the residue level of 2.6 ug/g, there appears to be little risk to native Australian animals from consuming muscle from poisoned pigs. Introduced mammals, such as the fox, wild dog, feral pig and cat appear particularly susceptible to secondary poisoning.

Carcasses degraded rapidly, with very little edible tissue remaining 7–10 days after death. Carcasses usually showed signs of insect activity (blowfly maggots and ants) within 24 hours, and began to liquefy after 3–5 days. Lace monitors (*Varianus varius*) were the main non-target species observed consuming carcasses, often dragging the entrails from the site for further consumption. Corvids (especially crows) and raptors (wedge-tailed eagles) were also frequently observed on carcasses.

Discussion

The tissue residue levels observed in this study are likely to represent the maximum from 1080 baiting at the given bait concentration (288 mg 1080/kg) since excessive consumption of bait was encouraged by free-feeding. These residue levels in muscle (2.6 ug/g) are similar to the maximum values recorded in free-ranging pigs (2.42 ug/g) and in penned pigs (2.9 ug/g) subjected to 1080 poisoning. Based on the residue level of 2.6 ug/g, there appears to be little risk to native Australian animals from consuming muscle from poisoned pigs. Native non-target species examined as part of this project (i.e. likely to consume carcasses) need to consume in excess of 15% of their bodyweight to be at risk from eating muscle tissue. Of the introduced mammals, dogs and foxes are most susceptible, requiring consumption of less than 5% of their bodyweight in muscle for a lethal dose. However, the much higher concentrations found in the viscera and stomach contents suggest that there is a potential poisoning risk to many native animals from consuming these tissues.

Remote photography confirmed that few consumed carcasses. Goannas readily consume flesh including viscera, but are at low risk due to their high tolerance to fluoroacetate. However their feeding habits may increase the exposure of other species to visceral tissues, increasing their likelihood of secondary poisoning. Despite anecdotes suggesting a low impact on secondary consumers, further assessments should be undertaken to assess the extent to which non-target species consume such tissues.

Regardless of whether they were partly consumed by non-target species, feral pig carcasses did not generally persist for longer than seven days in the seasons tested, This supports similar work completed in Western Australia, and suggests that, at least in warm conditions, carcasses will not persist and represent a long-term food source. Additionally, defluorination will occur within the tissues, further reducing the fluoroacetate content and concentration. Under cooler conditions 1080-poisoned carcasses can persist for extended periods; obviously the environmental conditions need be considered when assessing the longevity of, and secondary poisoning risk associated with, poisoning operations.

This work has been completed under Animal Ethics Approval PAEC 040303.

Expected completion

Preliminary study completed December 2004 but supplementary data will continue to be collected as part of ongoing research.

Funding

Queensland Government

A feral pig carcass

Pest management chemistry

Objectives

- To provide advice on the use, impact and environmental toxicology of vertebrate pesticides and herbicides to support their effective and responsible use to manage pest animal and weed populations
- To organise the registration, manufacture and quality assurance of chemical pest control products used to manage pest animal and weed populations
- To undertake chemical ecology research and analysis on pest populations

Staff

Bob Parker (Leader), Margie Cohn, Martin Hannan-Jones, Gina Paroz, Michele Rogers, Lesley Ruddle (AFRS)

Methodology

This project undertakes toxicological, eco-toxicological and chemical ecology investigations as well as providing chemical advice and support relating to the use of pesticides for pest management in Queensland. Its facilities include chemical formulation, climate control, glasshouse, laboratory, and quarantine facilities at AFRS. The project also uses the animal handling facilities at RWRS Inglewood and field sites.

Progress

Toxicology laboratory studies

This laboratory is the only one of its kind in Australia undertaking work on vertebrate pesticides. Staff availability has hindered throughput for this year; nevertheless, the workload has continued to grow. For the 12-month period 93 sodium fluoroacetate, 27 strychnine and 11 anticoagulant toxicology investigations were undertaken. Sodium fluoroacetate or 1080 poisoning is the most common investigation, and the domestic dog the most common animal investigated. The signs and symptoms of fluoroacetate poisoning in dogs are non-specific, and as a consequence can be observed in a number of other toxicologies such as strychnine poisoning and snakebite. For the four-year period from 2001 to 2004 inclusive, a total of 161 stomach samples from dogs suspected of dying from fluoroacetate intoxication were analysed, and only 39% of these were found to contain evidence of fluoroacetate intoxication. In each case results were positively confirmed using mass spectrometry, essentially eliminating false positives in the analytical technique.

Chemical ecology studies

Iophenoxic acid and sulfadimethoxine are used as blood markers for bait studies. Animals consuming the baits absorb these compounds, which will be present in their blood stream either as the compound or, as well in the case of iophenoxic acid, as a protein bound iodine metabolite. For the 12-month period, five biomarker studies were initiated.

Chemical registration

The unit continued to prepare chemical registration submissions for feral pig baits containing warfarin and for a Predicide Ejector package for wild dog and fox control. In addition storage stability studies were undertaken for cyanide and two pindone-based vertebrate pesticide products.

Vertebrate pesticide manufacture and quality control

This group manufactures the sodium fluoroacetate concentrate (180g/L) used by government operators across Queensland to prepare fresh wild dog, fox, feral pig and rabbit bait. During the 12 months approximately 300 L of concentrate solution was manufactured and distributed.

Routine testing of field prepared baits containing sodium fluoroacetate is undertaken to ensure they meet quality standards. Fourteen separate studies were undertaken during the year looking at both field prepared baits and baiting solutions. Studies typically involve random sampling of solutions and baits prepared in a given baiting area and enable the department to ensure that land managers continue to receive a product that will control their pest animal populations.

Expected completion

Ongoing

Funding

Queensland State Government

Local government

NSW Agriculture

Environmental Protection Agency, New South Wales

Tasmanian Department of Primary Industries, Water and Environment

Western Australia Agriculture

Agriculture Victoria

Pest Animal Control CRC

Animal Control Technologies Australia Pty Ltd

ALDI GC Pty Ltd

Gribbles Pathology

IDEXX Veterinary Pathology Services

Chapter 5 Management research projects

Adaptive management of rabbits

Objectives

- To improve measurement of the impact of rabbits and the effectiveness of control programs
- To establish landholder driven, scientifically monitored rabbit control programs
- To use these as demonstrations to promote the use of effective rabbit control

Staff

David Berman (Leader), Peter Elsworth, Joe Scanlan, James Speed (RWPARC)

Background

A map of the distribution and density of rabbits in Queensland (Figure 5.1) was produced in 1996. The map provided an estimate of the number of rabbits in Queensland and the relative impact in various regions. This was the basis for deciding where to focus research and control effort. The largest populations were in the Texas–Inglewood–Stanthorpe region and 25% of Queensland's rabbits inhabited Bulloo Downs, a large property (10 000 km^2) in south-west Queensland.

Rabbit haemorrhagic disease (RHD) reduced rabbit numbers by at least 70%. The effect of this biological control agent was enhanced in some places by mechanical rabbit control, such as warren destruction. On Bulloo Downs the drought and ripping warrens in the rabbits' drought refuge reduced rabbits to 0.001 per spotlight kilometre where there were once 1600 per spotlight kilometre in the 1980s.

Prior to 2000, there had been a reliance on biological control in Queensland, particularly in the arid areas where mechanical destruction of warrens was considered too expensive. Also there was a belief that it was a waste of time ripping warrens because a large proportion of rabbits 'Log rabbits' lived above ground. Scientifically monitored rabbit-control programs incorporating warren ripping proved these assumptions to be invalid.

On a property near Texas in south-eastern Queensland the landholder used a small single tine tractor to rip warrens and rabbits were effectively controlled. Other ripping programs in the temperate south-east also showed that this technique was valuable for long-term rabbit control and the cost could be recovered within a year or two through increased agricultural or pastoral production.

A warren ripping trial and control program completed on Bulloo Downs at the end of 2003 demonstrated clearly that rabbits could also be controlled in the extensive properties of the arid west and that there are substantial benefits from doing so for the environment and cattle production.

Rabbit control using biological agents or poison, without destruction of warrens, generally only provides short-term reduction in rabbit numbers. This was demonstrated during experimental releases of rabbit haemorrhagic disease virus (RHDV) on carrot bait. An isolated rabbit population at Kingaroy was wiped out in six days after releasing RHDV on carrot bait. However, the warrens were not destroyed and the rabbit population had re-established within two years. Other less isolated populations recovered within months of virus release. This work demonstrates that rabbits recover after control unless their breeding places (e.g. warrens, holes under concrete slabs) are destroyed.

Current research

During the past five years there has been an increase in rabbit numbers in the east where rabbits were previously in low numbers or where they were absent. The reason for this disturbing trend is uncertain but may be due to a reduction in the effectiveness of the biological control agents, RHD and myxomatosis. Most disturbing is an increase in the number of outbreaks within the Darling Downs Moreton Rabbit Board Area, where rabbits have never been allowed to establish and where native plants and animals and agriculture have been protected from the impact of rabbits for over 100 years since rabbits arrived in Queensland.

The reasons for the increase in rabbits need to be identified and a solution discovered to prevent them becoming the problem that they once were. Rabbit control needs to be as focused and efficient as possible. The importance of identification of the source of rabbits (key breeding places) and targeting control in these areas will be tested. Scientifically monitored rabbit-control programs are being established in and around the Darling Downs Moreton Rabbit Board Area. These will:

- demonstrate the importance of control activities in key breeding places
- assess the value of genetics as a tool to identify key breeding places
- measure the cost of eradication of small isolated rabbit populations.

The sites selected and data collected will become the foundation of a study to measure the benefits of rabbit control to biodiversity and agriculture/pastoralism in the south-east of Queensland.

Establishment of scientifically monitored, landholder driven control programs is an excellent way to demonstrate the best techniques and encourage rabbit control. These programs will show the best techniques, the benefits of controlling rabbits and the dangers of doing nothing.

Preliminary studies to assess the value of DNA technology as a tool for improving the efficiency of rabbit control have commenced. The method may be useful for identifying key breeding sites or areas where control effort should be concentrated.

To demonstrate the importance of breeding places, such as warrens and hay sheds, samples of liver have been collected from these places and surrounding areas. At a site near Killarney the majority, if not all, rabbits are probably born within a few warrens and a hay shed. If this is so then ripping the few key warrens and rabbit proofing the hay shed, for example, should fix the problem, even though rabbits are often seen elsewhere on the property.

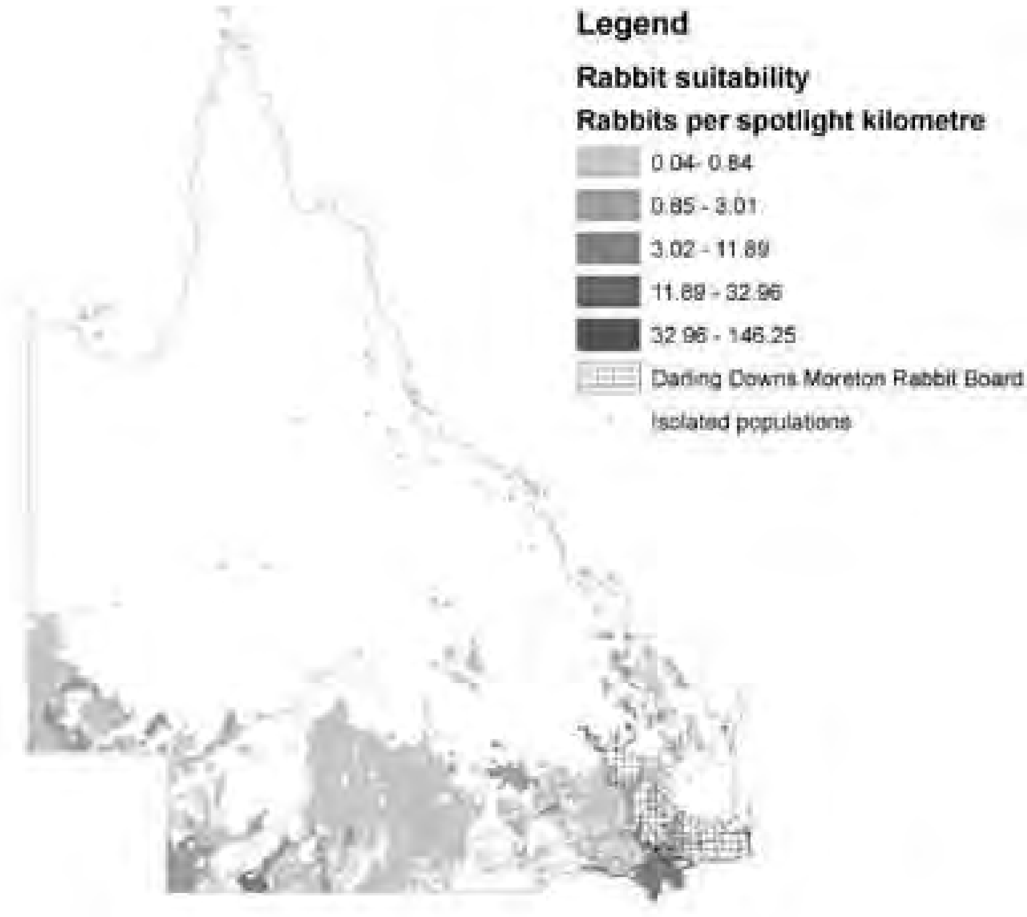


Figure 5.1 Rabbit densities

The highest rabbit densities were at Bulloo Downs and in the Texas–Inglewood–Stanthorpe regions in 1996, indicated by the darkest shading. Rabbit control demonstration programs have been completed at Benandre, Bulloo Downs and Wongavale. Rabbits have not been allowed to properly establish populations within the Darling Downs Moreton Rabbit Board Area, but an increased number of outbreaks are now occurring there and in other surrounding areas where rabbits were previously absent or at low density.

An attempt was made to capture all rabbits living in the hay shed. The shed was made rabbit-proof and rabbits were trapped in the shed and liver samples taken for DNA analysis. A total of 52 rabbits were caught in the shed, far more than expected. A warren system was also fenced off and 46 rabbits were caught and samples taken. These samples, as well as those from Wallangarra, Storm King Dam, and Leslie Dam, have been sent to Queensland University of Technology for DNA testing.

Publishing

Papers describing the work conducted at Bulloo Downs are in the process of being prepared for publication. The knowledge gained from our research is also being incorporated in a rabbit-control manual suitable for landholders.

Future work

The knowledge gained from research and control needs to be published in the scientific literature and disseminated to landholders via field days and a rabbit-control manual and perhaps the Internet. Successful control has been achieved in the west and the east. There is no need for landholders to suffer the damage caused by rabbits anywhere in Queensland because control methods are available. Further research is required to reduce the cost and increase the efficiency of control and measure the cost of damage caused by rabbits so that landholders can better decide how much they can afford to spend on rabbit control.

Expected completion

Ongoing

Funding

Stanbroke Pastoral Company

Rural Lands Protection Trust Fund

Natural Heritage Trust

Best practice wild dog baiting—evaluation of coordinated baiting programs

Objectives

- To measure the immediate baiting effect and the length of time to re-colonisation for broad-scale wild dog baiting campaigns
- To identify the source of re-colonising dogs (dispersal from non-baited areas or un-baited resident animals)
- To test methods to improve effectiveness of baiting. If practical, examine the utility of drying baits, pre-feeding and/or compare bait deployment methods of burying, tying and drying on target and non-target bait removal

Staff

Lee Allen (Leader), James Speed, (RWPARC)

Collaborators

Tambo, Blackall and Barcaldine shires

Description

Wild dogs are a declared pest in Queensland and are a serious pest to the sheep and cattle industry in the state. This project evaluates the effectiveness of coordinated wild dog baiting campaigns in central-western Queensland.

As a result of previous research into the impact of wild dog predation on beef cattle, we discovered that while wild dogs have the potential to cause up to 30% loss of calves, the wild dogs that recolonise after baiting are more predisposed to killing cattle than wild dogs in stable packs. Similar to other state pest control agencies, Natural Resources, Mines and Water in Queensland advocates and facilitates large-scale, coordinated baiting campaigns to prevent re-colonisation and subsequent predation of baited cattle properties, and also to protect adjoining and highly vulnerable sheep properties.

In central-western Queensland (north of the Barrier Fence) three shires, Barcaldine, Blackall and Tambo, separately contribute about $90 000 to aerial bait, six times a year in order to establish a 'chemical buffer' to prevent the ingress of wild dogs into sheep production areas. Participating councils and Land Protection Officers invited us to evaluate the effectiveness of these campaigns to identify how they might be improved.

We are evaluating how effective large-scale baiting programs are at reducing wild dog numbers generally; how quickly large-scale baited areas are re-colonised; what influence non-participating properties have on re-colonisation; and investigating how baiting programs can be made more effective.

This study does not attempt to measure predation losses, but assumes (based on previous research) that sheep production and wild dogs are incompatible and that reducing numbers and preventing the re-colonisation of beef cattle properties by wild dogs is the object of large-scale, coordinated baiting.

Methods

We set up over 300 permanent tracking stations along three transects running roughly east-west, across the baited buffer between Tambo and Barcaldine. Using the activity index methodology evaluated in Allen *et al* (1996) and further developed in Engeman *et al* (1998 & 2000), we monitored changes in the abundance and distribution of wild dogs and other wildlife. Transects traverse properties inside and outside the baited buffer area and include non-baited/non-participating properties.

Wild dog, fox and feral cat activity, as well as native wildlife, are being surveyed immediately before and after baiting. From this we can measure the initial impact of each baiting program on pest and native wildlife populations (% reduction of activity index). We can estimate when re-colonisation occurs and how baited properties are recolonised (natality of survivors or immigration) and show wild dog and fox abundance differences between non-baited cattle country, the baited buffer area and the adjoining sheep production areas. These three transects provide a general overview of wild dog activity over the whole area.

These studies where conducted under the animal ethics approval number: PAEC 030604

Progress

Transects have been established and all baiting programs since August 2003 have been monitored. Relative to other areas in Queensland, the activity of wild dogs is very low in Blackall and Barcaldine Shires and about average in Tambo. However, rapid re-colonisation of baited properties often occurs. An increase in wild dog activity sometimes occurs independent of baiting programs, suggesting peak periods of wild dog dispersal (November to May). Where baiting has left properties unoccupied by wild dogs, these vacant territories may potentially be facilitating dispersal and re-colonisation. This is evidenced by a rapid increase in wild dog activity on baited properties subsequent to baiting that simultaneously occurs on adjoining non-baited properties.

Expected completion

September 2006

Funding

Queensland Government

Bureau of Rural Resources

Tambo, Barcaldine and Blackall shires

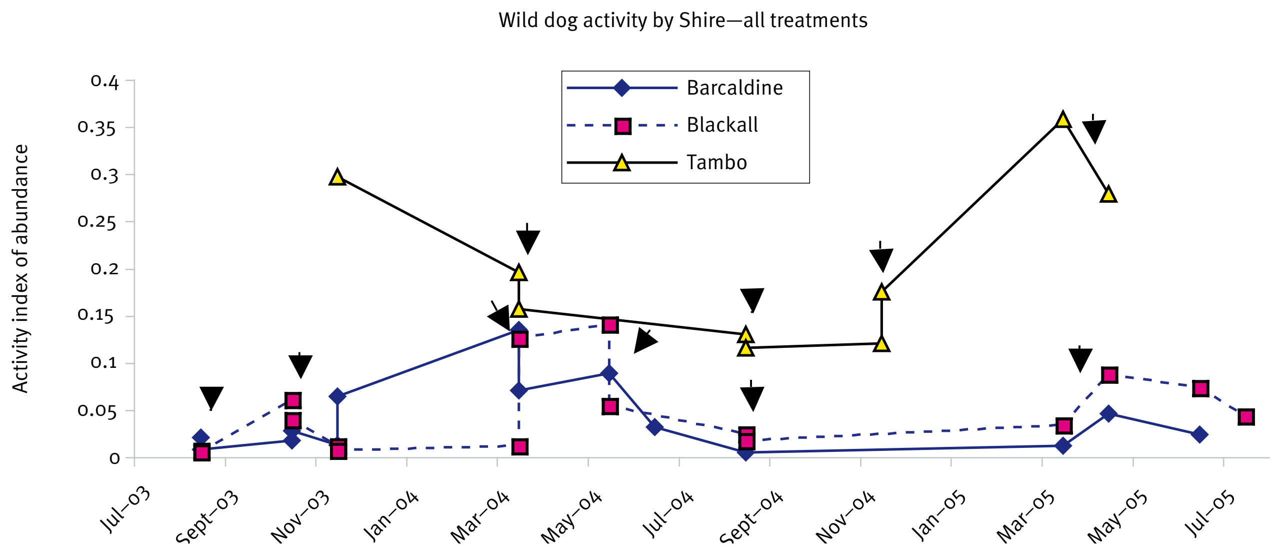


Figure 5.2 Wild dog activity by shire

Activity of wild dogs in the three shires in central-west Queensland (includes both baited and non-baited properties). Arrows represent baiting programs and the trends are interpolated between surveys.

Diet and trapping strategies of feral pigs in tropical rainforests

Objectives

- Diet
  - To quantify the diet of feral pigs in the Wet Tropics World Heritage Area (WHA)
  - To establish the predatory impact of feral pigs on rare and threatened species
  - To quantify the catch/effort effectiveness of hunting as a control technique
  - To establish a dietary reference dataset for use in future dietary analysis
  - To quantify the potential of feral pigs to distribute weed seeds
- Trapping strategy
  - To enhance the effectiveness of trapping as a feral pig control technique
  - To develop a trap bait strategy package that can be implemented throughout the WHA
  - To integrate trap bait strategy package with feral pig ecological information to further develop a feral pig management plan

Staff

Jim Mitchell (Leader) (TWRC), Bill Dorney (CWTA)

Background

Diet

Feral pigs are regarded as a significant threat to the conservation values of the WHA. They are also perceived as a threat to rare and endangered animal and plant species, although few data are available. This project will determine the diet of feral pigs and specifically examine their effects on threatened species. Another component will establish if the conditioned avoidance technique can be used to alter the food preference of pigs and subsequently protect rare and threatened species from predation.

Trapping strategies

Management techniques for feral pigs in rainforest environments are poorly developed and restrictive in scope. Trapping is considered the most effective technique for controlling pig populations. This project aims to further enhance this control technique by increasing the capture rate, target specificity, encounter rate and envelope of control, and decreasing trapping effort and associated costs. A trapping strategy will be developed which will examine components of a trap-baiting package, that is, carrier material, attractants, presentation and delivery systems.

Additional information on all aspects of feral pig ecology is vital for the continued development of management plans.

Methods

Diet

Feral pigs will be caught within four habitat types (rainforest, coastal swamps, sugar cane crops, and banana crops) between Cardwell and South Johnstone. For each pig captured, biological data will be recorded (morphometric measurements, reproductive status, presence of parasites and diseases, age, sex and weight) and one litre of stomach content collected. The composition of the diet of individual pigs will then be determined through volumetric and frequency of occurrence analysis of the gut samples. Specimens of species observed to be eaten by feral pigs will also be collected in the field and reference samples preserved.

Trapping strategies

Large-scale field trials are testing the attractability, palatability and encounter rates of various components of the trap bait system. Population density indices and seasonal distribution patterns are also obtained. A trapping strategy will be developed which will examine the following components of a trap-baiting package:

- Carrier material—basic trap bait material, which provides the bulk of the trap bait. Materials to be tested include waste bananas or fruit, cassava, abattoir wastes and salt licks.
- Attractants—food or scent lures to enhance capture success, sphere of influence and proportion of trappable population. Attractants used include truffles, earthworm waste, and scents of creosote, vanilla, molasses, egg, raspberry and fishmeal.
- Presentation—production and storage issues of the developed trap bait material. Trap bait material will be presented in a variety of formats, including wax blocks, sausage and dry blocks to assess the best method of production and storage.
- Delivery—assessment of the best strategy to enhance the seasonality of bait delivery success and aspects of the density. The amount of bait delivery required to enhance capture success and extend traps sphere of influence will also be assessed.

Progress

Diet

Stomach samples from 58 feral pigs taken from four broad habitat types (rainforest, coastal swamps, sugar cane crops, and banana crops) contained a wide range of food items. Plant material was consistently the largest component, although small animals (both vertebrates and invertebrates) were also commonly found. There were significant differences in the diet of pigs between habitats, with those found in cropping areas (sugar and bananas) generally having a higher proportion of plant material in their diet than those in rainforest and swamp habitats. Findings from previous local, national, and international studies examining feral pig and wild hog diets support those found here. Feral pigs within the wet tropics bioregion can be defined as generalist omnivores preferring plant material. They will, however, actively hunt small animals (both mammals and birds) and scavenge carcasses when the opportunity arises. A final report has been compiled, and discusses the implications of feral-pig diet selection in the Wet Tropics Region in relation to ecological impacts and potential for development of improved control options.

Trapping strategies

Two hundred and fifty permanent bait stations have been established over 200 km of transect lines in the Koombooloomba and South Johnson State Forest areas. Field trials have determined the frequency of visitations and palatability of base bait materials (banana, and control stations of sand). These base bait results have enabled a comparison of additional bait and attractant materials. Eight field trials have been completed. Attractants tested include fishmeal, raspberry, vanilla, meatmeal, creosote and molasses. Test combinations of banana and creosote, and grain and creosote have also been completed. Testing the effectiveness of grain feeding stations is close to completion. Testing of commercial feral pig baits has been completed. Bait stations have been established using flavoured water and rubbing posts; research is ongoing.

Ethics statement

This work has been completed under the Townsville Local Animal Ethics Committee—Activity number TSV/30/00.

Expected completion

June 2006

Funding

Rainforest CRC

Land Protection Fund

Fraser Island dingo management project

Objectives

- To set up wildlife monitoring transects and train Queensland Parks and Wildlife Service (QPWS) staff and a PhD student to conduct surveys
- To train the PhD student and QPWS dingo rangers how to capture, ear-tag and release dingoes
- To provide technical advice and assistance to the PhD student conducting dingo research on Fraser Island

Staff

Lee Allen (RWPARC)

Background

The research into Fraser Island's dingoes started in 2002 as a cooperative project between the Queensland Parks and Wildlife Service, The University of Queensland, Gatton, and the Department of Natural Resources and Mines. The project, which was funded by a grant from QPWS and an Australian Postgraduate Award Scholarship for Nick Baker (the PhD student involved), set out to investigate the ecology of the Fraser Island dingo population from a number of angles. It looked at the dingo diet; dingo and prey activity; temporal and spatial variation in dingo activity; the interaction between environmental factors and negative human-dingo interactions (attacks or threats to people and damage to camping equipment); a population estimate; and the genetic structure of the population.

This work was conducted under the Animal Ethics approval number PAEC 030604.

Methods

In brief, dingo numbers on Fraser Island will be calculated as a minimum 'known-to-be-alive' estimate based on DNA finger printing. DNA samples will be collected directly from captured animals and indirectly from scats and scent stations. Dingo and wildlife populations will be monitored from spoor identified from tracking stations across the island, using the activity index. The diet of dingoes will also be investigated from remains identified from scats. QPWS will also conduct regular face-to-face surveys of island visitors to measure negative human-dingo interactions. Together these data will allow QPWS to understand the dynamics of dingo populations on Fraser Island, their purity and numbers, and how prey populations affect the number of negative human-dingo interactions. This project will form the basis for QPWS`s future dingo management on Fraser Island.

Progress

This project is in its final stages. Fraser Island dingoes eat large amounts of fish, most of which is probably sourced from the disposal of fish offal on the beach, but some of which is sourced naturally by dingoes fishing in streams and lakes, or scavenging fish that have died naturally from the shore. The main prey resources utilised by the dingoes were the two species of bandicoots on the island, along with the numerous rat species. They also eat relatively large amounts of echidnas, crabs, small skinks and dragons, fruits and other vegetation, and insects (mostly beetles). It was found that dingoes are much more active in the eastern part of the island (mainly the eastern beach), with activity in the interior and western zones consistently lower. Unfortunately, the eastern zone is also the highest use area for humans, so dingoes and people inevitably come into contact with each other. Sometimes, this interaction will be a negative experience. The eastern zone has the highest available resources so it will continue to be used frequently by both humans and dingoes.

Low levels of DNA found in hair samples and other technical issues have meant that the DNA work has been somewhat restricted. However, some useful data are now starting to flow from the work. As with many island populations of other species, the dingoes on Fraser Island have very low genetic variability compared to their mainland cousins. This does not seem to be affecting their health at all and they actually have comparable variability to many of the highly inbred domestic dog breeds.

Ethics statement

This work was conducted under the Animal Ethics approval number PAEC 030604.

Expected completion

December 2005

Funding

Queensland Government

Queensland Parks and Wildlife Services

Mouse and rat management in Queensland

Objectives

- To develop an understanding of rodent population dynamics in southern and central Queensland which will enable grain growers to be proactive in managing rodents during periods of high populations and high potential damage
- To establish demonstration sites on the Darling Downs to show how different agronomic and farm management practices affect long term mice populations
- To refine the current plague prediction model for the Darling Downs if necessary
- To develop a plague prediction model for central Queensland using trapping data from the Dawson and Callide Valley transects
- To develop management guidelines for the native central Queensland rat, *Rattus* aff. *sordidus*

Staff

Julianne Farrell (Leader), Joe Scanlan, Peter Cremasco (RWPARC) and Craig Hunter (Land Protection)

Collaborators

- Animal Control Technologies (Aust)—donated zinc phosphide bait for use on treatment sites
- The Alexander, Bach, Black, Buss, Conway, Joseph, McVeigh, Pfeffer and Taylor families
- Arcturus Downs Pastoral Company

Mouse on sorghum

Mice damage to sunflower crop

Methods

Farm management monitoring

Eight grain growing properties on the Darling Downs are being used to develop and demonstrate best practice strategies for mouse control in Queensland's grain producing regions. A monthly trapping program has been established to monitor population dynamics and compare the effects of farm management practices such as perimeter and broad acre baiting, slashing or burning fence lines and verges, weed control, and harvesting operations between four treatment and four control sites.

Snap-back traps are set out in four lines of 20 traps per site on three consecutive nights each month. Two lines are set into a sorghum (summer) or wheat/barley (winter) crop and the remaining two lines are set into surrounding habitat, such as fence lines, road verges or fallows. Data gathered includes length, weight, sex and general body condition of each individual caught, as well as the breeding status (pregnancy, embryo development and lactation) of mature females.

Traps are baited with ham, set out in the late afternoon and picked up early the following morning.

Plague prediction modelling

Joe Scanlan is using artificial neural network simulations to develop a plague prediction model for the grain producing areas of central Queensland, using data gathered from long-established trapping transects in the Dawson and Callide valleys.

Trapping

Regular trapping is undertaken in the Springsure area to locate viable populations of the native rat, *Rattus* aff. *sordidus* in order to study their social structure, feeding habits and the reproductive cycles which lead to plagues.

Elliot live capture traps using sweet potato bait are set over several nights at approximately six-weekly intervals. If populations begin to build before the end of the project, individuals will be radio-collared and tracked until lost or the collar can be recovered.

The project leader holds a Queensland Health permit for the possession and use of restricted veterinary anaesthetics to assist in the secure application of radio collars.

Progress

Farm management monitoring

Monitoring of farm management practices and trapping on the Darling Downs field sites is ongoing. Results to date were presented by J. Farrell at the 13th Australasian Vertebrate Pest Conference in New Zealand, May 2005.

Conference proceedings are available at ‹www.landcareresearch.co.nz›.

Regular trapping on the Central Downs transect is undertaken, with results used to maintain the validity of the current plague prediction model for the Darling Downs region.

Plague prediction modelling

A preliminary plague prediction model for central Queensland was developed by J. Scanlan and presented by J. Farrell at the 13th Australasian Vertebrate Pest Conference, New Zealand in May 2005. Model development is ongoing.

Trapping

Prolonged drought conditions in central Queensland through 2003 and 2004 appear to have reduced rat numbers to untrappable levels, with only seven individuals caught in two years. No radio tracking has been undertaken to date.

Ethics statement

The following studies were conducted under the following animal ethics permits: PAEC Number 030605 and EPA Scientific Purpose Permit Number WISP01482303.

Expected completion

March 2006

Funding

Grains Research and Development Corporation (GRDC)

Queensland Government

Wild dog management in Queensland

Objectives

- To provide technical support and supervision to wild dog management projects
- To evaluate progress of wild dog research and conduct preliminary investigations for future research projects
- To have past wild dog research peer reviewed and published

Staff

Lee Allen (RWPARC)

Background

This project provides advice and supervision to wild dog projects, seeks to publish past wild dog research, evaluates the impact and management of wild dogs, and explores future research options.

Several wild dog projects have been conducted that improve our understanding of wild dog ecology and management. This project also supports other wild dog studies by providing student supervision and technical advice on wild dog management.

Progress

Co-supervision of student projects

A University of Southern Queensland Honours project evaluating tooth density as a means of estimating the age of adult wild dogs was completed during 2003. During 2004–2005 a manuscript comparing two methods of pulp cavity ratio estimates of age was submitted, refereed and accepted for publication in *Wildlife Research*.

Subsequently, a University of Queensland Gatton undergraduate student did a special research topic in 2004–2005 and produced a more accurate method of estimating the age of free-ranging wild dogs. Longitudinal sections were used to calculate pulp cavity ratios of 55 known-age adult wild dogs (ranging from 9 months to 13 years). A mean absolute error of 7.7 months for female dogs and 12.2 months for male dogs was achieved.

A collaborative wild dog project evaluating baiting programs in national parks and state forests was initiated during 2004–2005. The project is funded by QPWS and conducted by The University of Queensland. The Department of Natural Resources, Mines and Water is providing supervision, advice and assistance.

Writing-up of past research

A PhD thesis evaluating the impact of wild dog predation on beef cattle was re-written and re-submitted during 2004–2005. Draft manuscripts of research conducted on cyanide ejectors and two reviews of wild dog management were prepared and/or published.

Preliminary investigations for research projects

Several wild dog management projects are under consideration for funding:

- Evaluation of Livestock Protection Collars—Australian Wool Innovations
- Evaluation of strategic wild dog control in south-west Queensland—Consortium of local governments, QPWS, Murray-Darling Catchment Committee and others
- Use of satellite collar technology to study wild dog movements—Desert Channels cross catchment committee

Expected completion

September 2006

Funding

Queensland Parks and Wildlife Services

The University of Queensland

Queensland Government

Chapter 6 Modelling research projects

Modelling pest populations

Objective

To develop and test models of pest populations and their impact

Staff

Joe Scanlan (RWPARC)

Methods

The STELLA modelling environment is used to develop conceptual models, which are then parameterised to produce working models. Models have uses in all stages of the project life cycle. In the early stages of development, conceptual models can help identify key factors that have to be considered in any experimentation/research activities. Indeed, a preliminary model can be fully developed based solely on the literature and anticipated results. Such an approach can ensure that any experimentation undertaken is logically sound. During the analysis and interpretation stages, models are used to take site-specific results from experiments and examine the implications of those results under different conditions and over extended time periods. This can enable ‘model experiments’ to be done in situations where an experiment cannot physically be done. For example, examining the impact of climate change on distribution of rabbits in Queensland.

Progress

Extensive field work has commenced to provide validation data for the preliminary model of the sodium fluoroacetate (1080) content within meat baits used for wild dog control. The preliminary model shows a rapid decline in buried baits when temperatures are moderate and the soil is moist. By contrast, surface-laid baits in very dry and hot conditions retain a high content of 1080. Data from the sites across Queensland will be compared to model predictions, leading to refinement of the existing model.

The eradication of pests poses a dilemma with respect to ‘proving’ that something has been eradicated. A number of search tools have been developed to quantify the probability that an item (e.g. a weed or an ant) will be found using different search intensities. These probabilities can then be used to provide a level of confidence that an item will be found with a particular search strategy if present.

Several models have been submitted for publication this year—a rabbit population model; a fire ant spread model and an evaluation of the Darling Downs Plague Prediction model.

The rabbit population model shows that myxomatosis and rabbit haemorrhagic disease (RHD) are effective in reducing numbers in most areas of Queensland. RHD apparently is not present for extended periods in semi-arid to arid parts of the state where populations of susceptible rabbits remain low.

The fire ant spread model combines a cellular automaton model, for describing the spread within a location, with a logistic growth model of the increase in number of locations at which fire ants are found. Combined, these models estimate the potential area of fire ants within Australia, in the absence of control measures. Further work is being done on the impact of the eradication campaign on the extent of fire ants in south-east Queensland.

Expected completion

Modelling activities are ongoing.

Funding

Queensland Government

Refinement of a 1080 bait degradation model

Objectives

The objectives of this project are to:

- undertake laboratory and field experiments to investigate the effects of temperature, rainfall, soil conditions and bait age on rates of 1080 loss due to microbial breakdown, insect consumption and leaching
- refine the preliminary bait degradation model to incorporate relationships between bait age (and moisture content) and rates of losses
- validate the revised version of the model through simulation of all available field data sets, including published information as well as field experiments

Given the success of previous objectives, the model may be packaged into a user-friendly interface to be used by stakeholders, such as operational staff and trainers, in predicting/assessing bait longevity.

Staff

Joe Scanlan (Leader) Matt Gentle, Peter Elsworth (RWPARC), Bob Parker (AFRS)

Background

The Robert Wicks Pest Animal Research Centre has constructed a preliminary model to quantify the 1080 degradation rate in meat baits used in dog and fox control. This model attempts to determine bait longevity through modelling the effect of intrinsic (e.g. bait substrate, initial 1080 dose), presentation (e.g. buried vs surface) and environmental (e.g. climate, soil type) variables on the processes that drive 1080 degradation. Initial runs of the preliminary model have shown that this approach is likely to be successful, but it has also highlighted many deficiencies in our knowledge about the degradation response in specific environments, climatic or soil conditions. This project aims to identify these shortfalls, and collect experimental data to improve our ability to model the underlying processes of 1080 degradation.

Methods

Trials will be run at RWPARC Inglewood in climate controlled rooms to examine the impact of temperature and humidity on the rate of 1080 breakdown. The temperature and humidity conditions considered will cover the range of conditions expected in areas where meat baits are regularly used. Baits (standard size and 1080 content) will be collected at various intervals from initial setup. These trials will demonstrate the rate of microbial breakdown as influenced by temperature and humidity.

A factorial experiment will be conducted at RWPARC, Inglewood. Baits will be placed on the soil surface or buried, and samples will be taken at varying intervals after laying. As the rate of breakdown is expected to vary widely, the timing will vary between treatments. This will help define relationships that can be incorporated into the degradation model.

Departmental Land Protection Officers and co-operating landholders will undertake field trials in different seasons in representative regions of Queensland. These trials will involve producing baits and placing them in the manner that is 'normal' for their situation. Baits will be collected at varying intervals, depending on the anticipated rate of breakdown.

Relationships derived from theoretical considerations, published relationships, and laboratory and outdoor trials will be incorporated into the current preliminary model. The current model does not contain detailed processes, but rather seeks to replicate the results of several published datasets. While this is reasonably successful, it does not allow testing of situations that vary substantially from conditions in those papers. Initial runs of the model have been undertaken for each likely environmental combination to be encountered in the field trials. This will assist in determining the appropriate sampling regime and likely lifespan of the trials.

Progress

Trials throughout Queensland have been initiated in various regions, including the coastal north (South Johnstone), inland north (Charters Towers, Lakeland Downs) northern central (Cloncurry), coastal central (Yeppoon), inland central (Blackall), and inland southern (Inglewood and Cunnamulla). These field experiments, together with the laboratory experiments, will continue until early 2006, with the resultant analyses of samples to continue.

Expected completion

December 2006

Funding

Queensland Government

Bureau of Rural Sciences National Feral Animal Control Program

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Appendix 2 Publications

Books/chapters

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Appendix 3 Public presentations

Conference presentations

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Setter, SD 2004, Wet Tropics Weeds Research Report, Far North Queensland Pest Advisory Forum, Cooktown, 19 November.

van Haaren, PE 2004, Presentation of current research and updates to stakeholders of the Far North Queensland Pest Advisory Forum (FNQPAF) in Cairns, 27 August.

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Setter, MJ 2005, ‘Pond Apple Ecological Research’, Pond Apple National Management Strategy Group, Cairns, 21 March

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Vitelli, JS 2004 ‘Bellyache bush herbicide research update’ Weeds CRC Bellyache Bush Workshop, Charters Towers, November 29.

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