15th Australasian Vertebrate Pest Conference
Sydney June 20 - 23 - 2011

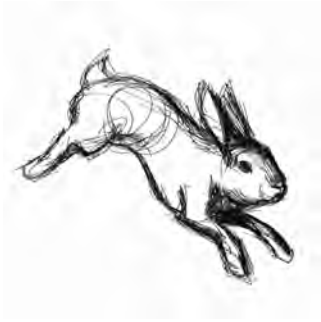


15th Australasian Vertebrate Pest Conference

20-23 June 2011

Sydney, Australia






Proceedings

Security from the impact of vertebrate pest animals

The 15th AVPC was hosted by the Vertebrate Pests Committee, the Invasive Animals Cooperative Research Centre and the NSW Department of Primary Industries

Gold Sponsors: Animal Control Technologies Australia and Waratah

Bronze Sponsors: Meat and Livestock Australia, Hunter Land Management and the Sporting Shooters Association of Australia

Invasive Animals Cooperative Research Centre

NSW GOVERNMENT Primary Industries

WARATAH® FIRST - BECAUSE IT LASTS.

acta

mla MEAT & LIVESTOCK AUSTRALIA

HUNTER LAND MANAGEMENT

SPORTING SHOOTERS ASSOCIATION OF AUSTRALIA

acta

Innovation, Research and Support of Excellence in Pest Animal Management for Agriculture and our Environment

FOXOFF® Fox Bait
RABBAIT® Pindone Oat Bait
MOUSEOFF® Bromadiolone
RATTOFF® Rat Bait
DENCOFUME® Fumigation Cartridges
RABBAIT® 1080 Oat Bait
PIGOUT® Feral Pig Bait
MOUSEOFF® Zinc Phosphide Bait
DOGGONE® Wild Dog Bait
SLUGGOFF® Slug & Snail Bait

Animal Control Technologies Australia Pty Ltd

Phone: 03 9308 9688 Fax: 03 9308 9622 Email: enquiries@animalcontrol.com.au

Further information at www.animalcontrol.com.au

acta

Introduction:

The Australasian Vertebrate Pest Conference, held in Sydney 20-23 June 2011, is the 15th in a series recommended by the Vertebrate Pests Committee (VPC). The conference is held triennially, with the last conference convened in Darwin in June 2008. The 2011 AVPC was organised in conjunction with the Invasive Animals Cooperative Research Centre and NSW Primary Industries. The theme of this conference "Security from the impact of vertebrate pest animals" is the vision of VPC's Australian Pest Animal Strategy (2007) which provides a national framework for the management of pest animals.

The role of VPC is to provide coordination in policy, planning and overall strategies which address pest animal problems. Through these triennial conferences, VPC aims to increase the exchange of ideas, knowledge and innovations of all those involved in pest animal management in Australia and New Zealand as well as internationally.

Organising Committee:

Dr Glen Saunders, NSW Primary Industries
Mr Andreas Glanznig, Invasive Animals CRC

Mr John Tracey, NSW Primary Industries
Mr Chris Lane, Invasive Animals CRC

Dr Elaine Murphy, New Zealand Department of Conservation
Dr Lyn Hinds, Commonwealth Scientific and Industrial Research Organisation
Dr Andrew Woolnough, Western Australia VPC Representative
Dr David Dall, Australian Pest Animal Strategy Coordinator and the Arts

Conference Organiser:

On Q Conference Support

PO Box 3711,
Weston Creek ACT 2611
Tel: 02 6288 3998
Email:info@onqconferences.com.au

ABN 93 835 779 670

Citation:

15th Australasian Vertebrate Pest Conference, Sydney, June 2011

Saunders, G and Lane, C (eds) (2011) Proceedings of the 15th Australasian Vertebrate Pest Conference. Sydney, June

Dockside Convention Centre
Balcony Level, Cockle Bay Wharf
Wheat Road
Darling Harbour
Sydney NSW 2000

Disclaimer:

This volume is a pre-conference compilation of working papers. The contents are not peer reviewed and apart from lay-out changes, have been printed as received from submitting authors. In many cases, the contents contain preliminary results only. Please consult with authors before using information contained in any of the abstracts.

Copies available from:

Invasive Animals CRC
Level D, Building 3
University of Canberra
Bruce, ACT 2617

Proceedings production: On Q Conference Support
Cover design by Tracey Lianos, Invasive Animals CRC

ISBN 978-1-921777-13-4

WARATAH® STOCKSAFE-T® FERAL

MAXIMUM PROTECTION, MINIMUM RISK

Stocksafe-T fencing for pests is your first line of defence against feral animal damage.

- Premium grade Australian steel delivers uniform strength and consistent quality over the length of the fence
- Longlife™ wire coating provides corrosion protection up to three times longer than standard galvanizing
- The new Stocksafe-T knot
  - Conceals sharp wire ends that may cut stock if they rub against the fence
  - Creates a rigid picket spacing that provides a protective barrier and improved safety containment
  - Forms a tight bond with the line wires that helps keep the fence from sagging and reduces maintenance
- Available in 3 different sizes: 11/90/15, 13/90/15 and 15/150/15
  (line wires/fence height/mesh spacing)

Keeps stock safe and feral animals out!

STOCKSAFE-T® WITH LONGLIFE® TECHNOLOGY
WARATAH®

onesteel

Phone 13 10 80 or visit www.onesteelwaratah.com.au

DAY 1 Monday 20 June 2011

8:45AM - 10:30AM OPENING & PLENARY SESSION 1

Chair: Hugh Millar

8:45 **Welcome to Country**
Uncle Greg Simms from Dharug nation with Russell Dawson on didgeridoo

9:00 **Official Opening**
Dr Richard Sheldrake
Director General, NSW Primary Industries

9:30 **Keynote**
Rocky or yellow brick road: Pathways to building a national institutional base for invasive animals R&D
Glanznig A 14

10:00 **Keynote**
The role of the Australian Government in managing vertebrate pest animals across the biosecurity continuum
O'Connell C 15

10:30AM - 11:00AM Morning tea

11:00AM-12:30PM CONCURRENT SESSIONS 2A-2B

2A: Human-Wildlife Conflicts: Integrating Ethics, Animal Welfare, and Science

Chair: John Hadidian/Camilla Fox

11:00 Does evicting female brushtail possums (*Trichosurus Vulpecula*) from roofs compromise the welfare of the animals?
Waller N, *Leung L* 16

11:15 Euthanasia vs translocation of problem porcupines in Israel
Nemtzov S 17

11:30 Is the myna a major problem? A triple bottom line evaluation
Spencer RJ 18

11:45 Dingo welfare will fair poorly in unfair play - ***Purcell B*** 19

12:00 Co-existing with carnivores in the US: Overcoming prejudice and persecution
Fox C 20

12:15 Reformatting the debate on the ethical use of animals so that scientists can become engaged
Lunney D 21

2B: Maori and Aboriginal Wildlife Management

Chair: George Wilson

11:00 Feral pigs, cattle and cane toads on the Angkum IPA, Lockhart River, Cape York
Dean C 22

11:15 Can harvest of introduced brushtail possums (*Trichosurus Vulpecula*) for fur by Maori be both economically sustainable and provide biodiversity benefits?
Jones C, *Nugent G, Barron M, Warburton, B* 23

11:30 Buffalo and pig control in Arnhem Land to reduce ecological and cultural impacts on permanent freshwater wetlands
Barrow D, Gumana Y, ***Ens E*** 24

11:45 Turning pests into profits: Introduced buffalo provide multiple benefits to Indigenous people of northern Australia
McMahon C 25

12:00 Ngaanyatjarra Lands Camel Shooting Program
Knight A, *Butler M* 26

12:15 Formidable obstacles: The policy and legislative challenges facing Indigenous commercial use of wildlife
Cooney R 27

12:30PM - 1:30PM Lunch

1:30PM-3:00PM CONCURRENT SESSIONS 3A-3B

3A: Human-Wildlife Conflicts (continued)

Chair: John Hadidian/Camilla Fox

1:30 Assessing the humaneness of invasive animal control methods ***Sharp T,*** *Saunders G, Jones B* 28

1:45 Relative welfare impacts of vertebrate pest control tools used in New Zealand
Fisher P, *Beausoleil N, Warburton B, Mellor D, Littin K* 29

2:00 Integrating animal welfare into pest animal control: A work in progress
Jones B, *Sharp T* 30

2:15 Humane wildlife management in the UK: A quantitative approach
Baker S 31

2:30 Animal welfare during Department of Conservation pest control operations
Forbes V, ***Fairweather A*** 32

2:45 A paradigm shift in Kangaroo management for the rangelands
Ben-Ami D, *Boom K, Ramp D, Croft D* 33

3B: Pest Eradication on Islands

Chair: Elaine Murphy/John Parkes

1:30 The ecology of exotic rodents and non-target species on Torres Strait Islands: Implications for exotic rodent eradication
Diete R, *Lavery T, Waller N, Leung L* 34

1:45 Optimising the use of the Judas Technique for maximising detection of vertebrate pests
Ramsey D 35

2:00 Lord Howe Island: Rodent eradication and community engagement
Wilkinson I, *Priddel D* 36

2:15 Experimental mouse invasions to determine biosecurity best practice
MacKay J, ***Murphy E,*** *Russell J, Hauber M, Clout M* 37

2:30 Fox eradication in Tasmania: A new approach
Elliot C, McGee J, Pauza M, ***Gaffney R*** 38

2:45 Non-target species management for the Macquarie Island Pest Eradication Project
Springer K, ***Carmichael N*** 39

3:00PM - 3:30PM Afternoon tea

3:30PM-5:00PM CONCURRENT SESSIONS 4A-4B

4A: Fertility Control for Pest Animal Management

Chair: Lyn Hinds

3:30 Effects of 4-vinylcyclohexene diepoxide on female brushtail possum health and fertility
Burd A, *Scobie S, Blenck C, Mayer L, Dyer C, Duckworth J* 40

3:45 Effect of different periods of treatment with 4-vinylcyclohexene diepoxide on fertility of female rats
Tran T, *Hinds L, Blome A* 41

4:00 Development of an oral bait to induce premature ovarian failure as a fertility control strategy for rodent pests
Mayer L, *Allred R, Bennett A, Dyer C* 42

DAY 1 Monday 20 June 2011 cont'd

4:15 Vaccine delivery to marsupial wildlife using replication-limited vaccinia virus
Duckworth J, *Cross F, Fleming S, Scobie S, Whelan E, Mercer A, Gleeson D, Prada D, Cowan P* 43

4:30 Assessment of an oral delivery system for immunoconraceptive vaccines
McDonald I, *Knight S, Finnie K, Barbē C, Hinds L* 44

4:45 Effects of GNRH-targeted immunocontraception on female fertility in two species of macropod
Snape M, *Hinds L, Fletcher D, Wimpenny C, Miller L* 45

5:00 Development of reproductive inhibitors for wildlife in the United States
Eisemann J, *Fagerstone K, O'Hare J, Miller L* 56

4B: Pest Eradication on Islands (continued)

Chair: Elaine Murphy/John Parkes

3:30 A modified vertical bait station design to measure poisoning risk in sympatric rodent populations using remote cameras
Meek P, *Zewe F, Ford H, Vernes K, Peacock D* 47

3:45 Multi-species eradications from inhabited islands
Glen A, *Saunders A* 48

4:00 Detecting invasion and/or survival post eradication using genetic methods: The stoat on New Zealand's islands
Veale A, *Gleeson D* 49

4:15 Identifying and managing challenges of rodent eradications on tropical islands
Samaniego-Herrera A, *Rodriguez-Malagōn M* 50

4:30 Success rates in eradicating rodents from islands using different rodenticides and aerial or ground-based delivery methods
Parkes J, *Fisher P* 51

4:45 Proposed management plan for cats on Christmas Island
Algar D, Hilmer S, ***Johnston M*** 52

5:00 Island arks: The need for a national island biosecurity initiative
Nias R, *Burbidge A, Ball D, Pressey R* 53

5:15 Finding foxes in Tasmania: Faecal DNA analysis reveals widespread distribution of an elusive introduced predator
Sarre S, *MacDonald A, Barclay C, Ramsey D* 54

5:30pm -7:00pm Icebreaker Function

In the Conference Exhibition area, Level 1, Dockside Conference Centre, Cockle Bay Wharf Sydney

DAY 2 Tuesday 21 June 2011

9:00am - 10:30am PLENARY SESSION 5

Chair: Hugh Millar

9:00 Role and functions of the Vertebrate Pest Committee
Millar H 56

9:15 The Australian Pest Animal Strategy and its implementation
Edwards G 56

9:25 Categorisation System and Exotic Animal Guidelines
Burley J 56

9:45 EPANS and the Feral Camel Action Plan
Woolnough A 56

10:05 Australian Biosecurity Intelligence Network
Banyer J 56

10:30am - 11:00am Morning tea

11:00am-12:30pm CONCURRENT SESSIONS 6A-6B

6A: Wild Dogs and Biodiversity

Chair: Brad Purcell

11:00 Biodiversity, what is it and why should we care?
Saunders AM, D 57

11:30 How strong is 'the growing body of evidence' for dingo suppression of mesopredators? Putting the methods under the microscope
Allen B, *Engeman R, Allen L* 58

11:45 When does wild dog predation upon native species move from natural to a threatening process? Observations from Wild Dog Control Programs and the potential impacts on koala populations from western and south east Queensland
Mifsud G, *Tabart OAM, D* 59

12:00 Assessing dingo predation risks to threatened vertebrates
Allen B, *Fleming P* 60

12:15 Does the parasitic disease of cattle and dogs, neosporosis, kill marsupials in Australia?
King J, *McAllan B, Spielman D, Lindsay S, Hürkovā-Hofmannovā L, Hartigan A, Al-Qassab S, Ellis J, Šlapeta J* 61

6B: Measuring and Managing the Impacts of Feral Camels

Chair: Andrew Woolnough/Quentin Hart

11:00 Overview of the Desert Knowledge Cooperative Research Centre Camel Research Project
Edwards G 62

11:15 Modelling the distribution and relative abundance of feral camels in arid Australia
McLeod S, ***Pople A*** 63

11:30 Optimising control strategies for camels using a Bayesian Belief Network and simulation models
Lethbridge M, *Souter N* 64

11:45 Assessment of a market-based instrument approach to removing large feral herbivores from the landscape in Western Australia
Rose K, Martin G, Gavin J, Agnew D, ***Woolnough A*** 65

12:00 Australian Camel Industry
Brisbane L 66

12:15 The Australian Feral Camel Management Project
Hart Q 67

12:30pm - 1:30pm Lunch

DAY 2 Tuesday 21 June 2011 cont'd

1:30pm-3:00pm CONCURRENT SESSIONS 7A-7B

7A: Wild Dog Management Techniques

Chair: Benjamin Allen

7B: Open Session

Chair: Glen Saunders

3:00pm - 3:30pm Afternoon tea

3:30pm-5:30pm CONCURRENT SESSIONS 8A-8B

8A: Open Session

Chair: Steve Lapidge

8B: Rabbit Management

Chair: Tarnya Cox

DAY 3 Wednesday 22 June 2011

9:00am - 10:30am PLENARY SESSION 9

Chair: Glenn Edwards

9:00 **Keynote**
Another inconvenient truth: How much pest control will it take to halt the decline in biodiversity?
***Choquenot D**, Clout M* 96

9:30 **Keynote**
Rodent outbreaks and extreme weather events: A southeast Asian and Australian perspective
***Singleton G**, Me Htwe N, Nelson A, Brown R* 97

10:00 **Keynote**
Invasive rodents: Their ecology, impacts and management
Dickman, C 98

10:30am - 11:00am Morning tea

11:00am-12:30pm CONCURRENT SESSIONS 10A-10B

10A: Community Participation in Pest Control

Chair: Peter West

11:00 Principles underpinning best practice management of the damage due to pests
***Braysher M**, Saunders G, Buckmaster T* 99

11:15 Community action to aid the survival of hooded plovers and small native mammals along the Cape Liptrap Coast -
Williams K 100

11:30 Monitoring pest control impact across the Goonoo landscape using remote cameras: Results and lessons learnt
***Towerton A**, Penman T, Kavanagh R, Dickman R, Robinson R, Chaffey C* 101

11:45 Exploring the capacity of NRM organisations to support invasive animal management now and into the future
***Marsh J**, Brown A, Lane C* 102

12:00 Challenges in managing vertebrate pests in peri-urban areas
Edwards S 103

12:15 Community and Landholder participation in the Feralscan Project
***West P**, Lane C, Marsh J* 104

10B: Pest Fish Management and Control

Chair: Wayne Fulton

11:00 Integrated pest management of the common carp in the American Midwest
***Sorensen P**, Bajer P* 105

11:15 Decision Support Tool for the management of freshwater fish incursions in Australia
***Acevedo S**, Saddlier S, Clunie P, Ayres R* 106

11:30 Challenges and future priorities for freshwater ornamental pest fish management in NSW
***Walker M**, Creese B, Frances J* 107

11:45 Does stocking Australian native predatory fish provide a control option for invasive European carp (*Cyprinus Carpio*)?
***Doyle K**, Walter G, McPhee D* 108

12:00 Electrofishing control of an Invasive Tilapia (*Oreochromis Mossambicus*) population in northern Australia
***Thuesen P**, Russell J, Thomson F* 109

12:15 Successful eradication of European Carp from Lake Cresent, Tasmania
Wisniewski C 110

12:30pm - 1:30pm Lunch

1:30pm-3:00pm CONCURRENT SESSIONS 11A-11B

11A: Community Participation in Pest Control

Chair: Peter West

1.30 Putting the pest management puzzle together - Landholder perspectives on national coordination and the necessity to access information in order to facilitate change in wild dog management
***Mifsud G**, Barry F* 111

1.45 Empowerment of community members in the south east NSW wild dog management plan process
Miners A 112

2.00 Wide-scale predator control in Hawkes Bay: Community involvement in conservation
***Ruscoe W**, Dickson R, Leckie C, Hania J, Glen A* 113

2.15 Twenty years of successful community possum control
Ellis S 114

2.30 Community action to tackle an invasive pest: The successful Canberra model
Handke B 115

2.45 Is western Victoria South Australia's Nullarbor? Keeping common (Indian) mynas out of South Australia
Bird P 116

11B: Pest Fish Management and Control

Chair: Chris Wisniewski

1:30 Biology, management and control of invasive Tilapia in northern Australia
***Russell J**, Thomson F, Thuesen P, Power T* 117

1:45 Genetic options for the control of invasive vertebrates: Current state of the art
Thresher R 118

2:00 Koi Herpesvirus (KHV): Its *p*otential as a biological control agent for carp in Australia
McColl K, Sunarto A, Williams L, Brown P, Gilligan D, Bell K, East I, ***Crane M*** 119

2:15 The identity, function and application of a female sex pheromone in the common carp
***Sorensen P**, Lim H* 120

2:30 Understanding Tilapia dispersal, diurnal movements, and habitat usage in northern Australia
***Thomson F**, Russell J, Thuesen P* 121

2:45 Social research and other strategies to reduce the risk of the pest fish Tilapia establishing in the Murray-Darling Basin .
***Ballagh D**, Frances J, Stewart D* 122

3:00pm - 3:30pm Afternoon tea

3:30pm-5:30pm CONCURRENT SESSIONS 12A-12B

12A: Open Session

Chair: John Burley

3:30 Rodenticide use in rodent management in the United States: An overview
***Witmer G**, Eisemann J* 123

3:45 Factors that influence mouse infestation and damage levels in grain crops: Landholders' perspectives
Mutze G 124

DAY 3 Wednesday 22 June 2011 cont'd

4:00 Population dynamics of house mice in Queensland grain-growing areas
Pople T, *Cremasco P* 125

4:15 ACTA Award: Bite Back – A community based wild dog management program in the arid zone of South Australia
Miller H 126

4:30 Benefits of applied genetics to invasive pest eradication and management programs
Oakey J 127

4:45 Assessing the social impacts of wild dog management
Please P, *Ecker S, Maybery D* 128

5:00 Assessing the returns on investment in wild dog managment: A broader analytical framework
Wicks S, *Mazur K, Buetre B, Ecker S, Please P, Hennecke B, Mifsud C* 129

5:15 Sunset on bluesky non Indigenous animal industries: An outline of proposed amendments to the Non Indigenous Animals Regulation 2006
Cutter N, *Cook L* 130

12B: Assessing and Managing Risks of Exotic Animals

Chair: Wendy Henderson/Marion Massam

3:30 An emergency response to a new exotic invasive vertebrate in Australia - the draft National Environmental Biosecurity Response Agreement (NEBRA)
Copp A, *McRae D, Staines M, Virtue J* 131

3:45 Victorian approach to prevention and preparedness for invasive animals
Martin S, *Paroz G, Wisniewski S, Corry M* 132

4:00 Incursions and interceptions of exotic vertebrates in Australia
Henderson W, *Bomford M, Cassey P* 133

4:15 From pets to pests – Assessing and managing high risk pet species
Knegtmans J, *Van Eyndhoven E* 134

4:30 Escape of exotic species from Zoos: A historical review and future risk management measures
Hogg C 135

4:45 The role of propagule pressure and the ongoing risk of exotic birds to Australasia
Cassey P 136

5:00 Australia's susceptibility to establishment by non-indigenous reptile species: A predictive modelling approach
Welbourne D 137

5:15 Are vertebrate pests a disease risk for commercial piggeries?
Pearson H, *Lapidge S, Hernandez-Jover M, Toribio J* 138

7:00pm-11:30pm Conference Dinner in Star Room

Level 6, IMAX Theatre Complex, Wheat Road, Darling Harbour

DAY 4 Thursday 23 June 2011

8:30am-10:30am CONCURRENT SESSIONS 13A-13B

13A: New Tools: Developments and Strategies in Pest Control

Chair: Charlie Eason/Chris Lane

8:30 Effectiveness of zinc phosphide, cholecalciferol, and cholecalciferol/coumatetralyl combination baits in reducing house mouse populations in maturing wheat crops
Leung L, *Pople A, Waller N, Diete R* 140

8:45 Optimising the palatability and longevity of stoat baits
Brown S, *Warburton B, Fisher P, Bunt C* 141

9:00 Protecting agriculture and threatened species internationally through the use of a human food preservative
Lapidge S, *Wishart J, Staples L, Eason C, MacMorran D, Kagerstone K, Witmer G, Campbell T, Eisemann J* 142

9:15 Development and registration of a new toxicant bait for wild dog and fox control
Humphrys S, *Saunders G, Staples L, Littlejohn J, Schröder J* 143

9:30 Research, development and registration of new toxins, and alternative delivery systems
Eason C, *Blackie H, Ross J, Shapiro L, Ogilvie S, Murphy E, Hix S, Henderson* 144

9:45 Field efficacy of the curiosity® bait for feral cats at mainland sites
Johnston M, *Algar D, O'Donoghue M, Morris J, Gigliotti F* 145

10:00 The efficacy of PAPP delivered from mechanical ejectors for fox management
Dall D, *Harland K, Hunt R, Spencer R* 146

10:15 New initiatives in predator control tools
Blackie H, *Eason C, MacMorran D, Woodhead I, Diegel O, Murphy E* 147

13B: Managing Environmental Pests - Feral Pigs

Chair: Jim Mitchell

8:30 Exploitation of a riparian vegetation by feral Pigs in southwest Western Australia
Adams P, *Fleming T, Fenwick S* 148

8:45 Feral Pigs in the tropics: Impacts and solutions
Mitchell J 149

9:00 Environmental impacts of feral Pigs: A review of plant and soil responses to pig disturbance in natural ecosystems
Elledge A, *McAlpine C, Murray P, Gordon I* 150

9:15 Biodiversity impacts of feral pigs in a temperate rainforest ecosystem
Krull C, *Burns B, Choquenot D, Stanley M,* 151

9:30 Eradication or sustainable harvest? Quantifying feral pig abundance using a distance sampling approach
Adams P, *Huston R, Pollock K* 152

9:45 Registration efforts in the United States towards developing a Feral Swine Toxicant
Eisemann J, *Lapidge S, Morrow P, Fagerstone K, O'Hare J, Staples L* 153

10:00 Economic assessment of the benefits and costs of a new feral swine management tool
Shwiff S, *Lapidge S, Anderson A* 154

10:15 Development of the HogHopper: A feral pig specific bait delivery device
Wishart J, *Lapidge S* 155

10:30am - 11:00am Morning tea

DAY 4 Thursday 23 June 2011 cont'd

11:00am-12:30pm CONCURRENT SESSIONS 14A-14B

14A: New Tools: Developments and Strategies in Pest Control

Chair: Charlie Eason/Jessica Marsh

14B: Managing Environmental Pests

Chair: John Tracey

12:30pm - 1:30pm Lunch

1:30pm-3:00pm CONCURRENT SESSIONS 15A-15B

15A: New Tools: Developments and Strategies in Pest Control

Chair: Charlie Eason/Annette Brown

15B: Managing Environmental Pests

Chair: Andreas Glanznig

POSTERS

Abstracts - Day 1

(In Program Order)

ROCKY OR YELLOW BRICK ROAD: PATHWAYS TO BUILDING A NATIONAL INSTITUTIONAL BASE FOR INVASIVE ANIMALS R&D

Andreas Glanznig
Chief Executive
Invasive Animals Cooperative Research Centre

Even though pest animals cost the Australian economy over $700m/yr, undermine food security and have large environmental impacts, innovation in pest animal management has been traditionally stymied by market failure and the challenges of building critical mass when research effort is spread very thinly through universities and Federal and State research agencies.

The Invasive Animals CRC was a response to these challenges. It brought together 41 partners and focussed their resources and research effort into Australia's largest integrated invasive animal R&D program worth $100m over seven years. Its track record will include a new class of red blood cell toxicants with an antidote, major progress on new or boosted biocontrol agents for carp and rabbits, as well as the development of the genetic detection techniques that underpins Australia's largest eradication program.

The current term finishes in 2012 and a funding application to extend the IACRC for a further five years has been submitted to the Federal Science Department's CRC Program. If there is enough support, it is then intended to morph the IACRC into a national research institute. This strategic juncture encourages a step back to ask questions about the appropriateness and effectiveness of this model to maintain medium term collaborative research in this space.

What is clear is that the IACRC fills a strategic niche that complements the shorter term research funding through the Federal Agriculture Department's APARP program, and provides the cash to encourage CSIRO, State agencies and universities to stay in this space. It also provides an efficient mechanism to coordinate investments by the Research and Development Corporations in this area. However, the CRC Program nor the Federal Science Department will fund the IACRC forever. It is not a question of if, but when (either in 2012 or 2017) when the IACRC exits the CRC Program and transitions into something else.

This brings into sharp relief the need for the national government body – the Vertebrate Pests Committee – and the Federal departments of agriculture and environment to put the issue of maintaining a coherent national R&D approach on their agendas and be part of the process to map out a way forward. A starting point is to reinvigorate the Australian Pest Animal Strategy (APAS) Research and Development Plan, which is still under development. To have any reasonable chance of being effectively implemented, it needs to clearly set out *how* and *by whom* its R&D program is to be implemented. While agriculture has usually taken the lead in this area, it is instructive that one of the 10 targets in A*ustralia's Biodiversity Conservation Strategy 2010-2030* is: *By 2015, reduce by at least 10% the impacts of invasive species on threatened species and ecological communities in terrestrial, aquatic and marine environments.* As biocontrol is the most cost-effective way to achieve this target, according to a PMSEIC working group analysis, the environment department should also have a major stake in the transition of the IACRC, particularly its work in carp and rabbit biocontrol.

THE ROLE OF THE AUSTRALIAN GOVERNMENT IN MANAGING VERTEBRATE PEST ANIMALS ACROSS THE BIOSECURITY CONTINUUM

Dr Conall O'Connell
Secretary
Australian Government Department of Agriculture, Fisheries and Forestry
GPO Box 858, Canberra ACT 2601

DOES EVICTING FEMALE BRUSHTAIL POSSUMS (*TRICHOSURUS VULPECULA*) FROM ROOFS COMPROMISE THE WELFARE OF THE ANIMALS?

Natalie Waller, Luke Leung,
The University of Queensland, The School of Animal Studies, Gatton QLD 4343
natalie.waller@uqconnect.edu.au

Large populations of brushtail possums (*Trichosurus vulpecula*) occur in urban areas in Australia. The animals use roofs for den sites, causing damage to buildings and noise disturbance to households. Large numbers are evicted yearly but little is known of the welfare of these animals. Evicted animals may not be able to re-establish home range and hence suffer from increased exposure to competition, predation, weather and other risks. This potential welfare problem is more acute for females because of their dependent young. Trapping to evict animals may cause injury and this appears to be influenced by the mesh size of cage traps. This study, therefore, aims to assess the welfare of evicted females by determining if the animals change body weight, home range and core area after eviction; and if the frequency of trap-related injuries is associated with the mesh size of traps.

The study was conducted in six experimental blocks in suburbs within 11 km from Brisbane CBD, Queensland from November 2009 to June 2010. Within each block, the pre- and post-eviction home ranges and core areas of two evicted and one control (not evicted) animal were estimated by radio-tracking for two weeks. The animals were evicted by a licensed pest controller using cage traps or a one-way door placed at the entrance to the roof. The entrance was blocked to stop the evicted animal from returning to the roof. All animals evicted using traps were released within 25 meters of the eviction site. The changes in home range and core area between the pre- and post-eviction periods were quantified by the volume of intersection (V.I.) index. The body weight of each animal was recorded two weeks before and two weeks after eviction. The frequency of trap-related injury was recorded from 45 animals during their first capture in traps with large (25 x 25mm) or small mesh sizes (12.5 x 12.5mm).

Mean percentage body weight change ($F_{1,9}$ = 3.46; P = 0.096) and mean VI indices for home range ($F_{1,9}$ = 0.08; P = 0.783) and core area ($F_{1,9}$ = 0.04; P = 0.842) did not significantly differ between control and evicted animals within blocks. These findings demonstrate that the eviction from roofs did not compromise the welfare of the animals. The ability of the evicted animals to maintain body weight, home range and core areas as the control animals is most likely due to the observation that all evicted animals found alternative den sites in other roofs within or near the pre-eviction home range. Our data indicate that evictions merely transfer the problem from one household to another. Further research is required to prevent evicted animals from invading other roofs. The frequency of trap injuries was 0.68 for the large mesh and 0.19 for the small mesh. This association was significant (x = 5.607; p = 0.0179) indicating that the smaller mesh size should be used for trapping to minimise injury.

EUTHANASIA VS. TRANSLOCATION OF PROBLEM PORCUPINES IN ISRAEL

Simon C. Nemtzov
Department of Ecology, Israel Nature and Parks Authority (INPA)
3 Am Ve'Olamo Street, Jerusalem 95463, Israel
simon@npa.org.il

When choosing how to deal with human-wildlife conflicts, one has to be mindful of a variety of issues, from the conservation status of the species, through environmental and ecological effects of the chosen remedy, and including also animal welfare issues. The final choice of what to do is often a trade-off of interests and restraints. When faced with conflicts involving protected species or charismatic mega-fauna, the choice of remedy can also have social, political and legal ramifications. Here I present a case study of dealing with of a common wildlife-agricultural conflict in Israel.

In Israel, the largest species of rodent is the native Indian crested porcupine (*Hystrix indica*). This species is in demand for traditional medicine and food by aboriginal hunters, but is fully protected by law. In some areas of the country, illegal poaching has severely reduced the local population. In other parts of the country the species is overabundant, and is a major agricultural pest, and even enters suburban areas causing damage in gardens and cemeteries. The reduction of human-wildlife conflicts in Israel is not managed by the Agricultural Ministry but rather, it is the mandate of the INPA, the government's wildlife conservation authority. However, lack of effective solutions can lead disgruntled farmers to resort to illegal poisoning, which is usually indiscriminant, and often harmful to non-target wildlife, such as raptors, carnivores and scavengers.

In order to reduce damage by porcupines, INPA rangers encourage the use of non-lethal methods such as proper fencing and guard dogs, but where porcupines are overabundant they are permitted to be trapped in cage traps and removed from the agricultural and suburban areas. Wildlife lovers, including the INPA rangers, often feel that one should give these animals "a chance" and release them in wild areas, but current translocation research has shown that such a move generally sentences such stressed animals to wandering, hunger and a difficult death. Euthanasia seems the most humane option, but it is ecologically indefensible when there are areas of the country with decimated populations where translocation could serve to reinforce the population.

The current policy is a trade-off of these issues, allowing translocation from agricultural and suburban areas and release in wild areas only if the local population at the release site needs reinforcement, and if the individuals are prepared before the release by allowing them to recover from the stresses of trapping, and acclimating them to the release site (thus making the translocation a kind of "soft" release). If these demands cannot be met due to financial or ecological reasons, only then is the porcupine euthanized.

One alternative option being explored now is to have problem porcupines from areas where they are overabundant be made available to the locals as bushmeat, in order to reduce demand for illegal poaching. It is not clear if such a move would really achieve the goal of greater conservation of the wild populations, so the implications and complications of this possible solution are currently being investigated.

IS THE MYNA A MAJOR PROBLEM? A TRIPLE BOTTOM LINE EVALUATION

Ricky-John Spencer
Water and Wildlife Ecology Group (WWE), Native and Pest Animal Unit,
School of Natural Sciences, University of Western Sydney, Richmond, NSW 2753
ricky.spencer@uws.edu.au

The Myna bird has been declared the second greatest threat to native birds after land clearing. They have the potential to spread disease, such as avian influenza and other infections that can affect humans. But few studies have evaluated their true impact on native species despite considerable amount of funding and other resources being diverted into community based trapping programs. Although community programs have provided intangible benefits, a true evaluation of their cost-effectiveness, as well as an evaluation on the true impact that mynas have on the environment has not been performed. In this talk, I use a triple bottom line approach to evaluate whether Common Mynas are a significant and emerging invasive pest species in Australia.

DINGO WELFARE WILL FAIR POORLY IN UNFAIR PLAY

Brad V. Purcell
School of Natural Sciences, University of Western Sydney,
Locked Bag 1797, Penrith South DC, 1797 Australia

Lethal control of dingoes *Canis lupus dingo* (dingoes/wild dogs/hybrids) has been used consistently for 150-200 years and has not yet exterminated dingoes from pastoral regions. In addition lethal control has proven ineffective to mitigate loss of biodiversity, and has had little if any influence on the economic viability of pastoral industries that have contributed to biodiversity loss across Australia. For example the Australian sheep industry has suffered a 4.2% per annum rate of decline between 1990 and 2008 due to continuous restructuring and market fluctuations, forces far greater than animal predation. In all dietary studies on dingoes, presence of livestock species has been a minor component of samples tested, and the difference between predation of livestock or scavenging of carcasses could not be distinguished in most. The relationship between free-ranging dingoes and predation losses is therefore tenuous, and likely over-rated in economic analyses. Cultural perceptions of the impacts dingoes have on the economy and threats to human activities currently inform dingo management plans, and tend to neglect ecological and behavioural data on dingoes. In addition, impacts of dingo control on ecosystem/landscape processes have not been adequately researched.

Ethical considerations of dingo control and livestock management are in conflict. Controlling dingoes stops them from leading natural lives and functioning within physiological and behavioural systems. Disruption of pack structure in top order predators may inadvertently change ecological and evolutionary processes to the detriment of ecosystem balance. Farming livestock in areas where dingoes are not controlled alternatively has implications for the welfare of livestock subject to dingo predation. Understanding behavioural ecology of social predators will assist in understanding behaviour patterns of their competitors and prey. Management strategies that compliment the ecological value of dingoes in Australian landscapes and economic values of livestock production need to be developed. In this paper I will explore how shifting the paradigm in how dingoes are viewed and treated is important to help create an environmentally sustainable Australia.

COEXISTING WITH CARNIVORES IN THE U.S. - OVERCOMING PREJUDICE AND PERSECUTION

Ms Camilla Fox
Project Coyote & Animal Welfare Institute

Livestock-predator conflicts – and increasingly conflicts with "nuisance" wildlife – have been managed by the U.S. Department of Agriculture's Wildlife Services (WS) program through cooperative agreements with states, counties, municipalities, and other entities. This federal agency relies heavily on a lethal arsenal that includes traps, snares, poisons, and aerial gunning. In 2009, WS killed more than 4 million animals in the United States including 115,000 mammalian carnivores, of which close to 90,000 were coyotes (*Canis latrans*).

Greater understanding of the ecological importance of native carnivores and increasing public opposition to lethal control has led to growing demand for humane and ecologically sound conservation practices. Despite shifting public attitudes and values, traditional predator/wildlife management techniques persist leading to increasing tension between conservationists and management institutions. This tension is reflected in increased litigation, legislation, and public ballot initiatives.

This presentation will focus on the problems and consequences of traditional federal top-down carnivore management in North America and present alternative adaptive-management approaches that foster community involvement and inclusion of a diversity of stakeholder values and ethics through cooperative "practice-based improvements" and modeling.

REFORMATTING THE DEBATE ON THE ETHICAL USE OF ANIMALS SO THAT SCIENTISTS CAN BECOME ENGAGED

Daniel Lunney
DECCW NSW
PO Box 1967, Hurstville NSW 2220
dan.lunney@environment.nsw.gov.au

The debate on the ethical use of animals rarely includes scientists, wildlife managers or conservation biologists. It has been abstract, and couched in philosophical terms. The leading proponents are philosophers, such as Peter Singer, who has established the term "animal liberation" as part of our language. The position has attracted adherents who criticise such practices as commercial use of wildlife, research on animals and the control of pest vertebrates. That criticism can emerge as policy, including legislative changes. Few of my fellow conservation biologists, including vertebrate pest control specialists, have read Singer or the raft of publications that contribute to this debate. This matters if the policies that emerge have not included the concerns for biological conservation. If the focus on individual animals is the only consideration, especially if it is based on an animal rights or animal liberation standpoint rather than animal welfare, then we face a future that has not incorporated the strengths of science. That is not to deny the importance of dealing with suffering and the issues of animal ethics, but I argue that the debate could be reformatted so that scientists can be engaged. I would recast the debate to emphasise the ethical context in which we deal with animals, such as whether they are in the wilderness, or in a cage, or somewhere in between, such as a city or farm. In each of these contexts, the ethical imperatives differ. A dog on a lead is the responsibility of the person holding the lead, but a dog without a collar in the street is looked at as lost, a stray, or even a threat. A dog in the wild may be part of the natural landscape, but if it moves onto grazing land it may be viewed as a threat to stock. The ethical response for each context differs, yet it is the same species, and sometimes the same individual animals. It is possible to map these contexts, literally, using a map or GIS. The wildlife manager could then look at the map to assist in the decision-making process, such as what code of practice to follow. A species-specific, spatially-explicit context for the ethical debate on how we manage animals presents a new approach to integrating ethics, welfare and science by incorporating the potential contribution of the scientist into this human-wildlife conflict.

FERAL PIGS, CATTLE AND CANE TOADS ON THE ANGKUM IPA, LOCKHART RIVER, CAPE YORK

Christopher Dean , Jennifer Smits
Angkum Indigenous Protected Area
Australian Wildlife Services, Canberra

Angkum homelands, about 80km south of Lockhart River, has great natural significance. It is in the Cape York Peninsula bioregion and Angkum sea country is within the Great Barrier Reef Marine Park. Yet pest animals are threatening Angkum's pristine environment and culturally important and threatened animals including Tukulu – marine turtle species. A major objective of managing the area will be feral pig, feral cattle and cane toad management. Angkum IPA rangers will be implementing a range of methods to control pest animals including trapping, artificial lagoons, hunting and the following monitoring methods:

- Night patrols of beaches during turtle nesting times
- Cybertracker surveys
- Judas collars to find pig home territory
- Track-based surveys (tracks, scats, damage)
- Photo Points at key feeding and wallowing sites to track change

Angkum Rangers are keen to use natural methods of control rather than chemicals and baits. In the summer, Rangers will trial pumping cane toad tadpole infested waterholes utilising the suns heat and soil temperature to bring about mortality of the tadpole.

The natural resources of the IPA are significant because Angkum is a tropical coastal environment covered in a wide range of vegetation from coastal mangrove forests and swamps, coastal rainforests, riverine vine forests, dense scrub on old prograded dune systems, inland to extensive eucalypt forests, ti-tree woodlands and grasslands on the coastal plains behind the littoral zone. To the west, rainforest clad mountains to rise sharply from the coastal plain. The area is in process to be declared an Indigenous Protected Area. Angkum elder's fundamental vision is to return to country. This vision centres on being able to use, harvest and control and trade their traditional coastal resources.

CAN HARVEST OF INTRODUCED BRUSHTAIL POSSUMS (TRICHOSURUS VULPECULA) FOR FUR BY MAORI BE BOTH ECONOMICALLY SUSTAINABLE AND PROVIDE BIODIVERSITY BENEFITS?

Christopher Jones, Graham Nugent, Mandy Barron, Bruce Warburton
Landcare Research, P.O. Box 40, Lincoln 7640, New Zealand
jonesc@landcareresearch.co.nz

Brushtail possums were introduced into New Zealand in the late 1800s in an attempt to establish a fur trade. The species has since become widespread, reaching much higher densities than in its native Australia and is now considered NZ's most important vertebrate pest due to its impacts on native forests, through canopy damage and predation on birds, and its status as the main wildlife vector for bovine tuberculosis. Current large-scale control (using aerially-applied 1080 poison) is expensive, controversial and tailored to deliver a range of specific goals at specific places with little integration across goals and no acknowledgement of the value of possum fur as a resource. Limited budgets and prioritised allocation of funding means that large tracts of native forest receive little or no pest control. We explore, through a combination of field study, modelling and interviews with Maori fur harvesters, whether sustainable fur harvest is viable economically, and whether such harvest could provide some level of biodiversity benefit to native podocarp forests in New Zealand's North Island where no official control is carried out. We also attempt to identify an optimal harvest by modelling the consequences of a range of spatial and temporal harvest strategies on local possum densities. This approach is particularly relevant to indigenous forest on Maori land where there are typically few resources for managing biodiversity and few opportunities to generate revenue or employment from the land without sacrificing biodiversity.

BUFFALO AND PIG CONTROL IN ARNHEM LAND TO REDUCE ECOLOGICAL AND CULTURAL IMPACTS ON PERMANENT FRESHWATER WETLANDS

Daniel Barrow[1], Yinimala Gumana[2] and **Emilie Ens[3]**
[1] Parks and Wildlife Service Northern Territory, PO Box 391 Nhulunbuy, NT, 0881
[2] Yirralka Rangers (Laynhapuy Homelands Association)
[3] Centre for Aboriginal Economic Policy Research, ANU, Acton, Canberra, ACT, 0200
emilie.ens@anu.edu.au

The Indigenous Protected Area (IPA) Program is a Commonwealth Government initiative that encourages Aboriginal land owning groups to include biologically significant areas of Aboriginal land in the national reserve system in exchange for financial assistance and support in managing that land for conservation and cultural heritage protection outcomes. Laynhapuy IPA covers an area of 7000 sq km and holds some of the largest pristine wetlands in the Northern Territory.

In September 1996 the highest population of Magpie geese (500,000), ever recorded in the NT was recorded on the Gurrumuru Wetlands. In the last ten years populations of buffalo and pigs have increased significantly and are having a major impact on health and culture of the Yolngu people. The old people regularly complain of the lack of bush foods like turtle, water chestnut, water lilies, fish and small mammals. They have also noticed freshwater bodies becoming undrinkable due to salt water intrusion. Two years ago NT Parks and Wildlife and the Yirralka Rangers came together to work on minimizing the impacts of large vertebrate pests throughout the IPA. Emilie Ens from the ANU has also assisted with monitoring the outcomes this work.

With the help of modern technology, including CyberTracker, and community ecological and cultural knowledge we have started to measure the outcomes of feral animal control programs. Using this two-ways approach we developed a data collection sequence using CyberTracker which uses Yolngu Matha (local Aboriginal language) and images to prompt data collection by the Yirralka Rangers who speak very little English. Information on ground surface features, ground cover and water quality have been collected this way and the Rangers have also established fenced exclusion zones to demonstrate the recovery of wetland areas when ferals are removed. The initiatives adopted and preliminary results are discussed.

TURNING PESTS INTO PROFITS: INTRODUCED BUFFALO PROVIDE MULTIPLE BENEFITS TO INDIGENOUS PEOPLE OF NORTHERN AUSTRALIA

Clive R. McMahon
Research Institute for Environment & Livelihoods, Charles Darwin University, Darwin, 0909, Northern Territory, Australia
clive.mcmahon@cdu.edu.au

Introduced species are a major driver of negative ecological change, but some introduced species can potentially offer positive benefits to society.

Asian swamp buffalo (*Bubalus bubalis*) were introduced to the northern Australian mainland in 1827 and have since become a serious pest. However, buffalo have also supported various profitable industries, including harvesting for hides, meat, and live export. We investigate an indigenous wildlife-based enterprise that harvests wild buffalo from indigenous-held lands in remote northern Australia. We used ecological modelling and social research techniques to quantify the buffalo dynamics and to examine their contributions to sustainable livelihoods in a remote Aboriginal community.

Results suggest that the current harvest rate will not drive the species to extinction and it is thus unlikely that the population size of buffalo will be reduced enough to alleviate ecological damage. This enterprise is profitable and provides regular royalty payments to traditional land owners and wage income for employees, along with several additional non-financial capital assets. We demonstrate that the commercial exploitation of introduced species can provide additional or alternative sources of protein and income to promote economic development for indigenous people. This type of enterprise could be expanded to more communities using harvest rates above maximum sustainable yield to provide greater positive social and ecological outcomes for indigenous communities.

KEYWORDS: sustainable harvest, economic development, livelihoods, wildlife, multi-disciplinary, food security.

NGAANYATJARRA LANDS CAMEL SHOOTING PROGRAM

Alex Knight, Mark Butler
Ngaanyatjarra Council Land and Culture Program
58 Head Street Alice Springs, NT 0871

An aerial Survey in 2007 found the camel density across the Ngaanyatjarra lands ranges from 0.25 in the Great Victoria Desert bioregion to 2/km in the Central Ranges Bioregion[1].

Camel density near the major communities in the Ngaanyatjarra lands was the highest in Australia. This problem has already come to the attention of Ngaanyatjarra communities. Camels were causing severe damage in the communities in particular Warakurna. The community asked Ngaanyatjarra council to assist them with control. In mid 2006 an independent commercial camel shooter was invited to shoot camels in the region and since that time over 30,000 camels have been shot with the meat sold to the pet food market in WA.

Camel shooters have worked under agreement with individual communities with a small royalty of 5c per kg paid to community incorporations. The council have supported these arrangements and provided overall governance.

With funding support from the national camel program we are in a position to expand our capability rapidly to reduce the camel population density to below the target level specified in the strategy.

Ngaanyatjarra Council plans to use camel funding to improve the efficiency and range of ground based shooting by;

. Aerial Spotting,
. Judas collars.
. Upgrade the tracks that the shooters use
. Making available mobile camps for shooting from more remote sites.

The cost of the actual shooting would continue to be borne by the commercial camel shooters with the sale of the camel meat.

The Ngaanyatjarra camel plan will also consider the control extremely remote camel populations by aerial shooting (with our own shooters) but only after this has been successfully demonstrated elsewhere and only after we have defined what camel populations we cant get from the ground. We envisage that if aerial shooting to waste was found to be necessary it would only commence in year 3.

1 National Camel Project Survey Report

FORMIDABLE OBSTACLES: THE POLICY AND LEGISLATIVE CHALLENGES FACING INDIGENOUS COMMERICAL USE OF WILDLIFE

Dr Rosie Cooney
Independent Consultant and Visiting Fellow, Institute of Environmental Studies
University of New South Wales
rosie.cooney@gmail.com

Indigenous enterprises based on the commercial use of wildlife, including pest animals, have considerable potential in providing opportunities for income and independence for indigenous people in remote areas in particular, enabling people to stay on country while using and building on traditional skills and knowledge. However, establishing indigenous wildlife enterprises faces a formidable array of hurdles involving the indigenous, state and Commonwealth policy, legislative and bureaucratic requirements. While the benefits of indigenous wildlife enterprises have been repeatedly endorsed in policy documents, major funding programs provide no or little support for them, and gaining the requisite licences and approvals can involve such delay, uncertainty, and administrative effort that fledgling initiatives are stifled at birth. Drawing on work carried out for the North Australia Indigenous Land and Sea Management Alliance (NAILSMA), this talk discusses the potential of indigenous wildlife enterprises for pest animal control, outlines the obstacles they face, and suggests options for the way forward.

ASSESSING THE HUMANENESS OF INVASIVE ANIMAL CONTROL METHODS

Trudy Sharp[1], Glen Saunders[1] and Bidda Jones[2]
[1]Vertebrate Pest Research Unit, Industry & Investment NSW, Orange Agricultural Institute, Forest Road, Orange NSW 2800
[2]RSPCA Australia, PO Box 265, Deakin West, ACT 2600
trudy.sharp@industry.nsw.gov.au

Many of the negative animal welfare impacts associated with the management of invasive animals can be minimised by using the most humane method that is effective for a given situation. However determining the 'humaneness' of a method has mostly been considered problematic compared to the assessment of other factors such as target specificity, efficacy, cost/benefit, etc. To address this, a framework was developed in 2008 to assess the overall humaneness of invasive animal control methods. This model uses published scientific information and informed judgment to examine the negative impacts that a method has on an animal's welfare and, if a lethal method, how the animal is killed. A score is generated so that the relative humaneness of different control methods can be compared.

This paper presents the results of a recent DAFF funded project that applied the Model for Assessing the Relative Humaneness of Pest Animal Control Methods developed by Sharp and Saunders (2008) to a range of invasive animal control methods used in Australia. A panel consisting of experts with knowledge and experience in animal welfare and invasive animal management performed the assessments with the assistance of experts with knowledge on specific animal species. Sixty humaneness assessments for 12 different species were completed. The results of the project have been presented in the form of humaneness assessment worksheets and matrices that will be published as a hard copy document and also on a public access website (feral.org.au).

References:

Sharp, T. and Saunders, G. (2008). *A model for assessing the relative humaneness of pest animal control methods*. (Australian Government Department of Agriculture, Fisheries and Forestry: Canberra, ACT) at:←http://www.daff.gov.au/___data/assets/pdf_file/0008/929888/humaneness-pest-animals.pdf→

RELATIVE WELFARE IMPACTS OF VERTEBRATE PEST CONTROL TOOLS USED IN NEW ZEALAND

Penny Fisher[1], Ngaio Beausoleil[2], Bruce Warburton[1], David Mellor[2] and Kate Littin[3]
[1] Landcare Research, PO Box 40, Lincoln, 7640, New Zealand
[2] Animal Welfare Science and Bioethics Centre, Massey University, Palmerston North 4442, New Zealand
[3] Ministry of Agriculture and Forestry, PO Box 2526, Wellington 6140, New Zealand

Increasingly, information about animal welfare impacts of vertebrate pest control methods is required by operators and policymakers. In a project commissioned by the Ministry of Agriculture and Forestry, a review panel with expertise in animal welfare science, pest animal management, veterinary science and toxicology found that a recently-developed humaneness assessment framework (Sharp & Saunders 2008) was readily applicable to the evaluation of the welfare impacts of New Zealand pest control tools. Some modifications were made in applying the framework, such as scoring functional impairments only until loss of consciousness and using Part A of the framework to evaluate vertebrate toxic agents (VTAs). A science literature search was undertaken for specific information about each VTA or control tool with regard to: humaneness or welfare impacts on animals; the mode of toxic action and behavioural, physiological, and pathological responses; description of effects, time to death and pathology and toxic effects on humans. Compilation of such information provided review and reference material for assessing each control tool/species combination, and identified gaps in knowledge. The control tools assessed included VTAs delivered in bait (e.g. 1080, cyanide, cholecalciferol, anticoagulants, phosphorus, avicides), as burrow fumigants (chloropicrin, magnesium phosphide) or to water as a piscicide (rotenone). Each control tool was assessed for targeted vertebrate pest species, and in some cases also for introduced mammal species known to be non-targets. For possums, rodents, carnivores and rabbits lethal anticoagulant poisoning was ranked as having the highest relative impact on welfare. In contrast, cyanide as used for possum control had the lowest relative welfare impact. In general, 1080 and phosphorus produced intermediate impacts. For many VTAs, there was insufficient information to conduct comprehensive analyses of welfare impacts. In particular, data on the time between onset of symptoms and loss of consciousness (duration of negative experiences) were lacking, as was information on the level of consciousness during critical events e.g. convulsions, respiratory compromise.

References:

Sharp, T. and Saunders, G. (2008). A model for assessing the relative humaneness of pest animal control methods. Australian Government Department of Agriculture, Fisheries and Forestry, Canberra, ACT.

INTEGRATING ANIMAL WELFARE INTO PEST ANIMAL CONTROL: A WORK IN PROGRESS

Bidda Jones[1], Trudy Sharp[2]
[1]RSPCA Australia, PO Box 265, Deakin West, ACT 2600
[2]Vertebrate Pest Research Unit , Industry & Investment NSW, Orange Agricultural Institute
Forest Road, Orange NSW 2800
bjones@rspca.org.au

The case for considering animal welfare as an integral part of the planning and implementation of vertebrate pest animal control programs has been advanced in a number of publications in recent years. In 2004, a discussion paper advocating a national approach towards humane pest animal control identified four primary benefits of this approach (Humane Vertebrate Pest Control Working Group 2004). They were: increased on-ground recognition of the need for humane control practices; the development of more humane control methods; the achievement of an appropriate balance between welfare considerations and other national objectives served by vertebrate pest control; and, ultimately, the avoidance or minimisation of animal suffering during vertebrate pest control operations. This paper examines what progress has been made in Australia towards attaining these benefits, using a number of examples from current strategies and practices.

One of the major hurdles identified in 2004 was the perceived difficulty in objectively measuring animal welfare: the development of an accepted assessment model has greatly assisted in overcoming this (Sharp and Saunders 2008). The uptake and review of standard operating procedures that provide information on animal welfare impacts have also helped to improve understanding of control methods and application of on-ground practices (Sharp and Saunders 2005). Enquiries relating to the humaneness of different control methods and feedback from operators on best practice outcomes have also increased, whilst research has been undertaken specifically to examine the humaneness of new or existing techniques. But there is still much room for improvement. More research is needed to fill gaps in current knowledge and a sustained effort is required to address negative attitudes towards pest animals, especially where the relevance of minimising animal suffering in pest animal management is questioned. In order to ensure that control activities are supported and understood – and maintain Australia's 'security from the impact of pest animals' - future strategies will need better to inform the public of the welfare impact of control programs and take account of increasing community concern about the treatment of animals.

References:

Humane Vertebrate Pest Control Working Group (2004) *A national approach towards humane vertebrate pest control.* Discussion paper arising from the proceedings of an RSPCA Australia/AWC/VPC joint workshop, August 4-5, Melbourne. RSPCA Australia, Canberra.

Sharp, T and Saunders, G (2005) *Humane pest animal control: codes of practice and standard operating procedures.* New South Wales Department of Primary Industries: Orange. http://www.dpi.nsw.gov.au/agriculture/pests-weeds/vertebrate-pests/codes/humane-pest-animal-control

Sharp, T and Saunders, G (2008) *A model for assessing the relative humaneness of pest animal control methods.* Australian Government Department of Agriculture, Fisheries and Forestry, Canberra, ACT.

HUMANE WILDLIFE MANAGEMENT IN THE UK: A QUANTITATIVE APPROACH

Sandra E. Baker
Wildlife Conservation Research Unit, Department of Zoology, University of Oxford, UK

A wide range of potential wildlife management methods are available for addressing conflict between people and wildlife, including lethal and non-lethal approaches. While some management approaches may better lend themselves to a particular situation and others may not be legal, it remains difficult to decide which of the available options is the most humane. We aim to take a quantitative approach to assess the welfare impact of a range of vertebrate management methods (lethal and non-lethal) that reflect a wide range of potential welfare impact types. This work focuses on selected model species that represent key management issues and a broad range of management options in the UK.

This is a work in progress, but we aim to conduct quantitative welfare scoring of the methods available for each species, using and potentially developing models previously described by Sharp and Saunders (2008) and Mellor and Reid (1994). For example, we might incorporate elements of Honess and Wolfensohn's (2010) Extended Welfare Assessment Grid, which has similarities to the QALYS system used in human healthcare for assessing the costs and benefits of otherwise non comparable aspects of an intervention.

As well as making our own assessment we will canvass the opinions of experts in wildlife management and in animal welfare to examine how consistently or otherwise methods are scored. The goal is to produce a list of control methods for each species, each with an associated welfare impact score, thus allowing methods to be ranked for each species in terms of likely welfare impact. This work should lead to recommendations for the humane management of the selected species (and by extension certain others) in the UK (and by extension, beyond).

ANIMAL WELFARE DURING DEPARTMENT OF CONSERVATION PEST CONTROL OPERATIONS

Verity Forbes[1] and **Alastair Fairweather**[2]
[1] Department of Conservation, Private Bag 701, Hokitika 7842, New Zealand
[2] Department of Conservation, PO Box 516, Hamilton 3434, New Zealand
vforbes@doc.govt.nz

Over the last two decades the profile of animal welfare during pest control operations has increased markedly. Worldwide, this has had a significant impact on the way pest control operations occur. In some cases it has led to pest control becoming less efficient and the goals of the pest control becoming unachievable.

In New Zealand the Animal Welfare Act 1999 is the legal basis for the welfare of animals. Currently, the provisions of the Act do not apply to the hunting and killing of animals in a wild state unless the animal is in captivity, e.g. in a trap, or the animal is being wilfully ill-treated.

Despite the exclusion, the Department of Conservation (DOC), as a major land manager and as a government department accountable to the public of NZ, wishes to be recognized as being responsible in the way it undertakes pest control. Here we outline DOC's operational animal welfare policy that aims to achieve a balance between ethical pest control while ensuring conservation goals are achieved effectively and efficiently.

A PARADIGM SHIFT IN KANGAROO MANAGEMENT FOR THE RANGELANDS

Dr Dror Ben-Ami, Kelly Boom, Dr Daniel Ramp, Dr David Croft
THINKK, ISF, UTS
Ultimo NSW
dror.ben-ami@isf.uts.edu.au

The harvesting of kangaroos is regulated by proportional quotas, the licensing of shooters and two Codes of practice for the humane shooting of kangaroos which the shooters must adhere to. The commercial code has stringent welfare guidelines and applies to about 90 percent of shot kangaroos but is not enforced at the point where the kangaroo is killed. The non-commercial code is much more relaxed and applies to the other 10 percent which are mostly shot on private properties by non-licensed shooters, and carries greater possibility for enforcement since it applies to particular properties. However, there is an increasing awareness that kangaroos are not universally over-abundant, that there has been no measurable environmental improvement from their harvesting and that there are significant welfare issues with kangaroo harvesting and culling. This has led to a challenge to the kangaroo industry by a concerned public, the media, non-profit animal protection and environmental organisations, and academics. However, if the cessation of kangaroo harvesting were to occur there would undoubtedly be more requests, and perhaps more need, from graziers and crop farmers for permits to kill kangaroos. In this paper we explore the type of policy changes necessary to reflect the changing landscape of scientific knowledge and attitudes towards kangaroos. We suggest that the interests of graziers and animal welfare advocates could be supported if harvesting was discontinued and a quantitative assessment of income loss was provided when a damage mitigation permit for killing kangaroos was requested. Damage to graziers and farmers could then be audited for transparent public information and the government regulator could follow through with mitigation measures that are in line with current values. A permit to kill could be given more judiciously and be expected to incorporate more stringent welfare regulatory mechanisms. Alternatively, graziers/farmers could be compensated financially for their losses.

THE ECOLOGY OF EXOTIC RODENTS AND NON-TARGET SPECIES ON TORRES STRAIT ISLANDS: IMPLICATIONS FOR EXOTIC RODENT ERADICATION

Rebecca Diete, Tyrone Lavery, Natalie Waller, Luke Leung
School of Animal Studies, University of Queensland, Gatton, QLD, 4343

Exotic rodents are a major threat to insular plants, animals and ecosystems on islands. The eradication of exotic rodents on islands has recently been identified as a priority for biodiversity conservation in Australia. The roof rat (*Rattus rattus*) and house mouse (*Mus domesticus*) have invaded many islands in the Torres Strait. These exotic rodents are sympatric with three potential non-target species on some Torres Strait islands: a native rodent, the grassland melomys (*Melomys burtoni*); and two reptiles (*Bellatorias frerei* and *Eugongylus rufescens*). This study aims to gain a sound understanding of the ecology of these species. This knowledge would be useful for developing strategies to eradicate exotic rodents and manage non-target impacts. This study also aims to develop a barrier system to exclude the non-target species from the bait station and to select a more palatable wax block bait to improve eradication success.

Transect trapping was conducted on Mer Island in the wet and dry season in 2010. Total trapping effort in all natural habitats (grassland, forests and littoral zone) was 3,427 trap nights for Elliott traps, 862 for pitfall traps and 440 for snap traps. No exotic rodents were detected in any of these natural habitats. A smaller trapping effort (323 Elliott and 212 snap trap nights) in the town detected the presence of roof rats and house mice. The grassland melomys was captured in large numbers in the natural habitats, with a mean of 24.9 individuals per 100 trap nights. The most plausible explanation for these findings is the large native rodent populations excluding the exotic rodents from these habitats.

A series of field trials of five systems with increasing barrier were conducted in grassland and forest habitats on Mer in February, April and August 2010. The effectiveness of the barrier system in excluding non-target species was quantified by trapping with an Elliott trap with its entrance against an opening of the bait station. The bait station was a length of 100 mm wide corrugated plastic pipe and the combined length of the trap and pipe was 500 mm. A wooden stake was used to elevate the bait station and a length of PVC pipe was placed 100 mm below the station and over the stake as a collar. The two reptiles were caught in bait stations laid on the ground but not in any elevated bait station. When compared to bait stations laid on the ground, reduced numbers of grassland melomys were caught in elevated bait stations; further reduced numbers were caught in elevated stations with small collars; and, finally, none were caught in elevated bait stations with a slightly larger collar (50 x 180 mm PVC pipe). These barrier systems would exclude non-target animals on islands where different combinations of these non-target species may occur.

Extruded (Ditrac®) and cast (Rodex®) wax block baits, both containing 0.05% brodifacoum were tested by presenting both bait types in bait stations (500 mm PVC pipe of 100 mm diameter) placed t 30 m apart on Poruma Island where a large population of roof rat occurred. The consumption of Ditrac® was estimated to be 17.8 times higher than that of Rodex®, indicating Ditrac® is a more effective bait for eradicating exotic rodents on islands. The results of this study may be useful in developing strategies for eradicating exotic rodents on Torres Strait islands.

OPTIMISING THE USE OF THE JUDAS TECHNIQUE FOR MAXIMISING DETECTION OF VERTEBRATE PESTS

David S.L. Ramsey
Arthur Rylah Institute for Environmental Research, 123 Brown Street, Heidelberg, VIC 3084
david.ramsey@dse.vic.gov.au

The Judas technique involves the use of radio-telemetered individuals released into an area and located periodically in the hope that they will associate with wild individuals thus revealing their presence. The technique is especially useful on social vertebrate pest species such as feral pigs (*Sus scrofa*) and feral goats (*Capra hircus*) and is often used towards the end of eradication programs where Judas individuals are used to detect survivors of control. However, efficient use of the Judas technique is hampered by some difficult questions, such as deciding how many Judas individuals to release, as well as the length of the deployment time to answer the question of interest. As the Judas technique is usually fairly expensive to implement, having a quantitative approach to determining the optimal number of Judas animals as well as a basis for deciding the minimum deployment period for each Judas would be beneficial. Here we describe a new method for determining the optimal sample size and deployment period of Judas individuals to achieve a high probability of detection of wild individuals. The methods are also useful for quantifying the probability that wild individuals have been eradicated, when none are detected by Judas individuals. The methods are illustrated with actual data from island eradication programs on feral pigs and goats.

LORD HOWE ISLAND: RODENT ERADICATION AND COMMUNITY ENGAGEMENT

Ian S. Wilkinson[1], David Priddel[2]
[1]Department of Environment, Climate Change and Water, Locked Bag 914, Coffs Harbour, NSW 2450, Australia
[2]Department of Environment, Climate Change and Water, PO Box 1967, Hurstville BC, NSW 1481, Australia
E-mail: ian.wilkinson@environment.nsw.gov.au

In common with a number of oceanic islands, World Heritage listed Lord Howe Island (LHI), 760 km north-east of Sydney, has populations of invasive rodents. The house mouse (*Mus musculus*) probably arrived around 1860, and the black (ship) rat (*Rattus rattus*) in 1918. Both species have had significant impacts on the biodiversity of the island, and predation by ship rats on islands is listed as a Key Threatening Process under both NSW State and Australian Government legislation.

Planning for an eradication of both species is underway, and a critical component of that planning is to address the challenge posed by the presence of a permanent human population on the Island. The need for a high level of community support necessitates ongoing community engagement to dispel misinformation and to identify and address legitimate concerns and objections.

Feedback at community meetings, from surveys and by public submissions to the exhibition of the Draft Eradication Plan indicate that the main areas of concern relate to the potential impacts on the environment, human health and tourism. It is clear that doubt and misunderstanding remain in the community despite the provision of large amounts of information, either verbally at meetings or through written media, much of which directly addressed many of the issues raised. The dissemination of misinformation by some in the community may have led to confusion and exacerbated the concerns of some residents.

Although a rodent-free island will provide substantial social and economic benefits to the LHI community, getting everyone fully onboard, has proved more challenging, and the consultation period more protracted, than originally envisaged. Hindsight has highlighted the importance of how and by whom communities are engaged. The experience at LHI provides valuable lessons for future eradications on inhabited islands.

EXPERIMENTAL MOUSE INVASIONS TO DETERMINE BIOSECURITY BEST PRACTICE

Mr Jamie MacKay [1], **Dr Elaine Murphy** [2], Dr James Russell [1], Professor Mark Hauber [3], Professor Mick Clout [1]
[1] The University of Auckland, Private Bag 92019, Auckland, New Zealand
[2] Department of Conservation, New Zealand
[3] Hunter College, City University of New York
Email: j.mackay@auckland.ac.nz

Stoats were introduced to New Zealand in the 1880s in an attempt to control rabbits, but were quickly implicated in the decline of native birds. Stoat control will have to be on-going if some native species are to survive on the mainland. Para-aminopropiophenone (PAPP) is being developed as a new, humane poison for stoats. Cage trials have shown PAPP presented in a meat bait was palatable and effective, while symptoms observed demonstrated PAPP to be humane. To evaluate the formulation in the field, two trials were undertaken in Waitutu Forest, Southland. Meat baits containing 13 mg PAPP were placed in bait stations for 5 nights and tracking rates were used to monitor changes in stoat abundance. In the first trial, the index of stoat abundance was reduced by 83% and in the second trial by 87%. Our results indicate that PAPP is an effective toxin for stoats in the field and has the potential to provide a significant new tool for management of native species. PAPP also represents the first new active ingredient to be developed as a vertebrate pesticide in New Zealand for 30 years and we have submitted the data for registration of a PAPP-based stoat control product.

FOX ERADICATION IN TASMANIA: A NEW APPROACH

Craig Elliott, Jane McGee, Matt Pauza and **Robbie Gaffney**
Fox Eradication Branch, DPIPWE, 134 Macquarie St, Hobart, TAS, 7000

Evidence of the presence of the European Red Fox in Tasmania has a long and diverse history. This pest animal presents a significant threat to the State's biodiversity and natural environment and to primary industries. Recent recordings of the species from 1998 to February 2011 include four carcasses, one skull, one blood deposit, two sets of footprints, 57 scats containing fox DNA as well as approximately 300 unconfirmed reported sightings annually from the public. In 2006, as a result of this mounting evidence and the threat posed by the animal, the Tasmanian Government announced their commitment to manage a joint state and commonwealth funded 10-year program to eradicate the species from the state.

In August 2009, a review of the Program was completed by Landcare Research New Zealand. The primary recommendations from that review provide the basis for the Program's future. The most significant change is a move away from a "reactionary" program to a "precautionary" baiting strategy, whereby baiting activity is undertaken on a 'rolling front' across all areas of predicted fox occupancy habitat in the state. Other recommendations include the increased efforts in monitoring for survivors or reinvaders behind the baiting front with the introduction of fox scent tracking dogs. This new approach began in Tasmania's south in May 2010 with a second baiting front commenced in the North West of the State in January 2011.

The Program is supported by a range of community and industry engagement activities, to build public awareness of the Program's work and the threat posed by this pest, and a series of applied research projects that are designed to better inform and measure the effectiveness of this "rolling front" approach and the possible impacts of foxes in the State.

NON-TARGET SPECIES MANAGEMENT FOR THE MACQUARIE ISLAND PEST ERADICATION PROJECT

Keith Springer and **Noel Carmichael**
Tasmania Parks and Wildlife Service, GPO Box 1751, Hobart TAS 7001
keith.springer@parks.tas.gov.au
noel.carmichael@parks.tas.gov.au

The mitigation of non-target species impacts is one of the key challenges of the AUD$25 million plus Macquarie Island Pest Eradication Project (MIPEP). The MIPEP aims to eradicate rodents (*Mus musculus* and *Rattus rattus*) and rabbits (*Oryctolagus cuniculus*) from sub-Antarctic Macquarie Island through the aerial application of cereal-based brodifacoum bait over the entire island, followed by a multi-year ground program employing teams of hunters and rabbit-detector dogs to target surviving rabbits.

Spreading bait in winter has two advantages, bait uptake is increased due to target species having reduced natural food sources, pest numbers are at their lowest, and are not breeding. Many native species are also absent during winter so non-target impacts are reduced. However, the winter period between April and September has the shortest days and worst weather conditions and presents enormous challenges for helicopter baiting operations. An aerial baiting program was attempted in the winter of 2010 but had to be postponed following a delayed arrival on-island and unusually bad weather being encountered during June and July.

Although only about 8% of the planned 305 tonnes of bait was distributed during the 2010 winter, considerable non-target bird mortality was recorded in subsequent months, primarily amongst scavenging seabird species such as Kelp Gulls (*Larus dominicus*), Giant Petrels (*Macronectes giganteus* and *Macronectes halli*) and Skuas (*Catharacta lonnbergi*). Whilst mortality among non-target seabirds had been expected as a result of baiting, by February 2011, over 900 birds had been recorded that were likely to have died as a result of primary, secondary or tertiary brodifacoum poisoning.

In response to this level of non-target bird mortality, particularly among threatened species, the Australian and Tasmanian governments conducted a review of the project in late 2010. The review found that, whilst some species were likely to be adversely affected by the project, the island's ecosystem and most other island species would substantially benefit from the continuation of the project, and recommended that enhanced mitigation measures be introduced to minimise non-target species impacts. Following the assessment of a range of potential mitigation measures, two principal measures have been adopted: the release of Rabbit Haemorrhagic Disease Virus amongst the island's rabbit population, in order to reduce the rabbit population prior to baiting and thereby minimise the number of poisoned rabbit carcasses available for consumption by scavenging seabirds; and the deployment of field teams during and after aerial baiting to search for and remove poisoned carcasses, in an attempt to minimise the incidence of secondary and tertiary poisoning.

The MIPEP plans to undertake another aerial baiting attempt this winter and project staff will deploy to the island in mid-April 2011. If successful, the MIPEP will be the largest and most complex sub-Antarctic island rabbit and rodent eradication undertaken.

EFFECTS OF 4-VINYLCYCLOHEXENE DIEPOXIDE ON FEMALE BRUSHTAIL POSSUM HEALTH AND FERTILITY

Anna Mae Burd[1,2], Susie Scobie[2], Christa Blenck[1], Loretta Mayer[1], Cheryl Dyer[1] and Janine Duckworth[2]
[1]SenesTech, Inc., 2901 W. Shamrell Blvd #101, Flagstaff, AZ, USA 86001
[2]Landcare Research, PO Box 40, Lincoln 7640, New Zealand

In an attempt to find a permanent, sustainable fertility control method for the brushtail possum, an industrial chemical, 4-vinylcyclohexene diepoxide (VCD), is being investigated. Studies in rodents have shown that VCD selectively reduces the finite pool of immature ovarian follicles, resulting in a rapid onset of premature ovarian failure and permanent sterility (reviewed in Hoyer et al. 2001; Hoyer and Sipes 2007). To assess its potential as a fertility control agent for brushtail possums, we examined the effects of VCD on the health of female possums and the depletion of immature ovarian follicles in two separate experiments. In the first experiment, adult female possums were orally gavaged daily for 13 days with 500 or 750 mg VCD/kg body weight mixed 1:3 in sunflower oil (n=7, n=8, respectively) or sunflower oil only (n=8). At the completion of the experiment, somatic and reproductive organs were weighed, blood was collected for complete blood count (CBC) assessments and ovaries sectioned for follicle population analysis. There were no significant differences in body weight, CBC parameters, or liver, kidney, adrenal, reproductive tract or ovarian weights when compared with controls. Primordial follicle estimates of VCD treated females were not significantly different from controls (control, 139164f6875; VCD 500, 157504f62696; VCD 750, 103254f26268). Because VCD is prone to hydrolytic breakdown to its inactive tetrol form under acidic conditions, such as those found in the possum stomach (pH 1.89f0.46), in the second experiment we attempted to increase the follicle-reducing efficacy of VCD by using an antacid pre-treatment or a lipid emulsion solution (Intralipid 20%, Pharmaco) as protective formulations for the oral delivery of VCD. Adult female possums were orally gavaged daily for 10 days with 750 mg VCD/kg either in (1) sunflower oil (1:3) following antacid pre-treatment (containing 1014 mg $CaCO_3$, 169 mg $MgCO_3$, 169 mg $Mg_2O_8Si_3$ suspended in 3 mL water) (n=8) or (2) in lipid solution (1:3) (n=9). Control animals were gavaged with equivalent volumes of (1) sunflower oil following antacid pre-treatment (n=6), (2) lipid solution (n=6) or (3) sunflower oil only (n=6). Compared with controls there were no effects on body weight, liver, kidney, adrenal, reproductive tract, or ovarian weights of VCD treated animals. The effect of VCD on primordial and primary follicular counts will be described. Collectively, these two experiments demonstrate that VCD does not cause deleterious effects to possum somatic or reproductive organs or haematological parameters. We will discuss the potential effectiveness of antacid and lipid solution formulations for increasing the chemosterilant activity of VCD in possums. Future studies will examine the comparative metabolism of VCD in the brushtail possum with the aim of increasing efficacy and developing oral fertility control baits for controlling wild pest possum populations throughout New Zealand.

References:

Hoyer, P.B. and Sipes, I.G. (2007) Development of an animal model for ovotoxicity using 4-vinylcyclohexene diepoxide: a case study. *Birth Defects Research* 80: 113-125.

Hoyer, P.B., Devine, P.J., Hu, X., Thompson, K.E. and Sipes, I.G. (2001) Ovarian toxicity of 4-vinylcyclohexene diepoxide: a mechanistic model. *Toxicologic Pathology* 29: 91-99.

EFFECT OF DIFFERENT PERIODS OF TREATMENT WITH 4-VINYLCYCLOHEXENE DIEPOXIDE ON FERTILITY OF FEMALE RATS

Tung T Tran[1,2], Lyn A. Hinds[1], and Anthony K. Blome[3]
[1] CSIRO Ecosystem Sciences, GPO Box 1700, Canberra, Act, 2601, Australia
[2] Research School of Biology, Australian National University, Australia
[3] SenesTech Inc., Arizona, USA
thanhtung.tran@csiro.au

Fertility control of rodents could be used as an additional approach for the management of pest populations in agricultural production systems. One potential technique is the use of chemosterilants which induce permanent sterility in females. In this study, one candidate chemical, 4-vinylcyclohexene diepoxide (VCD), was tested for its effects on the fertility of female laboratory rats (*Rattus norvegicus*). VCD, by parenteral and oral administration, has been shown to deplete primordial follicles in the ovaries of female rats and mice (Hoyer *et al.*, 2001, Mayer *et al.*, 2002, 2004; Ito *et al.*, 2009). These studies administered VCD (80-320mg/kg/day) daily for 15 or 30 days.

In our study, the effects on fertility and ovarian primordial follicle numbers were assessed after a period of treatment (daily for 10 days), which was then repeated either once or twice at 14-21 day intervals, using a higher, oral dose of VCD (500 mg VCD/kg/day). Six-week old female rats (208f18 g body weight) were divided into groups that were treated as follows: G*roup 1* animals received either corn-oil or VCD for a period of 10 days; G*roup 2* animals received treatment for two periods of 10 days separated by 21 days; G*roup 3* animals received treatment for three periods of 10 days separated by 21 and 14 days respectively.

At the end of treatment, ovaries were collected for histological assessment. Animals in *Group 4* were treated as in G*roup* 3, but following their last period of oral gavage, they were paired with fertile, untreated males for 4 breeding rounds to assess their fertility. Their ovaries were then collected and primordial follicle numbers assessed.

Analysis of ovarian follicles demonstrated that oral administration of VCD (500 mg/kg) to female rats induced significant depletion in primordial follicles for all treatment schemes, and significantly reduced primary follicles when the animals were successively treated for 2 or 3 periods of 10 days. Depletion of primordial and primary follicles resulted in consequent depletion of secondary and larger follicles in treated animals. The fertility of female rats following exposure to VCD for three 10 day periods was significantly reduced ($P < 0.05$) by the 2^n round of breeding. VCD has potential as a chemisterilant although the duration of treatment would need to be considerably shorter for field delivery.

References

Hoyer, P. B., Devine, P. J., Hu, X. M., Thompson, K. E. and Sipes, I. G. (2001) Ovarian toxicity of 4-vinylcyclohexene diepoxide: A mechanistic model. *Toxicologic Pathology,* 29**,** 91-99.

Ito, A., Mafune, N. and Kimura, T. (2009) Collaborative work on evaluation of ovarian toxicity 4) two- or four-week repeated dose study of 4-vinylcyclohexene diepoxide in female rats. *Journal of Toxicological Sciences,* 34**,** SP53-SP58.

Mayer, L. P., Devine, P. J., Dyer, C. A. and Hoyer, P. B. (2004) The follicle-deplete mouse ovary produces androgen. *Biology of Reproduction,* 71**,** 130-138.

Mayer, L. P., Pearsall, N. A., Christian, P. J., et al. (2002) Long-term effects of ovarian follicular depletion in rats by 4-vinylcyclohexene diepoxide. *Reproductive Toxicology,* 16**,** 775-781.

DEVELOPMENT OF AN ORAL BAIT TO INDUCE PREMATURE OVARIAN FAILURE AS A FERTILITY CONTROL STRATEGY FOR RODENT PESTS

Loretta P. Mayer, Rachel P. Allred, Aaron C. Bennett, and Cheryl A. Dyer
SenesTech, Incorporated, 2901 W. Shamrell Blvd, Flagstaff, AZ 86001
loretta.mayer@senestech.com

Chemical induction of premature ovarian failure results from follicular depletion causing sterility of female rats and mice in laboratory settings (Mayer et al. 2002, 2004, Haas et al., 2007). The industrial chemical 4-vinylcyclohexene diepoxide (VCD) administered via repeated i.p. injections induces follicular depletion. VCD targets the non-regenerating primordial follicle pool thereby depleting the mammalian ovary of viable follicles for development and ovulation (Flaws et al., 1994). In a thirteen-week study performed by the National Toxicology Program, oral gavage of VCD at 500 and 1000 mg/kg/d resulted in ovarian atrophy (Chhabra et al., 1989). Studies were performed in our laboratory to determine if the ovarian atrophy previously reported could be induced via a shorter exposure period. Adult female Sprague-Dawley rats (60 days of age, n=6-8) were gavaged daily with corn oil (control) or 500 mg/kg VCD in corn oil for 15 and 30 days. Ovarian histological analyses were performed to estimate the relative sizes of the remaining primordial follicle pools. Fifteen days of VCD exposure resulted in a 34.6% reduction in primordial follicles relative to controls, and after 30 days the depletion was 81%. In these and previous studies, oral VCD exposure was administered in a single bolus on a daily basis. However, studies performed in mice indicated that an increase in the frequency of daily VCD exposure (i.p. injection) results in acceleration of follicle depletion (Mayer et al. 2004). Therefore, it was reasonable to suggest that follicular depletion could be induced via VCD exposure in a feeding protocol that would result in reduced time-to-follicular depletion when compared to gavage studies. Adult female Sprague-Dawley rats (60 days old, n=6) received 500 mg/kg/d VCD in corn oil or corn oil vehicle by gavage. Ovarian analyses were performed to determine the percent of primordial follicle depletion following 3d (0%) or 5d (9%) of treatment. In a subsequent study, juvenile female Sprague-Dawley rats (28 days of age, n=6) were fed *ad libitum* a bait containing 4.6 mg of VCD per gram of bait or control bait for 3 and 5 days. Consumption levels of the VCD bait resulted in an average VCD dose of 534 mg/kg/d. Follicular depletion was determined for all groups and when compared to control there was a reduction of 23% at 3 days, and 30% at 5 days. Taken together, these results indicate that VCD is efficacious in depleting primordial follicles when administered orally. Further, the rate of follicle depletion can be accelerated by feeding VCD in a bait formulation. These studies suggest that VCD is a viable candidate for development of a fertility control agent that can be delivered in a bait to manage rodent pest species.

References:

Mayer, L., Pearsall, N., Christian, P., Devine, P, Payne, C, McCuskey, M., Marion, S., Sipes, I, and Hoyer, P. (2002) Long-term effects of ovarian follicular depletion in rats by 4-vinylcyclohexene diepoxide. *Reproductive Toxicology*, 16:775-781

Mayer, L., Devine, P., Dyer, Ca. and Hoyer, P. The follicle-depleted mouse ovary produces androgen. (2004). Biology of Reproduction, 71:130-138.

Haas, J., Christian, P., and Hoyer, P. (2007) Effects of impending ovarian failure induced by 4-vinylcyclohexene diepoxide on fertility in C57Bl/6 female mice. Comparative Medicine, 57:443-449.

Flaws, J., Doerr, J., Sipes, I., and Hoyer, P. (1994). Destruction of preantral follicles in adult rats by 4-vinyl-1-cyclohexene diepoxide. *Reproductive Toxicology*, 8:509-514.

Chhabra, R., Elwell, M., and Peters A. (1989). Toxicity of 4-vinyl-1-cyclohexene diepoxide after 13 weeks of dermal or oral exposure in rats and mice. Fundamental and Applied Toxicology, 14:745-751.

VACCINE DELIVERY TO MARSUPIAL WILDLIFE USING REPLICATION-LIMITED VACCINIA VIRUS

JJanine Duckworth[1], Frank Cross [1], Steve Fleming [2], Susie Scobie[1], Ellena Whelan[2], Andrew Mercer[2], Dianne Gleeson[3], Diana Prada [3] and Phil Cowan[4]

[1]Landcare Research, PO Box 40, Lincoln 7640, New Zealand

[2]Virus Research Unit, University of Otago, PO Box 56, Dunedin New Zealand

[3]Ecogene Laboratory, Landcare Research Auckland 1142, New Zealand

[4]Landcare Research, PO Palmerston North 4442, New Zealand

Oral vaccine delivery systems suitable for disease mitigation or fertility control in free-living wildlife are a significant challenge. A highly successful system, based on a replication-limited recombinant vaccinia virus (rVV), has been widely used to control rabies in wildlife in the US and Europe. However the potential of rVV as delivery system has not yet been assessed in any marsupial species. In the present study we have evaluated the infectivity of rVV, as well as cell-mediated and antibody immune responses, in the marsupial brushtail possum (*Trichosurus vulpecula*), a significant pest species in New Zealand. Possums were exposed by the oronasal route to a model recombinant vaccinia construct rVV399, which expresses the Eg95 antigen of the hydatid disease parasite *Echinococcus granulosus*. After a single dose, rVV339 infected 3/8 possums, and infected 7/7 animals after three doses. A single oronasal dose with the non-modified strain of vaccinia virus (Lister) on which rVV399 was based infected 8/8 treated possums. The recombinant and parent viruses persisted in the mucosal epithelium around the palatine tonsils for only up to 2 weeks post-exposure, but generated blood lymphocyte anti-viral immune responses in the infected possums that were sustained for at least 4 months. Serum antibody reactivity to Eg95 was recorded in 7/8 possums which received a single dose of rVV399 and in 7/7 animals which received triple-dose delivery. This study demonstrates that vaccinia virus will readily infect possums via the oronasal route and generate immune reactivity against both viral and heterologous antigens. This highlights the potential of recombinant vaccinia as a wildlife vaccine delivery system for the brushtail possum and other marsupial species.

ASSESSMENT OF AN ORAL DELIVERY SYSTEM FOR IMMUNOCONRACEPTIVE VACCINES

Ian McDonald[1,2,3], Sam Knight[4], Kim Finnie[4], Chris Barbé[4] and Lyn Hinds[1,2]
[1]CSIRO Ecosystem Sciences, Canberra, ACT
[2]Invasive Animals CRC, Canberra, ACT
[3]School of Agriculture and Food Sciences, UQld, Gatton, Qld
[4]Ceramisphere, Sydney, NSW
ian.mcdonald@csiro.au

One of the major challenges facing oral delivery of immunocontraceptive vaccines (e.g. GnRH constructs and other proteins) is the identification of an effective delivery system which will (1) protect the constructs from degradation in the gastrointestinal tract (GIT), (2) efficiently transport constructs through the GIT for specific uptake by mucosal inductive sites (Peyer's patches), and (3) assist stimulation of a systemic immune response. Preliminary studies assessing GnRH recombinant proteins in laboratory rodents indicate that they are effective if administered via parenteral routes; however they are not effective when delivered orally in an unprotected form.

We have been assessing silica nanoparticles, which have the capacity for controlled release, are fully biodegradable and can be easily manipulated (Finnie *et al.* 2006). However, the biodistribution of these nanoparticles has not been assessed when delivered orally (Rigby *et al.* 2008; Xie *et al.* 2010). It is also unclear whether surface modifications, such as pegylation (He *et al.* 2010; Ku *et al.* 2010), will enhance mucosal uptake over non-modified particles.

In this study we assessed the oral uptake of pegylated and non-pegylated small (≈300nm) and large (≈900nm) silica nanoparticles which carried two markers (Alexafluor 633 and gold). The biodistribution of the particles in a range of tissues was determined at various intervals over a 24h period. The results suggest that the smaller sized particles were more effectively taken up by Peyer's patches and into the lymphatic system to the spleen, and also by the liver. However, their efficacy in inducing an immune response remains to be assessed. Further studies incorporating known highly immunogenic proteins (such as tetanus toxoid) into the particles are now being conducted, before assessment of GnRH constructs.

References

Finnie KS, Jacques DA, McGann MJ, Blackford MJ, Barbé CJ (2006) Encapsulation and controlled release of biomolecules from silica microparticles. *Journal of Materials Chemistry* **16**, 4494-4498.

He QJ, Zhang JM, Shi JL, Zhu ZY, Zhang LX, Bu WB, Guo LM, Chen Y (2010) The effect of PEGylation of mesoporous silica nanoparticles on nonspecific binding of serum proteins and cellular responses. *Biomaterials* **31**, 1085-1092.

Ku ST, Yan F, Wang Y, Sun YL, Yang N, Ye L (2010) The blood-brain barrier penetration and distribution of PEGylated fluorescein-doped magnetic silica nanoparticles in rat brain. *Biochemical and Biophysical Research Communications* **394**, 871-876.

Rigby SP, Fairhead M, van der Walle CF (2008) Engineering silica particles as oral drug delivery vehicles. *Current Pharmaceutical Design* **14**, 1821-1831.

Xie GP, Sun J, Zhong GR, Shi LY, Zhang DW (2010) Biodistribution and toxicity of intravenously administered silica nanoparticles in mice. *Archives of Toxicology* **84**, 183-190.

EFFECTS OF GNRH-TARGETED IMMUNOCONTRACEPTION ON FEMALE FERTILITY IN TWO SPECIES OF MACROPOD

Melissa Snape[1,2,3], Lyn Hinds[1,2] , Don Fletcher[4], Claire Wimpenny[4] and Lowell Miller[5]
[1]CSIRO Ecosystem Sciences, GPO Box 1700, Canberra, ACT, 2601
[2]Invasive Animals CRC, University of Canberra, Bruce, ACT, 2617
[3]Australian National University, Acton, ACT, 2601
[4]Land Management and Planning, ACT Government, GPO Box 158, Canberra, ACT 2601
[5]USDA National Wildlife Research Centre, Fort Collins, Colorado, USA

High densities of macropods (kangaroos and wallabies) are often observed in fragmented urban landscapes, where their partial containment by roads or fences can result in vehicle-wildlife collisions and environmental damage. Managing the abundance of native species is often contentious, especially in urban areas where residents regularly oppose conventional lethal techniques for animal "right to life" reasons. Public safety considerations also limit the use of firearms in urban areas. Fertility control has been proposed as an acceptable alternative method for managing overabundant macropods, although the employment of techniques currently available is often hindered by low contraceptive efficacy or costs associated with the need to capture and/or recapture animals individually for treatment. Immunocontraceptive vaccines targeting gonadotrophin releasing hormone (GnRH) overcome some of these issues. In particular, a single vaccination with the GnRH vaccine, 'GonaCon-Blue™' (Fagerstone et al 2008), has induced long-lasting infertility in a range of eutherian species. However, this vaccine's long term effects have not been determined in macropod marsupials.

This study evaluated the effects of the GnRH vaccine 'GonaCon-Blue™' on female reproduction in two species of macropod. Adult female tammar wallabies, Macropus eugenii (n=36) and sub-adult female eastern grey kangaroos, M. giganteus (n=26) were treated either with a sham injection (control), a single dose of GnRH vaccine (Vacc1), or an initial dose of GnRH vaccine followed by a booster immunisation 4 weeks later (Vacc2; tammars only). In the tammars, a large proportion of females were carrying pouch young at the time of treatment, and ~80% were presumed to also be carrying embryos in diapause. Although treatment did not affect current lactation, four months after treatment, successful blastocyst reactivation was reduced in treated animals compared to controls by 75% and 100% in Vacc1 and Vacc2 female tammars respectively. Oestrous cycles were also suppressed in 100% of treated animals for at least four years, thus preventing further conception in this species. Following single administration of the GnRH vaccine to sub-adult eastern grey kangaroos, the onset of breeding was delayed in all individuals by at least two years, resulting in 100% infertility in treated animals, whereas all sham vaccinated control females produced a young in each of their first two breeding seasons. This vaccine's high level of efficacy, coupled with its lack of apparent detrimental side effects and potential for remote delivery via darting, emphasizes its potential as a publically acceptable and cost effective non-lethal method of managing overabundant macropods in urban areas.

References

Fagerstone, K.A., Miller, L.A., Eisemann, J.D., O'Hare, J.R. and Gionfriddo, J.P. (2008) Registration of wildlife contraceptives in the United States of America, with OvoControl and GonaCon immunocontraceptive vaccines as examples. *Wildlife Research*, 35, 586-592

DEVELOPMENT OF REPRODUCTIVE INHIBITORS FOR WILDLIFE IN THE UNITED STATES

John D. Eisemann, Kathy Fagerstone, Jeanette R. O'Hare, and Lowell Miller
USDA National Wildlife Research Center, 4101 LaPorte Ave, Ft Collins, Colorado USA 80521
John.D.Eisemann@aphis.usda.gov

Traditional methods for reducing overabundant wildlife, such as hunting and trapping, are often restricted or infeasible in urban and suburban areas. Societal pressures have forced wildlife managers to seek alternative management tools. In 2006, the regulatory authority for contraceptives for wildlife and feral animals was transferred from the U. S. Food and Drug Administration (FDA) to the U. S. Environmental Protection Agency (EPA). The FDA maintained authority over contraceptives in livestock, companion animals and zoo animals. While this change does not reduce the rigor at which products are evaluated, it does place the regulatory authority over wild and feral contraceptives into an agency more adept at evaluating the risk of environmental releases of the products. For the past 18 years, scientists with the U.S. Department of Agriculture's (USDA) Wildlife Services, National Wildlife Research Center (NWRC) have been developing and testing wildlife contraceptives. The NWRC recently registered the first single-shot contraceptive vaccine for use in white-tailed deer (GonaCon™). This same product has potential for use in a number of other mammalian pests and further registrations are being considered. Another successful product registration involving a collaboration with a private company resulted in the first avian contraceptive product registration since Ornitrol was cancelled in early 1990's. OvoControl can now be purchased for managing pigeons and Canada geese in the US. A number of other compounds are currently being tested for use in wildlife that could have promise in the future. Contraceptives will not replace other management tools, but can be used to help manage overabundant wildlife in urban and residential areas where other management methods, such as hunting, are not always an option. This talk will provide an overview of past wildlife contraception efforts, and discuss the current state of research and the regulatory status.

A MODIFIED VERTICAL BAIT STATION DESIGN TO MEASURE POISONING RISK IN SYMPATRIC RODENT POPULATIONS USING REMOTE CAMERAS

Mr Paul Meek [1], Ms Frances Zewe [2], Dr Hugh Ford [3], Dr Karl Vernes [3], Dr David Peacock [4]
[1]Department of Industry and Investment, Vertebrate Pest Research Unit, PO Box 4019, Coffs Harbour, NSW 2450, Australia
[2] University of Western Australia
[3] University of New England
[4] Primary Industries and Resources SA
Email: paul.meek@industry.nsw.gov.au

The control of exotic rodents is a high priority for island conservation. The eradication of black rats (*Rattus rattus*) from Muttonbird Island in New South Wales is being tackled to enhance the survival and breeding success of the wedge-tailed shearwaters (*Puffinus pacificus*) on the island. The native swamp rat (*R. lutreolus*) also exists on the island and may be at risk from black rat control measures. This study aimed to see if swamp rats could be protected on the Island by using remote camera technology to assess a vertical bait station that delivers poison baits to only black rats. We hypothesised that black rats would climb the 50 cm vertical bait station, whereas swamp rats would be excluded, due to their inability or unwillingness to climb. The results of our study found that 92%of 12 captive black rats entered the vertical bait stations in the laboratory, and wild black rats were observed entering vertical bait stations in the field. In contrast, 18 of 22 swamp rats climbed the vertical bait stations in the laboratory, none were observed entering them in the field. The trial was later broadened to include bush rat (*R. fuscipes*) and the Fawn-footed Melomys (*Melomys cervinipes*) to evaluate potential applications on other islands. Both these species climbed the vertical bait stations in the laboratory but showed no interest under natural field conditions.

MULTI-SPECIES ERADICATIONS FROM INHABITED ISLANDS

Al S. Glen[1] and Alan Saunders[2]
[1]Landcare Research, PO Box 40, Lincoln 7640, New Zealand
[2]Landcare Research, Private Bag 3127, Hamilton 3240, New Zealand
glena@landcareresearch.co.nz

The number, scale and complexity of successful invasive species eradications is increasing. So far, most eradications have targeted one or a few vertebrate pests on small to medium-sized, uninhabited islands. Biological communities on inhabited islands are often more modified, and larger inhabited islands also typically support larger suites of invasive species, which may interact with each other and with the native biota in complex ways. Some invasive species may also be valued by island residents for cultural, spiritual or economic reasons. In addition to factoring in ecological complexity, eradication managers must ensure the needs of island residents are reflected in project objectives if eradication is to be achieved and desired outcomes sustained. There is growing recognition that social and economic dimensions of conservation may be at least as important as ecological and logistical ones, which have predominated in the past. As our attention turns towards larger, inhabited islands, we will need to develop our ability to integrate social, economic and ecological dimensions, and to accommodate greater complexity. Using the Juan Fernández Archipelago in the Chilean Pacific as an example, we discuss the feasibility of managing suites of invasive species on inhabited islands.

The Juan Fernández Archipelago is a globally significant biodiversity hotspot. Over 60% of native plants and six of the seven native land birds are endemic; some critically endangered. The main threats to the survival of this unique biota come from invasive species. Weeds are displacing native plants; rodents impede forest regeneration and probably prey on native birds; goats, rabbits and cattle disperse seeds of introduced species, trample and consume native plants and cause severe erosion; feral and domestic cats, as well as coatis (a South American relative of the raccoon), prey upon critically endangered native birds.

A recent study assessed the feasibility of managing invasive plants and animals in the archipelago. Here we focus on the proposed eradication of a suite of seven invasive mammal species. We describe the logistical and social challenges involved in this proposal, as well as recommendations to overcome these. Using ecological theory and previous experience, eradications must be planned to take into account species interactions. Operations must be carried out concurrently or in a carefully timed sequence so that removal of one species does not exacerbate the impacts of any other. Monitoring and contingency plans must detect and address any 'surprise effects'. Above all, it is imperative that the local community understands, supports and is engaged in eradication activities and subsequent biosecurity measures. Ideally key stakeholders will assume "ownership" of restoration activities.

Despite the important progress which has been made in recent decades, eradication achievements still lag behind the rate of biodiversity loss and extinctions. It is vital that we continue to build our collective capacity to eradicate different suites of invasive species from larger islands. Working alongside island residents to develop and refine multi-pest management approaches on inhabited islands will be a key to stemming the tide of island extinctions.

DETECTING INVASION AND/OR SURVIVAL POST ERADICATION USING GENTIC METHODS: THE STOAT ON NEW ZEALAND'S ISLANDS

Andrew J. Veale[1], Dianne Gleeson[2]
[1] SBS, University of Auckland, Private Bag 92019 Auckland
[2] Landcare Research Private Bag 92170 Auckland
avea002@aucklanduni.ac.nz

As invasive mammals are eradicated from a growing number of islands around the world, the risk of reinvasion is of increasing concern. Understanding the process of invasion, the structure of isolated populations of invasive mammals, and the detectability of new invaders are important aspects of the growing field of invasion ecology. Within the New Zealand environment, the primary threat to native fauna on coastal islands is the stoat (*Mustela erminea*); a voracious predator that can swim at least 3.0 km. Numerous stoat eradication programs are currently underway on New Zealand's islands, however on many of these islands stoats are still being caught. Using genetic techniques it is possible to assess where these stoats came from – are they surviving residents or invading migrants? Through this we can assess the level of success of eradication programs, and we can model the invasion rate and the population predicted on these islands. Results to date indicate that stoats can swim further, and do so more regularly than previously thought. This reinforces the need for ongoing management and biosecurity after an eradication operation. The results also highlight the need for pre-eradication genetic sampling for invasive species – even in situations where reinvasion is considered unlikely.

IDENTIFYING AND MANAGING CHALLENGES OF RODENT ERADICATIONS ON TROPICAL ISLANDS

Araceli Samaniego-Herrera[1], and Marlenne Rodríguez-Malagón[2]
[1]School of Biological Sciences, University of Auckland, Private Bag 92019, Auckland, New Zealand
[2]Grupo de Ecología y Conservación de Islas, Av. Moctezuma 836, Zona Centro, Ensenada, B.C., México
Email: araceli.samaniego@islas.org.mx

The negative impacts of invasive rodents on native flora, fauna and ecological processes are well documented. The eradication of invasive rodents from islands is now considered as "regular practice" in temperate ecosystems. Within the tropics, however, the recent management incursions have shown that specific issues need to be addressed in order to increase the eradication success rate. Abundant rodent populations, land crab interference and potential risk to resident native fauna are among the main concerns, yet not well understood because the lack of basic information and experimental research. Based on field work conducted on several Mexican islands in the tropical region, preliminary conclusions are discussed: 1) rodent populations on tropical islands are substantially more abundant that those on temperate islands, 2) land crab communities might show seasonal patterns and they are not easily disturbed while they are in the "hibernation-like" state, which translates into a window for eradication operations, 3) despite the higher density of rodents and the presence of land crabs, low bait application rates (similar to what is used for temperate islands) might be enough for rodent eradications on some tropical islands if the operation is carefully timed.

SUCCESS RATES IN ERADICATING RODENTS FROM ISLANDS USING DIFFERENT RODENTICIDES AND AERIAL OR GROUND-BASED DELIVERY METHODS

John Parkes and Penny Fisher
Landcare Research, PO Box 40, Lincoln 7640, New Zealand
parkesj@landcareresearch.co.nz

Since 1971 over 700 attempts to eradicate one or more invasive rodents have been made on 532 islands in 26 countries. Although 12 rodenticides have been used, 70% of attempts have used the anticoagulant brodifacoum. It is highly toxic to mammals and birds, and persists in the carcasses (particularly the liver) of poisoned animals exposing non-target species to risk from secondary and tertiary poisoning. The anticoagulant, diphacinone, has been used in 9.5% of attempts. It has a lower toxicity and environmental persistence profile than brodifacoum, but requires rodents eat bait every day for several days to obtain a lethal dose. This may compromise the ability of diphacinone bait to kill 100% of the target population.

In this paper we have looked at the outcomes (eradicated or not) of a subset of attempts using the two rodenticides against five rodents species. The subset included all attempts against *Rattus exulans* and *Mus musculus* (which are poor swimmers), but only attempts on islands →500 m from a source population for *R. rattus* and *R. tanezumi*, and →1000 m for *R. norvegicus*. This was to partially avoid potential confusion in outcomes when natural reinvasion is possible. We further divide these attempts by the general method by which the bait was delivered – aerial broadcast versus various ground-based methods.

Rodent species	Rodenticide	No. aerial attempts	% aerial failures	No. ground attempts	% ground failures
M. musculus	Brodifacoum	25	32%	19	47%
	Diphacinone	0		1	100%
R. exulans	Brodifacoum	39	0%	37	30%
	Diphacinone	2	50%	0	
R. rattus/tanezumi	Brodifacoum	28	11%	25	17%
	Diphacinone	3	100%	11	18%
R. norvegicus	Brodifacoum	33	0%	30	20%
	Diphacinone	0		15	13%

Pooled across species and methods, the failure rates of diphacinone were not significantly different from brodifacoum ($X = 2.15$, $P = 0.14$). The two rodenticides had similar failure rates for ground-based methods of baiting (Fisher's Exact Test, $P = 0.046$), but significantly higher failures rates for aerial diphacinone (Fisher's Exact Test, $P = \leftarrow 0.0001$) – but note the small samples sizes in the table. Assuming our pooling of delivery methods (there are many differences in both aerial and ground-based methodologies), across rodent species (e.g. feeding behaviours are not the same) and ignoring the different baits used, results suggest diphacinone can achieve eradication, at least for ground-based use, but requires more examples of success with aerial delivery before it can be used with confidence.

PROPOSED MANAGEMENT PLAN FOR CATS ON CHRISTMAS ISLAND

Dave Algar[1], Stefanie Hilmer[1] and **Michael Johnston[2]**
[1]Department of Environment and Conservation, P.O. Box 51, Wanneroo, WA 6946
[2]Department of Sustainability and Environment, PO Box 137, Heidelberg, VIC 3084
dave.algar@dec.wa.gov.au

The impact of cats on the biodiversity of Christmas Island is of concern to land management agencies and the broader community. Domestic and stray cats reside in the residential, commercial and light industrial area while a population of feral cats exists across the rest of the island (i.e. mining lease, national park and other Crown land). Concern has been raised regarding the threat that all 'classes' of cats present to the viability of a number of endangered fauna populations. Additionally, previous research has demonstrated that the cats on the island also have a very high prevalence of *Toxoplasmosis,* a parasite that can lead to serious human health complications. The management of cats on the island is a complex task as reduction/eradication in cat numbers alone could lead to changes in the abundance of other exotic species populations, especially the introduced black rat which then may threaten wildlife species and also have disease implications.

Land management agencies on Christmas Island commissioned a management plan (see Algar and Johnston 2010) for the development of a long-term cat and black rat management and eradication plan to mitigate the environmental and social impacts of cats and black rats across all land tenures (shire-managed lands, Crown land including mine leases and Christmas Island National Park).

In this presentation we provide a background to the threats and impacts of cats on the island's natural and social environment, including wildlife predation and disease threats to wildlife and human health. We outline modifications made to the current local cat management laws (*Shire of Christmas Island Local Law for the Keeping and Control of Cats 2004*) under the *Local Government Act 1995 (WA) (CI)* to enable this management plan to commence. These changes to the management laws will limit domestic and stray cat impact on the iconic native fauna of Christmas Island, promote responsible cat ownership and provide measures required to implement a 'last cat policy' for the Island.

We outline the recommended strategy that provides a staged approach to cat management and control leading to eradication. Techniques, actions and priorities are described as are recommendations of where additional research is required. A monitoring program to measure the effectiveness of the strategy is reported. Monitoring requirements to maintain a cat free status including quarantine requirements to prevent, detect and quickly manage, new incursions is also discussed.

Algar, D and Johnston, M. (2010). *Proposed Management plan for cats and black rats of Christmas Island.* Western Australian Department of Environment and Conservation.

ISLAND ARKS: THE NEED FOR A NATIONAL ISLAND BIOSECURITY INITIATIVE

Raymond C. Nias[1], Andrew A. Burbidge[2], Derek Ball[3] and Robert L. Pressey[4]
[1]TierraMar Consulting, PO Box 1260 Sutherland, NSW 1499
[2]87 Rosedale St, Floreat, WA 6014
[3] Reef Catchments Inc., PO Box 815, Mackay, QLD 4740
[4] Australian Research Council Centre of Excellence for Coral Reef Studies, James Cook University, Townsville, QLD 4811

Threats to island biotas from non-indigenous species have been extensively documented and remain among the most powerful drivers of biotic extinction. Despite this, Australia does not have a national, comprehensive plan of action for island biosecurity. Recent initiatives by Australian governments could provide the basis for the first systematic and comprehensive approach to securing the future of Australia's continental and oceanic islands. A National Island Biosecurity Initiative would lay the foundations for effective island biosecurity. It would protect globally significant populations of migratory species and play a major role in preventing the extinction of hundreds of threatened species and ecosystems. We present an overview of the NIBI and recent progress on island biosecurity policy in Australia.

FINDING FOXES IN TASMANIA: FAECAL DNA ANALYSIS REVEALS WIDESPREAD DISTRIBUTION OF AN ELUSIVE INTRODUCED PREDATOR

Stephen D. Sarre[1], Anna J. MacDonald[2], Candida Barclay[3], Dave Ramsey[4],
[1]Institute for Applied Ecology, University of Canberra, ACT 2601
[2]Invasive Animals Cooperative Research Centre, University of Canberra, ACT 2601
[3]Tasmanian Department of Primary Industries, Parks, Water & Environment, Prospect, TAS 7250
[4] Arthur Rylah Institute for Environmental Research, Brown St, Heidelberg, VIC 3084

The red fox (*Vulpes vulpes*) was recently introduced to Tasmania, an island refuge for many Australian species at risk of predation. Eradication of the fox population at this early stage is important for both conservation and agriculture in Tasmania but monitoring this elusive pest presents special problems. We use DNA analysis of faeces to identify fox traces and highlight areas of fox activity. Since 2007, we have screened around 8000 scats collected as part of a strategic and tactical survey across Tasmania and in response to fox sightings. Special attention is needed to maximise amplification success and to prevent contamination when working with trace DNA, especially given the large scale of this project and the unknown ages of the scats. Consequently we apply strict protocols at all stages of our work, from scat collection in the field to sample handling and analysis in trace DNA facilities. Fox DNA has been identified from scats collected across Tasmania, demonstrating a widespread distribution of this top predator ranging from the central north, to many sites in the east and south east. Genotyping with microsatellites and a sex marker have demonstrated that a number of individual foxes are responsible for these scats. These data have influenced directly the eradication strategies adopted by the Tasmanian Department of Primary Industries, Parks, Water & Environment. Advances in genetic approaches will further increase the quantity and nature of the information recoverable from these scats and other traces samples.

Abstracts - Day 2

(In Program Order)

PLENARY SESSION 5 - VERTEBRATE PEST COMMITTEE

ROLE AND FUNCTIONS OF THE VERTEBRATE PEST COMMITTEE

Millar H

THE AUSTRALIAN PEST ANIMAL STRATEGY AND ITS IMPLEMENTATION

Edwards G

CATEGORISATION SYSTEM AND EXOTIC ANIMAL GUIDELINES

Burley J

EPANS AND THE FERAL CAMEL ACTION PLAN

Woolnough A

AUSTRALIAN BIOSECURITY INTELLIGENCE NETWORK

Banyer J

BIODIVERSITY, WHAT IS IT AND WHY SHOULD WE CARE?

Dr Denis A Saunders AM
Research Fellow CSIRO Ecosystem Sciences, ACT

Most people think they know what biodiversity is; however it is obvious most do not. To many, biodiversity is taken to mean species diversity. In fact, it is sometimes even more narrowly defined to cover just the conservation of rare or endangered species, usually the conspicuous flowering plants or vertebrates. This erroneous interpretation leads to biodiversity being seen in an extremely restricted way and is accelerating its simplification.

Despite its importance to our survival, we have little idea what biodiversity was present in Australia in 1778 and not much better idea of what is present now. Australia's record for managing its biodiversity is not great. This has been reported upon in all Australian State of the Environment Reports since 1996. Those plant and animal groups we do have information on are all showing alarming declining trends. These losses will continue. And the worry is not just that we are losing some precious heritage, or that we have fewer biodiversity "goods" to commercialise. It is the breakdown in ecosystem processes that supply the support systems on which we depend, and the changes in the way they function, that pose the most critical environmental issues Australians face.

What are the challenges for the future? We need to combat ignorance about the importance of biodiversity. We need to continue to catalogue our biodiversity. We also need to take account of changes that seem inevitable and plan to minimise their impacts. We also need to educate people that maintenance of biodiversity cannot be achieved simply by designating areas for that purpose. We need to establish ways to conduct our production enterprises to minimise and ultimately prevent further loss of biodiversity. Economic systems that account for the environmental costs of production are also required, along with a means of ensuring these costs are met and used to remediate environmental problems, so as not to leave burdens on future generations.

HOW STRONG IS 'THE GROWING BODY OF EVIDENCE' FOR DINGO SUPPRESSION OF MESOPREDATORS? PUTTING THE METHODS UNDER THE MICROSCOPE

Ben Allen[1], Rick Engeman[2], and Lee Allen[3]
[1]The University of Queensland, School of Animal Studies, Gatton, Queensland
[2]National Wildlife Research Centre, United States Department of Agriculture, Colorado, USA
[3]Biosecurity Queensland, Robert Wicks Pest Animal Research Centre, Toowoomba, Queensland

There is growing interest in the role that apex predators play in shaping terrestrial ecosystems and maintaining trophic cascades. In line with mesopredator release theory, dingoes (*Canis lupus dingo* and hybrids) are assumed by many to regulate the abundance of red foxes (*Vulpes vulpes*) and feral cats (*Felis catus*), thereby providing indirect benefits to various threatened vertebrates. Several recent papers have claimed to provide evidence for the biodiversity benefits of dingoes in this way, adding to the "growing body of evidence" for positive dingo management. But how strong is this evidence? Is there any reliable "evidence" in it?

We examined both field and desktop studies of dingoes (published since 1995) to highlight several critical weaknesses in the methodological approaches used in many of these reports (see Allen *et al*., 2011, or Allen BL, 2011, for details). Of the 20 field studies examined, 15 of them (75%) contained serious methodological flaws, including the lack of consideration for seasonal and habitat differences in activity, the complication of simple track-based indices by incorporating difficult-to-meet assumptions, and a reduction in sensitivity for assessing populations by using binary measures rather than potentially continuous measures. Of the desktop studies reviewed, methodological oversights primarily ignored or discounted alternative hypotheses, including the impacts of historical livestock grazing. These deficiencies may partly explain the unreliability of the literature investigating interactions between invasive Australian predators, which has been described as 'inclusive' by most reviews.

We therefore assert that most of the "growing body of evidence" for mesopredator release is merely an inconclusive growing body of literature only, and is often based on inadequate science. Readers and reviewers of such studies should be more vigilant in looking for study design issues that may be more important than initially appears to be the case. We encourage those interested in studying the ecological roles of dingoes relative to invasive mesopredators and native prey species to account for the factors we identify, and caution the value of studies that have not done so.

References

Allen BL (2011). A comment on the distribution of historical and contemporary livestock grazing across Australia: Implications for using dingoes for biodiversity conservation. *Ecological Management and Restoration*

Allen BL, Engeman RM, Allen LR (2011). Wild dogma: An examination of recent "evidence" for dingo regulation of invasive mesopredator release in Australia. *Current Zoology*

WHEN DOES WILD DOG PREDATION UPON NATIVE SPECIES MOVE FROM NATURAL TO A THREATENING PROCESS? OBSERVATIONS FROM WILD DOG CONTROL PROGRAMS AND THE POTENTIAL IMPACTS ON KOALA POPULATIONS FROM WESTERN AND SOUTH EAST QUEENSLAND

Greg Mifsud, National Wild Dog Facilitator, IA CRC
Deborah Tabart, OAM CEO Australian Koala Foundation

Australia's top order predator has taken on significant change in genetics and abundance since the introduction of the Dingo from southern Asia 4000-5000 years ago (Corbett 1995). Since European settlement, this top order predator has been exposed to domestic dogs with the resulting hybrid wild dogs now occupying much of the landscape. Habitat modification, such as access to permanent water following the construction of artesian bores that allowed livestock to forage in arid areas, thus providing water and prey during droughts, increased prey availability after European settlement and contributed to increases in canid populations throughout Australia (Corbett 2001). This increase suggests that predation pressure from canids in some areas is higher than prior to European settlement.

Wild dogs can exert a high intensity of predation pressure on native fauna, especially medium to large macropods. Even low densities wild dogs may place additional pressure on species already suffering population declines from other threatening processes. As a consequence, predation from wild dogs has been identified as a key threatening process to the existence of a range of rare and threatened species, and could be so for Australia's iconic Koala. Despite this, significant debate exists regarding the necessity to manage wild dogs for biodiversity. Failure to manage wild dogs may result in further increases in population densities on public and private land, potentially increasing predation upon these species.

We will discuss the potential of wild dogs to significantly impact koala populations in western and south eastern Queensland using information on wild dog density collected from control programs developed through the IA CRC project "Facilitating a strategic approach to wild dog management throughout Australia". The paper will pose questions about whether wild dog densities have caused declines in koala populations or whether it was due to drought, disease, habitat loss or a combination of all these factors. Our first study area is around Charleville in semi-arid Queensland, and will use information on Koalas collected during an ARC research project, while comparing dog control data collected by Murweh Shire Council. The second example will be from South East Queensland where information on wild dog attacks and control have been collected from local government areas north of Brisbane. These data will be overlaid on the Australian Koala Foundation's Koala Habitat Atlas (Callaghan *et al* 2011) map of the region and spatial analysis of the data used to help identify management solutions if the following questions can be answered: To what degree do Koalas use the same habitats as wild dogs? What role does habitat fragmentation play in increased predation of Koalas by wild dogs? At what density of wild dogs does the rate of predation exceed what could be considered 'natural' to become a threatening process? What are the management implications for controlling wild dogs for biodiversity? And the most important question of all: Did these dogs cause the decline of koala populations in these regions?

References

Callaghan, J., McAlpine, C., Mitchell, D., Thompson, J., Bowen, M., Rhodes, J. de Jong, C., Sternberg, R. Scott, A. (2011). *Ranking and mapping koala habitat quality for conservation planning based upon indirect evidence of tree species use: a case study of Noosa Shire, southeast Queensland*. Wildlife Research, 2011, 38, 1-14.

Corbett LK (1995) 'The dingo in Australia and Asia.' (UNSW Press: Sydney)

Corbett LK (2001) The conservation status of the dingo *Canis lupus dingo* in Australia, with particular reference to New South Wales: threats to pure dingoes and potential solutions. In 'A Symposium on the Dingo'. (Eds CR Dickman and D Lunney) pp 10-19. (Royal Zoological Society of New South Wales: Mosman)

ASSESSING DINGO PREDATION RISKS TO THREATENED VERTEBRATES

Ben Allen[1] and Peter Fleming[2]
[1]The University of Queensland, School of Animal Studies, Gatton QLD
[2]Department of Industry and Investment, Vertebrate Pest Research Unit, Orange NSW

The reintroduction of dingoes (*Canis lupus dingo*) into sheep grazing areas southeast of the dingo barrier fence has been suggested as a mechanism to suppress foxes (*Vulpes vulpes*) and feral cats (*Felis catus*), thereby aiding the recovery of threatened fauna through trophic cascade effects. Dingoes are well known to actively hunt smaller prey species, though they're also expected to provide *net* benefits to these species because it is often assumed that the indirect effect of dingoes on mesopredators is greater than the direct effect of dingoes on prey. Hence, understanding the direct risks of dingo predation to threatened vertebrates is essential to managing threatened species where these three predators exist.

Using the Western Division of New South Wales as a case study, Dickman *et al.* (2009) assessed the risk of fox and cat predation to extant threatened species and concluded that reintroducing dingoes into the area would have positive indirect effects for most of the threatened vertebrates there. However, the authors did not assess the direct risk of dingo predation to the same threatened species. We assessed the risk of dingo predation to the same threatened species using the same methods described by Dickman *et al.* (2009). We show that regardless of whether or not dingoes suppress fox and cat populations, dingoes themselves present a High Risk to up to 46 of 80 (56%) extant species and a High Risk to up to 18 of the 21 (86%) locally extinct species also considered for reintroduction into the region following the establishment of dingoes. Few species were free from dingo predation risk at some level. Inconsistencies in our results suggested that generic approaches to predation risk assessments are unable to adequately describe predation risk for individual species or populations. Hence, species- or population-specific risk assessment methods may be more reliable. Moreover, for predator introductions, predation risk assessment methods should focus on the abilities of the predator, rather than the potential vulnerability characteristics of the prey.

In line with Major (2009), we maintain that dingoes can and do present significant predation risks to many threatened vertebrates irrespective of any suppressive effects dingoes may have on foxes or cats. Where dingoes are present, threatened species recovery plans should be careful to assess dingo predation as a potential risk factor that may hinder species recovery. A greater understanding of predator interactions in Australia is required to inform best-practice management of dingoes and threatened species.

References

Dickman C., Glen A., Letnic M. (2009) Reintroducing the dingo: Can Australia's conservation wastelands be restored? In 'Reintroduction of top-order predators'. (Eds MW Hayward and MJ Somers) pp. 238-269. (Wiley-Blackwell: Oxford)

Major R. (2009) 'Predation and hybridisation by feral dogs (*Canis lupus familiaris*) - Key Threatening Process listing.' New South Wales Department of Environment, Climate Change, and Water

DOES THE PARASITIC DISEASE OF CATTLE AND DOGS, NEOSPOROSIS, KILL MARSUPIALS IN AUSTRALIA?

Jessica King [1,2], Bronwyn McAllan [2], Derek Spielman [2], Scott Lindsay [2], Lada Hürková-Hofmannová [3], Ashlie Hartigan [2], Sarwat Al-Qassab [4], John Ellis [4] and Jan Šlapeta [2]

[1] Invasive Animals CRC, ACT

[2]University of Sydney, NSW

[3] University of Veterinary and Pharmaceutical Sciences, Brno, Czech Republic

[4] University of Technology, Sydney, NSW

Neosporosis (causative agent *Neospora caninum*) is a major protozoal reproductive disease of cattle worldwide, causing significant reproductive disease such as abortion outbreaks. Recently, the Australian dingo was identified as a definitive host of *N. caninum* capable of shedding infective *N. caninum* oocysts into the environment (King et al., 2010a). As marsupials are a common prey species in the diet of dingoes in Australia, it has been suggested that a plausible sylvatic life cycle could be occurring between dingoes and their marsupial prey, very similar to that of *Echinococcus granulosus* (King et al., 2010b). However confirmatory data to support the hypothesis that Australian native marsupials may be acting as an intermediate hosts of *N. caninum* and a possible conduit for infection of wild canids in Australia is lacking.

The aim of our study was to determine the susceptibility of Australian native marsupials to *N. caninum* and to determine if neosporosis is a disease that could cause significant morbidity or mortality in native Australian marsupials. This was achieved through the experimental infection of the carnivorous marsupial, the fat-tailed dunnart (*Sminthopsis crassicaudata*), with *N. caninum*. This experimental trial provides the first evidence that *N. caninum* can have a detrimental effect on Australian native marsupials and that a plausible sylvatic route of transmission may be occurring between wild canids and their natural prey in Australia.

I will present the results from this experimental trial and explain how the findings significantly enhance future research into the life cycle of *N. caninum* and the role that Australian wild canids and marsupials play in the transmission of the disease to livestock and other animals.

References:

King, J.S., Slapeta, J., Jenkins, D.J., Al-Qassab, S.E., Ellis, J.T., Windsor, P.A., 2010a. Dingoes are definitive hosts of *Neospora caninum*. Int. J. Parasitol. 40, 945-950.

King, J.S., Jenkins, D.J., Ellis, J.T., Fleming, P., Windsor, P.A., Slapeta, J., 2010b. Implications of wild dog ecology on the sylvatic and domestic life cycle of *Neospora caninum* in Australia. Vet J. doi: 10.1016/j.tvjl.2010.03.002

OVERVIEW OF THE DESERT KNOWLEDGE COOPERATIVE RESEARCH CENTRE CAMEL RESEARCH PROJECT

Glenn Edwards
Dept of Natural Resources, Environment, the Arts and Sport
glenn.edwards@nt.gov.au

The Desert Knowledge Cooperative Research Centre (DKCRC) report "Managing the impacts of feral camels in Australia: a new way of doing business" was released in 2008. This report clarified the distribution, abundance and population dynamics of feral camels, evaluated stakeholder perceptions of feral camels, assessed feral camel impacts, reviewed the options available for managing these impacts and outlined a management framework for feral camels in Australia.

Feral camels were found to occur in Western Australia, South Australia, the Northern Territory and Queensland and to occupy an area 3.3 million km in size. Forty three percent of camels were found to be on Aboriginal land. The overall population was estimated to be 953,000 camels and modelling indicated that the number of camels was doubling about every nine years.

There was a general appreciation by Aboriginal people that camels damage natural and cultural resources and affect Aboriginal customary use of country. Most Aboriginal people viewed feral camels as a potential resource but acknowledged that camels needed to be controlled. There was a general lack of support for culling which was seen as wasteful. Pastoral and conservation managers recognised the impacts that camels are having on the natural environment and on pastoral production and accepted that efforts were needed to manage these impacts. Both groups favoured culling and commercial use to manage camel impacts.

Feral camels cost more than $10M in direct economic impacts (including infrastructure damage, competition with livestock and feral camel management costs) each year. Costs to the natural environment and the cultural values of Aboriginal people are significant but difficult to quantify in dollar terms. These costs dwarf any positive economic benefits that camels currently provide ($0.6M pa). Feral camels are also an important emitter of greenhouse gases.

Aerial culling was considered to be the most cost-effective and humane way of reducing the density of camels over the large expanses that need to be managed. Ground-based culling has application only in particular situations. Camels may be commercially harvested over relatively large areas for meat, the establishment of domestic herds or for live export, but it is difficult to harvest all camels and not all camels are of commercial quality. Fencing to protect vulnerable assets from camels is expensive and has application only at the local scale. Being a long-lived species with a low reproductive rate, camels are an unsuitable candidate for fertility control.

The DKCRC report recommends that feral camels be managed to a long-term target density of 0.1–0.2 camels/km at property to regional scales in order to mitigate broad-scale negative impacts. The DKCRC project also recommended a national approach to managing the impacts of feral camels and defined four management zones with management prescriptions for each zone.

The DKCRC research was the catalyst for the Australian Feral Camel Management Project and the National Feral Camel Action Plan. The two are coupled- the former delivering immediate management actions to reduce camel impacts while the latter provides guidance on managing feral camels and their impacts now and into the future.

MODELLING THE DISTRIBUTION AND RELATIVE ABUNDANCE OF FERAL CAMELS IN ARID AUSTRALIA

Steve McLeod[1] and Tony Pople[2]
[1]Vertebrate Pest Research Unit, Industry & Investment New South Wales, Forest Rd, Orange NSW 2800
[2]Biosecurity Queensland, Department of Employment, Economic Development and Innovation,
GPO Box 46, Brisbane Qld 4001
steven.mcleod@industry.nsw.gov.au

Determining the distribution and abundance of pest species is required for planning, directing and evaluating their control. This is particularly true for feral camels, which occur at relatively low densities in remote areas, and so control programs incur high travel costs. The broad-scale pattern of distribution of feral camels is known from infrequent aerial surveys that cover only part of the camel's range. Estimates of abundance have therefore required extrapolation over both time and space (Saalfeld and Edwards 2010). A further problem is that the low density of camels combined with the low sampling intensity of surveys leads to imprecise estimates of density at a relatively fine scale (e.g. ← 10,000 km), leading to potentially misleading distribution patterns that may result in misdirected management effort. Distribution patterns may be better represented with a spatial model that links aspects of the environment with probability of occupancy by camels and, ideally, density. Features of the environment attractive to camels can also be identified.

A resource selection function was fitted to data from a 2001 survey in the southern Northern Territory (McLeod and Pople 2010). This involved two steps. First, habitat suitability was modelled using habitat covariates for ~500 locations of camel groups and an equal number of 'pseudo-absence' locations selected randomly along transect lines where camels were not observed. Second, the relationship between density and habitat was modelled using a generalised additive model, conditional on camels being present. Habitat covariates included aspects of climate, distance to water sources, roads and human population centres, and the topography and broad vegetation class in 1 km and 5 km buffers around each location. The most parsimonious model identified a handful of high density 'hotspots'. However, the model is static. If, as expected, camel population size continues to increase, the pattern of distribution may also change. A comparison of historic and future surveys can address this. Rainfall may also alter the pattern of distribution, as the high mobility of camels is well known. Rainfall or the normalised difference vegetation index could therefore be a useful predictor.

More recent survey data across all states containing feral camels now allows a more complete assessment of their habitat associations. Surveys are still spatially incomplete. A habitat model may best estimate the full distribution and indicate the Australia-wide population size.

References

McLeod, S. R., and Pople, A. R. (2010). Modelling the distribution and relative abundance of feral camels in the Northern Territory using count data. *The Rangeland Journal* 32: 21-32.

Saalfeld, W. K., and Edwards, G. P. (2010). Distribution and abundance of the feral camel (*Camelus dromedarius*) in Australia. *The Rangeland Journal* 32: 1-9.

OPTIMISING CONTROL STRATEGIES FOR CAMELS USING A BAYESIAN BELIEF NETWORK AND SIMULATION MODELS

Mark Lethbridge[1] and Nick Souter[2]
[1]Flinders University, GPO Box 2100, Adelaide SA 5001
[2]Ecoknowledge, 130 Franklin Street Adelaide SA 5000
mark.lethbridge@flinders.edu.au

Decisions about pest species management are often confounded by uncertainty about the location and density of the species, different values held by stakeholders and conflicting objectives. Decision frameworks can help remove much of the subjectiveness around pest management by exploring the uncertainties and risks associated with alternative management strategies. The inputs thought to be essential for improving the management of camels and optimising control strategies are generally based on evidence about camel density, impact and accessibility. This requires weighting intelligence gathered about camel behaviour (movement, distribution and abundance) and environmental data (rainfall, waterpoints and land systems).

After considering landholder preferences, the utility of different control strategies for a known density of camels is then dictated by cost-efficiency. This will depend on the type of harvest or culling operation. Moreover, the cost of gathering intelligence versus uncertainty associated with the information also needs to be considered in any decision framework.

We describe the development of a Bayesian Belief Network (BBN) decision support tool that organises evidence and decisions into nodes, by building conditional probability relationships between each node. The conditional probabilities are learnt from empirical data and prediction models. By coupling the BBN to a spatially-explicit stochastic simulation model, we demonstrate how it can be used to help find an optimal control strategies for each of a range of different scenarios.

ASSESSMENT OF A MARKET BASED INSTRUMENT APPROACH TO REMOVING LARGE FERAL HERBIVORES FROM THE LANDSCAPE IN WESTERN AUSTRALIA

Ken Rose[1], Gary Martin[1], John Gavin[2], Deb Agnew[2], & **Andrew Woolnough**[1]
[1]Department of Agriculture and Food, 100 Bougainvillea Avenue, Forrestfield, WA 6058
[2]South Australian Arid Lands Natural Resources Management Board, PO Box 2227, Port Augusta, SA 5700 andrew.woolnough@agric.wa.gov.au

Market-based instruments (MBIs) are essentially policy instruments that use price or other economic variables to provide incentives for solving a particular issue. In this case, the issue is the management of large feral herbivores (LFH); specifically feral camels, feral donkeys and feral horses. The aim of this project was to deliver the most cost-effective removal mechanism to achieve desired reductions in LFH densities in strategically defined and selected regions, with the focus primarily directed towards feral camels.

With financial support from the Australian Government's Caring for Our Country progam, the MBI approach was tested in Western Australia (WA) as part of a larger cross-jurisdictional assessment of MBIs. In WA, government agencies and land managers have become increasingly concerned about the impacts of LFHs in the rangelands. These animals have had a serious and expanding impact on biodiversity, culturally-valued heritage sites and pastoral infrastructure, requiring increased control efforts to curb their destructive effects.

A targeted number of LFH were identified to be removed in a strategically selected area of pastoral land (in the Wiluna Shire of WA) to counteract any anticipated level of natural recruitment of LFH through breeding. A competitive tender (i.e. a MBI) requested suitably qualified professionals to provide and implement a strategy to undertake a short-term LFH control, whilst also aiming to foster in the region economic and social outcomes such as employment, infrastructure development and community engagement. No specific control mechanisms were prescribed in the tender documents. However methods proposed and used did need to meet acceptable animal welfare standards and be acceptable to the WA Department of Agriculture and Food. Some methods of control, such as aerial shooting, were not permitted because of the need to use government shooters for such operations.

The competitive tender process was besieged with issues and roadblocks. Examples of the kinds of issued encountered included land tenure matters and access to lands, willingness of landholders to be involved, unforseen weather events and the natural variability in LFH densities. Obstacles like these caused changes in the terms of tender (e.g. revising down target number of LFHs) and progress of the contract. Even the revised LFH removal target was unable to be met, 181 feral camels, 2 feral donkeys and 304 feral horses were removed from the landscape.

In summary, the MBI approach tested in WA (i.e. a competitive tender approach to removing LFH from the landscape using techniques other than aerial control) was ineffective, costly, controversial, and did not offer a viable means of feral camel management. However, significant lessons and knowledge were gained by going through the process (e.g. landholder expectations, Aboriginal engagement, contract processes, legislation issues, animal welfare, dealing with unforseen risks etc.), which will subsequently guide future management activities. Given the generic term of MBIs there may be other mechanisms worth exploring such as carbon markets or declared species groups, but the competitive tender approach to animal removal can not be recommended in WA.

AUSTRALIAN CAMEL INDUSTRY

Lauren Brisbane
Australian Camel Industry Association Inc,
Po Box 312, Glasshouse Mountains Qld 4518
laurenbrisbane@aapt.net.au

The Australian Camel Industry Association was established in 2009. The Association was established to represent the diverse needs of industry members and provide credible information for the commercial use of camels as a pastoral animal in Australia.

The dromedary camel is the oldest pastoral animal in recorded history – its use dates back six thousand years. Camels are revered in the Middle East and North African nations, they symbolise wealth, the sustainability of life in harsh arid climates and the rich enduring culture of those regions.

Camels were introduced for their climate suitability, which is the very reason why they have prevailed in the arid rangelands areas of Central Australia. Like most introduced species in Australia they are classified as feral and remain unchecked in their traverse of a continent where state jurisdictions and classifications dictate their value and management.

Two models exist which highlight the camels' value as a pastoral animal in Australia. In Queensland camels are classified under the 1915 Stock Act. Feral camels traverse the far western border regions in relatively low numbers and managed camels are widely grazed under strict biosecurity protocols. Camels in Queensland contribute to land management outcomes through weed control and increased cattle weight through the transfer of a gut bacterium from camels to cattle when co-grazed.

In the APY Lands in South Australia, Indigenous communities have been provided with employment opportunities and industry in the supply of feral camels to the emerging halal and domestic camel meat markets. The transference of Islamic people into western culture has created a demand for international exports of a cultural meat.

The food security issues that will arise as we head towards 2030 will dictate the need for a wide variety of protein sources that do not fit into the fiercely contended traditional European models of pastoral enterprise in Australia.

THE AUSTRALIAN FERAL CAMEL MANAGEMENT PROJECT

Quentin Hart
Ninti One Limited, PO Box 284, Canberra ACT 2601
quentin.hart@nintione.com.au

The Australian Feral Camel Management Project (AFCMP) is one of the largest and most diverse nationwide collaborations ever to be targeted at an established pest species in Australia. The project is working with a large number of partners and stakeholders to mitigate the impact of feral camels on desert ecosystems, the pastoral industry, remote Aboriginal communities and public safety. It has a solid information base through the foundational work of the Desert Knowledge CRC (DKCRC Report 47, available at www.feralcamels.com.au) which guided the overarching project objective to reduce the feral camel density to ←0.1 animals per square kilometre at priority biodiversity areas.

Since a four-year agreement between Ninti One Ltd and the Australian Government's Caring for Our Country program was signed in February 2010, the AFCMP has made substantial progress based on an early realisation of the need for comprehensive collaboration processes due to the diverse range of land tenures (Aboriginal, conservation estate, pastoral and Crown) across which feral camels roam and the diverse stakeholder interests, including commercial use.

Under the guidance of a representative Steering Committee, project partners are working effectively together to develop and implement agreed approaches to manage an established pest animal at priority sites across different land tenures and all state/territory boundaries within the feral camel's huge range (three million square kilometres) for the first time.

A comprehensive evaluation plan has been developed to assess the biophysical, socio-economic and governance performance of the project, including: the extent of engagement with landholders and other stakeholders; capacity building for long-term camel removal; and collaboration with other monitoring processes to assess the impacts of feral camels.

The AFCMP is engaging with two themes that were highlighted at the 2010 50th Ecological Society of Australia conference: the need to develop workable solutions to biodiversity issues based on informed stakeholder preferences and learning by doing; and combining Aboriginal and Western ecological knowledge for land management solutions.

FILLING THE GAPS - IMPROVING WILD DOG MANAGEMENT IN VICTORIA

Gina Paroz[1], **Melissa Drew**[1], Michael Rosier[2] and John Burley[1]
[1]Victorian Department of Primary Industries, GPO Box 4440, Melbourne 3001
[2]Victorian Department of Primary Industries, PO Box 48, Frankston 3199

Wild dog management in Victoria, as in other states, has long been a contentious issue. Wild dogs in Victoria largely live and breed on public land and impact on livestock enterprises on adjacent private land, creating tension between public and private land managers. Amid reports of increasing wild dog numbers in recent years, and changes in legislation such as a requirement for 24-hour checking of leghold traps, development of new approaches and policy options has been necessary. In 2008 DPI commenced a four-year project to review the effectiveness of current Victorian wild dog control techniques, develop a new Code of Practice (COP) and Standard Operating Procedures (SOPs) for wild dog management in Victoria, and investigate policy options for improved management of wild dogs.

Gaps in policy, knowledge and operational approaches were identified by undertaking a comprehensive review of current policy and practice in Victoria, and looking to other states to learn more about best practice management and how this could be applied in Victoria. Key issues identified through this process included:

- Persistence of a predominantly reactive wild dog management program;
- Little understanding of the triple bottom line impacts of wild dogs in Victoria and the barriers to adoption of wild dog management on private land; and
- Need for improvements in monitoring and evaluation of program effectiveness

To address these issues, we began by redefining the goal and objectives of wild dog management in Victoria, including development of key performance indicators to enable better evaluation of program effectiveness. We developed new policy where existing policy was seen as a hindrance to best practice wild dog management, and commissioned studies to address information gaps. A new COP and SOPs, integrating the learnings from the review, are also being developed.

Some of the advances in the approach to wild dog management in Victoria will be discussed, including:

1. the impact of a policy change to allow the use of 6mg 1080 baits on public land;
2. development of a social benefit cost analysis of wild dog management in Victoria; and
3. novel research undertaken by the DPI 'Practice Change Research' group to identify the right mix of interventions to support successful wild dog management in Victoria.

CAPTURING THE BENEFITS AND MITIGATING THE NEGATIVE IMPACTS OF WILD DOGS

Lee Robert Allen
Robert Wicks Pest Animal Research Centre, Biosecurity Queensland,
Department of Employment, Economic Development and Innovation, PO Box 102, Toowoomba
lee.allen@deedi.qld.gov.au

While sheep and goat behaviour, in response to the presence of wild dogs, makes them particularly vulnerable to attack to the extent that they are regarded as incompatible, the impact of wild dogs on cattle is less predictable. Studies of calf loss based on lactation failures from known-pregnant cattle in south-west and far North Queensland show that the magnitude of losses and frequency of years that calf predation occurred was significantly greater when wild dogs were controlled compared to when and where they were not controlled. Seasonal conditions, the presence of alternative prey resources and whether wild dogs were baited or not are critical factors determining predation risk. Meanwhile, wild dogs have positive impacts for graziers by preying on, or competing with, introduced pest species and reducing the impacts of over-abundant macropods. This paper proposes a strategy of how wild dogs might be strategically managed and integrated with livestock production to maximize the biodiversity and land sustainability benefits of wild dogs.

ASSESSING STRESS IN WILD DOGS DURING POST-TRAPPING PROCEDURES

Huw Nolan[1], Guy Ballard[2] and Wendy Brown[1]
[1]School of Environmental and Rural Sciences – Animal Science, University of New England, Armidale, NSW 2351
[2]Vertebrate Pest Research Unit, Industry and Investment NSW, PO Box U86, University of New England, Armidale, NSW 2351

Wild dogs (including pure dingoes, *Canis lupus dingo*, feral domestic dogs, *C. lupus familiaris*, and their hybrids) are widely distributed throughout Australia and have a significant impact on stock losses. There remains no accurate estimate of the agricultural losses due to wild dog predation. However, wild dog control costs around $7 million / year (Flemming *et al*, 2001). Wild dogs are trapped frequently across Australia for various reasons e.g. monitoring wild dog activity with GPS collars. There is general consensus that padded leg-hold traps are a humane method of trapping wild dogs for scientific purposes; but scientists disagree over which are the best post-trapping procedures with regards to animal welfare. Some of the post-trapping procedures may be stressful to the animals and scientists currently rely on anecdotal evidence to assist in their efforts to minimise the stress associated with these procedures. We aim to quantify the stress experienced by wild dogs during processing by measuring cortisol levels in hair and saliva, along with heart rate variation and behavioural observations. Data currently being collected includes a comparison between a standardised procedure and a simple variation (with and without the dogs' eyes covered) as there is currently debate as to which is the best practice.

References:

Fleming, P., Corbett, L., Harden, R. and Thomson, P. (2001). Managing the impacts of dingoes and other wild dogs. Bureau of Rural Sciences, Canberra

UNDERSTANDING THE DRIVERS AND BARRIERS TOWARDS THE ADOPTION OF AN INNOVATIVE CANID CONTROL TECHNOLOGY

Darren Southwell, **Stefanie McCowen**, Osman Mewett, Veronica Boero and Bertie Hennecke
Australian Bureau of Agricultural and Resource Economics and Sciences,
GPO Box 1563, Canberra ACT 2601
bertie.hennecke@abares.gov.au

While the adoption of innovative technologies in the field of natural resource management has been relatively well studied, the drivers that facilitate the adoption of new vertebrate pest control technologies have received comparatively little attention. This is surprising given the impact that vertebrate pests have on the environment, economy and communities; the availability of many new vertebrate pest control technologies/practices; and the slow rate of adoption experienced for new pest control technologies in the past.

Since 2003, the Invasive Animals Cooperative Research Centre in collaboration with other agencies has investigated the toxin para-aminopropiophenone (PAPP) as a new and complementary control method for wild dog and fox populations. Wild dogs, which include feral domestic dogs (*Canis lupus familiaris*), dingoes (*C. l. dingo*) and their hybrids, and the European red fox (*Vulpes vulpes*) are considered major pests in Australia. Current control methods available to private and public landholders include: exclusion fencing; shooting; trapping; baiting and the use of guardian animals to protect livestock. PAPP baits have been developed as canid control products with target selectivity, humaneness and the availability of an antidote as priority features.

In this study we elicited the key drivers and barriers towards the adoption of a PAPP product for wild dog and fox control. We conducted a structured survey of 526 randomly selected livestock producers stratified across industries and geographic space, and also surveyed over 50 regional land managers across Australia. With a fully specified questionnaire, landholders' perceptions relating to management of wild dogs or foxes, existing control methods, and the potential future availability of a PAPP product were quantified. By identifying key perceptions, the existing state of knowledge of PAPP products for canid control was elucidated. The study also suggests the need to focus extension programs to target perceptions that are found to be either poorly understood or inaccurately perceived by respondents.

LOSING THE BATTLE OF PROTECTING AUSTRALIA'S SHEEP HERD FROM WILD DOGS

Lee Allen
Robert Wicks Pest Animal Research Centre, Biosecurity Queensland,
Department of Employment, Economic Development and Innovation, PO Box 102, Toowoomba
lee.allen@deedi.qld.gov.au

In the early 1980s there were few areas within the protected area of Queensland Wild Dog Barrier Fence where wild dogs (WDs) could be found. Inability to remove WDs in these areas has, in three decades, resulted in the widespread, and in places, common presence of wild dogs throughout Queensland's 'protected area'. The likely causes of WD re-invasion are discussed based on recent studies using satellite transmitters that show 15% disperse distances over 100 kilometres from natal areas. In fact, dispersal movements of over 1000 kilometres were recorded. This paper examines the conditions that historically prevailed when WDs were first eradicated in the protected area and suggests strategies that will be necessary to protect vulnerable livestock species in the future.

MANAGERS OF WILD DOGS: CO-MANAGEMENT BY COMMUNITIES IN NORTH EAST NSW AND SOUTHERN QUEENSLAND

Guy Ballard[1], Peter J. S Fleming[1], Paul Meek[1], Greg Mifsud[2], Bruce Moore[3] and Sam Doak[4]
[1]Vertebrate Pest Research Unit, I & I NSW, UNE, Armidale, NSW, 2351
[2]Biosecurity Queensland, Robert Wicks Research Centre, Toowoomba, Qld, 4350
[3]Barnard River Wild Dog Control Association, Hanging Rock via Nundle, NSW 2340
[4]Department of Environment, Climate Change and Water, Walcha, NSW 2354
guy.ballard@industry.nsw.gov.au

Wild dog issues are complex and vexatious, although the nature of specific management problems varies between regions and landuses. Effective management of wild dog issues requires the involvement of a range of land managers, often with diverse wildlife-related values and specific attitudes towards integral aspects of wild dog management.

Generally, public involvement in contemporary wildlife management occurs along on a continuum from exclusion to inclusiveness, where exclusive/ top-down/ expert approaches are least desirable and inclusive/ community co-management approaches are preferred. Many recent cooperative wild dog management programs developed using a strategic approach and the cross-tenure strategy appear to fit a model of community co-management, but the level of community involvement typically varies in practice. In some instances, community groups and their champions drive management and these appear successful, although the longevity of these programs is yet to be resolved. Conversely, other programs driven by agencies and their managers vary in their success, and, as a consequence, stakeholders become disaffected and openly antagonistic to managers of public lands or others with different enterprise mixes. The success or failure of both models is dependent on the strength of the relationships within a community and between agencies, their staff and the community.

The strategic approach is an iterative process that aids co-management but the process itself is undergoing iterative changes as more experience is gained. Here we report observations of several wild dog management programs across north eastern NSW and southern Queensland. Reflecting on the characteristics of successful programs and considering steps that likely improve outcomes for all stakeholders, we comment on program drivers, legislated responsibilities, successes, failures, community involvement and longevity of programs. We additionally present interim results of program monitoring and associated applied research that has informed management strategies.

We outline and recommend a revised strategic approach, with a cross-tenure strategy to promote community co-management of wild dogs. Effective co-management is aided by independent facilitators, the most up-to-date applied science and local monitoring to establish and improve the best practice for wild dog management. It is important that results of management and associated research are disseminated to affected stakeholders so that they can understand and account for biological, economic and social realities, and implement current best-practice management actions that are based on results rather than hypotheses.

MONITORING INTRODUCED MAMMALIAN PREDATORS IN THE WHANGAMARINO WETLAND, NEW ZEALAND – INTERIM RESULTS

Craig Gillies[1] and Matthew Brady[2]
[1]Department of Conservation R&D Group, P.O. Box 516 Hamilton
[2]Department of Conservation Waikato Area Office, P.O. Box 20025 Hamilton
cgillies@doc.govt.nz

The Whangamarino wetland in the upper North Island of New Zealand is one of three nationally important sites managed under the Department of Conservation's Arawai Kakariki Programme. Reducing populations of introduced mammalian predators to levels that will allow the recovery of threatened wetland birds and reintroduction of locally extinct species has been identified as a key objective of the programme. However, there is currently very little information on introduced mammalian predators in wetland ecosystems in New Zealand compared with other ecosystem types. Furthermore, existing monitoring techniques designed for surveying mammalian predator abundance in forest and grassland environments may not be appropriate for using in wetland conditions.

We will report on the results of the first year of a four year programme aiming to describe the introduced mammalian predator guild in Whangamarino and validate small mammal monitoring techniques in a wetland environment. Our initial results indicate that feral ferrets (*Mustela furo*) are the most numerous of the mammalian carnivores present, but weasels (*M. nivalis*) are seasonally abundant, feral cats (*Felis catus*) and stoats (*M. erminea*) are also present in the wetland. Other pest mammals present or seasonally abundant in the wetland include possums (*Trichosurus vulpecula*), two species of introduced rat (*Rattus norvegicus* and *R. rattus*), house mice (*Mus musculus*) and the European hedgehog (*Erinaceus europaeus*). It would appear that the presence and abundance of these small mammals in some parts of the wetland may also be related to the water levels which can fluctuate markedly throughout the year.

To date we have tested WaxTags® as a method for measuring rodent and hedgehog abundance and camera traps for detecting the carnivores – both techniques are already showing promise.

STRATEGIC VERTEBRATE PEST MANAGEMENT TRAINING IN AUSTRALIA

Tony Buckmaster [1,2], Mike Braysher [1,2]
[1] University of Canberra, ACT 2601
[2] Invasive Animals Cooperative Research Centre, University of Canberra, ACT 2601

Vertebrate pest management training is in a parlous state in Australia. The level of retained corporate knowledge is continually declining as many senior pest managers are leaving the workforce and taking the skills gained through years of experience with them leaving a vacuum of appropriate skills in vertebrate pest management. There is a serious lack of courses both in Australia and worldwide that provide training in vertebrate pest management either at an undergraduate or postgraduate level and even less that are based on current best practice. The recent report on training and capacity building in vertebrate pest management recommended that that a national training strategy be developed that focuses on vertebrate pest training through the Vocational Education and Training (VET) framework and that this include articulation into the university sector (Brown 2010)

In 2008 the Diploma in Conservation and Land Management (Vertebrate Pests) was developed in consultation with state government pest agencies to provide field officers with the skills needed to develop and implement strategic vertebrate pest management plans. The course is based on the principles of the Australian Pest Animal Strategy and uses case studies from successfully operating programs to explain strategic management of pests. The course is offered through flexible on-line delivery supported by three workshops. This allows students to undertake the studies remotely rather than having to regularly attend a classroom.

In 2010 a Graduate Certificate in Wildlife Management (Invasive Animals) was developed through the University of Canberra. It provides mid and upper level land managers with the skills to identify pest animal problems and to develop and implement effective pest management strategies that are part of a strategic approach to sustainable resource management. It aims to give these land managers the capacity to identify and manage their pest problems including being able to adapt and respond to changing land use practices. Similar to the VET diploma, the course is offered through flexible on-line delivery and encourages students to incorporate the pest animal management problems faced in their workplace into their studies.

For land managers wishing to extend their qualifications in wildlife or pest management past the graduate certificate stage, the University of Canberra is developing graduate diploma and Masters level courses. These higher level qualifications will be designed following input from industry and should be able to be tailored to the individual needs of students.

References:

Brown M (2010) 'Scoping study on training and capacity building in vertebrate pest management.' A report to the Invasive Animals Cooperative Research Centre and Industry and Investment NSW.

UTILISATION OF WILDLIFE IN AUSTRALIA - A CONFLICT OF VALUES

Anthony W. English AM RFD
Game Council NSW
Orange NSW 2830

Any discussion on the commercial use of wildlife in Australia would start with the harvest of large macropods in at least 4 states and territories, for the production of meat and skins (Pople and Grigg 1999). The kangaroo industry is well regulated and is subject to a National Code of Practice for the Humane Shooting of Kangaroos and Wallabies. While this industry is not perfect it does serve as a model for the harvest of other wildlife species, and this was recognised by Ramsay (1994) in his comprehensive overview of the wildlife species that had a real or potential value for at least some of the community. In the almost two decades that have elapsed since the publication of Ramsay's list and discussion, there has been a change in the minds of a significant number of our citizens in their attitude to harvesting wildlife. Their previous conservatism has become less common despite the arguments mounted by those who would ban the use of firearms, backed by emotive media.

The notable exceptions with some degree of harvest are feral pigs with the export of meat as wild boar, feral goats mustered for meat or live sales, plus a number of species sought by hunters (deer, water buffalo, banteng, foxes and rabbits). Feral horses and donkeys are shot in northern Australia and some are trapped and taken away to abattoirs. The dilemma posed by the sheer number of camels makes this species of particular concern right now, while recent attempts to establish safari hunting of large saltwater crocodiles have not been approved at Commonwealth level.. On the other hand the successful farming of crocodiles is the best example of the intensive farming of an endemic species.

The farming of deer in Australia has become a mainstream agricultural industry , although it remains a small one when compared to traditional livestock production. On the other hand, the deer hunting industry continues to grow in Australia, with all the benefits identified by Dryden and Craig-Smith (2004) in their appraisal of the safari hunting of exotic wild game. This debate is about the variety of values that can be identified within the "pest versus resource" topic. This paper will use the deer hunting industry as an example of the diversity of views about the way ahead.

References

Dryden, G. and S. Craig-Smith (2004) Safari hunting of Australian exotic wild game. RIRDC Publication No04/108.

Pople, A. and Grigg, G. (1999) Commercial hunting of kangaroos in Australia. Environment Australia Biodiversity Group, Canberra ACT,

Ramsay, B..J.(1994) Commercial Use of Wild Animals. Bureau of Resource Sciences, Australian Government Publishing Services, Canberra.

WHY 0.02%? A REVIEW OF THE BASIS FOR CURRENT PRACTICE IN AERIAL 1080 POSIONING OF RABBITS IN NEW ZEALAND

Graham Nugent[1], Bruce Warburton[1], Penny Fisher[1], Laurie Twigg[2]
[1] Landcare Research, PO Box 40, Lincoln 7640, New Zealand
[2]School of Biological Science and Biotechnology, Murdoch University, South St, Murdoch, 6150 Australia
nugentg@landcareresearch.co.nz

Aerial poisoning of rabbits emerged in the latter half of the 20th century as a crucial tool for reducing the cost to pastoral agriculture in New Zealand. However, the need for aerial poisoning declined dramatically in 1997 with the illegal release of RHD, a viral disease lethal to rabbits. Now, the impact of RHD appears to be waning and land managers have resumed aerial baiting with1080, but still using practices established before 1997. These practices include the use of prefeeding, a low toxic bait loading, and very high sowing rates.

In contrast, aerial baiting of possums with 1080 in New Zealand now uses a comparatively high toxic loading, and much smaller amounts of prefeed and toxic bait. This partially resulted from ongoing research and refinement over the last decade during which time aerial baiting of rabbits was in abeyance. The disparity in the approach between rabbit and possum baiting programs prompted a review of the rationale on which the current practices used against rabbits are based. Two issues emerged strongly. Firstly, the low toxic loading used (0.02-0.04% 1080, depending on bait type) appears not to be based on experimental optimisation using New Zealand rabbits but instead, on early (1960s) Australian assessments. It appears that a low toxic loading was also favoured more to reduce the risk to livestock than for efficacy against rabbits. Secondly, despite long-standing concerns about carrot bait quality, current practices still appear to produce large number of sub-lethal bait fragments. The key consequence of this is that most rabbits will need to find several baits (carrot pieces) to ingest a lethal dose, and this needs to happen before the stop-feed action of 1080 occurs (within 30 min – 3 hours of ingestion). The mid-1990s best practice of multiple pre-feeds and very high toxic-bait sowing rates is likely to have evolved through trial as a way of (unknowingly) compensating for both low toxicity and poor bait quality and the consequent need for rabbits to find multiple baits. We therefore conclude that there is potential to substantially reduce the amounts of bait and toxin used for rabbit control while maintaining high levels of efficacy.

WARATAH FENCING: HOW WARATAH FENCES OUT FERAL ANIMALS

Chris Brown-Price
Waratah Fencing Products, PO Box 245C, Newcastle NSW 2300
brown-price@onesteel.com

FERAL CATS IN THE TALL FORESTS OF FAR EAST GIPPSLAND

Tony Buckmaster [1,2]
[1] School of Biological Sciences, University of Sydney, NSW 2006
[2] Invasive Animals Cooperative Research Centre, University of Canberra, ACT 2601

Much of the research on feral cats in Australia has occurred in the continent's arid and semi-arid regions. Consequently, little is known about the ecology of feral cats in tall forests. Using a combination of both VHF and 'store on board' GPS collars, feral cats were tracked in the forests of Far East Gippsland to both determine home range size and to examine their movement patterns. The use of GPS collars to obtain accurate and high volumes of location data allowed the intra-home range movements of feral cats to be examined in ways not previously possible using conventional VHF radio telemetry.

Feral cats in productive tall forests have home ranges smaller than those in the arid and semi-arid zones where food resources are limited but larger than those inhabiting farmland and grassland habitats where food resources are generally greater. Feral cats employ movement patterns that increase the likelihood of encountering sparsely distributed prey items.

GPS tracking revealed that feral cats in Far East Gippsland have large areas of apparently suitable habitat within their range that they do not use. My initial hypothesis was that this related to a lack of prey availability within these areas. This was not supported by prey species trapping data. It is most likely that these areas are being actively avoided by cats to minimise their risk of intraguild predation by larger foxes and wild dogs. The potential ramifications of this for land managers are discussed.

PESTSMART: AN INFORMATION TOOLKIT FOR PRACTICAL PEST ANIMAL CONTROL

Keryn Lapidge[1], Steven Lapidge[1] Andreas Glanznig[2]
[1] Invasive Animals Cooperative Research Centre, 48 Oxford Tce, Unley, SA 5061
[2] Invasive Animals Cooperative Research Centre, University of Canberra ACT 2601
keryn.lapidge@invasiveanimals.com

The Invasive Animals CRC is developing a suite of end-user centred information toolkits on developing and implementing best-practice regional and local management strategies. These PestSmart toolkits will consolidate state of the art knowledge on strategic planning and management of major agricultural pest animal species, combined with product use manuals, case-studies, fact-sheets, guidelines and extension materials. Much of this will be derived from the Invasive Animals CRC's seven year R&D program.

All PestSmart toolkit products and publications will be freely available online at www.feral.org.au/pestsmart/. Some information is already live and more is on the way. Users can browse the information based on pest species of interest, type of information required (eg. Policy and legislation, management, maps, images), or information relevant to different groups of people (land managers, regional/NRM managers, policy makers).

PestSmart toolkits will form the basis of a nationwide PestSmart Roadshow, planned for key regions around the country in the first half of 2012. Roadshow events will directly demonstrate the use and benefits of the new products to land managers and farmers.

A demonstration of the website and types of information available will be given.

PRELIMINARY POPULATION ESTIMATES USING THREE METHODS FOR WILD RED DEER (*CERVUS ELAPHUS*) IN SOUTH EAST QUEENSLAND

Matt Amos[1], Greg Baxter[2], Neal Finch[1], and Peter Murray[1]
[1]School of Agriculture and Food Sciences, The University of Queensland, Gatton, QLD 4343
[2]School of Geography, Planning and Environmental Management,
The University of Queensland, Gatton QLD 4343

We compared several commonly used population estimation methods to determine the most appropriate method to estimate density or provide indices of density for wild red deer (*Cervus elaphus*) in the Cressbrook Dam catchment, near Esk in South-East Queensland. Methods trialled were:

. Walked Line Transect Sampling (Distance Sampling)
. Spotlight Counts
. Passive Activity Index (Soil Plots)

Each method was compared using the following criteria of: (1) ability to detect multiple species including deer, (2) catch per unit effort, and (3) ease of use.

Walked line transect sampling was conducted in both open grassland and dry sclerophyll forest over 3 days in Spring 2009, Summer 2010, Autumn 2010 and for 4 days in Spring 2010. Observers noted all target species that could be seen and recorded the distance and bearing to the animal using a laser rangefinder and magnetic compass respectively. Data were analysed using the Distance 6.0 computer package. Spotlight counts were conducted over 3 nights in Spring 2009, Summer, Autumn and Spring 2010 on transects in the open grassland. Spotlights surveys were carried out from a vehicle travelling at approximately 5 km/h with one hand held spotlight on each side of the vehicle. Ten soil plots were constructed approximately 1 km apart on existing vehicle tracks at Cressbrook Dam and sampling was conducted over 3 days in Summer, Autumn, and Spring 2010. The number of plots was increased to 24 for the Spring sampling. They were prepared into a fine bed upon which animal tracks could be viewed by raking the ground 1.5 m wide over the full width of the vehicle track. Soil plots were prepared in the afternoon and then observations were made early the next morning.

The walked line transect method estimated an overall density for deer of 24.4 deer/km (16.1 to 37.2 deer/km). The mean daily count of deer in Spring 2009 from spotlighting was 133 (±18.9) and in 2010 was 185 (f31.1). Seven animal species were observed using both walked line transects and spotlight counts, while eight species were detected with soil plots. The catch per unit time were 18.5 deer/person hour for spotlighting, 12.1 deer/person hour for walked line transects and 2.3 deer/person hour for soil plots.

In conclusion, the walked line transect method compared well to other methods, detecting most animal species and being reasonably time efficient on a catch per unit basis. The walked line transect method was the only method to yield an estimate of overall abundance. The spotlight method was the easiest and most efficient method to produce an index of relative abundance of wild red deer in the open grassland areas. Spotlight data compared well to data from previous years at this site. The soil plot method appeared to be the least productive method on an efficiency basis for detecting deer alone, but the best choice if both deer and wild dogs/dingoes are to be detected.

WHAT NEW ZEALANDERS THINK OF PESTS AND PEST CONTROL

Phil Cowan[1] and Bruce Warburton[2]
[1]Landcare Research, Private Bag 11052, Palmerston North 4442, New Zealand
[2]Landcare Research, PO Box 40, Lincoln 7640, New Zealand
cowanp@landcareresearch.co.nz

Decisions about what pests are managed and why are usually made by management agencies, and those decisions may or may involve varying degrees of public consultation, which often only engages a small proportion of the community. To obtain a wider view of public opinion about pests and pest management in New Zealand, we employed a commercial survey company to undertake a stratified, web-based survey of c.1000 people. People were asked questions about which mammal and bird pests they considered most damaging to biodiversity and agriculture, the reasons for their choices, and how they viewed the level of expenditure on animal pest control. They were also asked for their views about introduced animals that are both a pest and a resource. Finally, to put pest management in a wider context, people were asked about how the control of pests ranked against other environmental issues affecting or likely to affect New Zealand. The results from the survey will be presented and the implications for pest management priorities and for communication about pest management will be discussed.

DIDACTIC LESSONS DERIVED FROM A PREVIOUSLY SKUNK RABIES FREE AREA OF WYOMING

Craig Ramey[1], Kenneth Mills[2], Justin Fischer[1], Robert McLean[1]
[1] USDA/APHIS, National Wildlife Research Center, LaPorte Ave, Fort Collins, CO, USA 80521
[2]Dept. Veterinary Services, WY State Vet Lab, University Wyoming, Laramie, WY, USA 82070
CraigA.Ramey@aphis.usda.gov

The first "complete" epizootic movement study in rabid striped skunks (*Mephitis mephitis*) is presented from "first" to "last" case (→200 documented) near Yellowstone National Park. Since at least the time of Buffalo Bill Cody circa 1900, the "lower" (i.e. ~90 km) Shoshone River Basin (SRB) had been skunk rabies free; however, in 1988 the epizootic's Index Case (IC) occurred. The epizootic ended in 1993. Public concerns were about human and domestic animal's health and safety. Various local-federal groups and agencies were involved, and the National Wildlife Research Center (USDA) was asked to analyze epizootic's movements. The SRB's primary physiographic features in the 1800s were a narrow riparian "skunk" habitat surrounded by a sagebrush floodplain. During the SRB's settlement, agricultural expansion converted the floodplain to pastures and hay production, increasing the skunks' habitat fourfold. In 1989, skunks were live trapped and tested for rabies by the Wyoming State Veterinary Laboratory. Two novel methods were utilized during the early 1990s, GPS for rabid skunk's locations and GIS for recording these locations, hydrology and land use information. Epizootic analyses included: Average Monthly Movements (AMMs), Standard Deviational Ellipses (SDEs), and Multivariate Movement Maps (MMMs) (Ramey et al. 2010). Although AMMs were useful to understanding the "helter-skelter" (HS) daily rabid skunk's capture locations, problems arose as both the sample size increased and HS rabies locations moved further from the IC. Using 6-month SDEs (i.e. spatial statistics), the epizootic moved radially out from the IC until it reached the Shoshone River in the summer of 1989. Then it moved simultaneously up and down the SRB. SDEs were useful in surveillance (e.g. higher incidence areas for public safety). MMMs, using descriptive wave characteristics (i.e. leading edges and crests), illustrated the instantaneously and spatially described density of cases. Viewed over time, they demonstrated directional epizootic movements. All are presented because each presented particular insights; however, MMMs provided the most. Our methods and inferences should be useful to epidemiologists, public health officials, veterinaries, and others to better prepare for a possible rabies occurrence(s) and/or epizootic in Australia.

References:

Ramey, C., Mills K., and Robin M. (2010). Evolving Analyses of the Shoshone River Skunk Rabies Epizootic in Wyoming. *Proceedings of 24th Vertebrate Pest Conference* 24:XXX-XXX.

BIOECONOMIC MODELING OF THE IMPACTS OF FERAL SWINE TRANSMITTED DISEASE

Stephanie Shwiff[1], Tyler Cozzens[1], Aaron Anderson[1] and Seth Swafford[2]
[1]USDA/APHIS/WS National Wildlife Research Center
4101 LaPorte Ave
Fort Collins, CO 80521
(970) 266-6150
Stephanie.A.Shwiff@aphis.usda.gov

[2]USDA/APHIS/WS MissouriEstimating the economic impacts of wildlife transmitted disease is an important part of sound policy decision making. Feral swine can transfer disease to humans, livestock, domestic animals, and causes wildlife loss and other biodiversity impacts. There are multiple economically important diseases currently in the United States in which wildlife are a reservoir, such as swine brucellosis and rabies. Additionally, foreign animal diseases, such as foot-and-mouth disease, are of particular concern because of the potential for devastating economic impacts. The use of bioeconomic models to quantify the impact of wildlife transmitted diseases requires the use a disease spread model and economic model modified to incorporate wildlife. This presentation is an overview of recent modeling efforts that have incorporated feral swine into domestic livestock disease spread models and the resulting economic impact of disease spread from feral swine herds to domestic livestock.

ACHIEVING AND PROVING FREEDOM FROM DISEASE FROM MULTIPLE VERTEBRATE HOSTS ACROSS COMPLEX LANDSCAPES

Graham Nugent, Dean Anderson, Andrew Gormley
Landcare Research, PO Box 40, Lincoln 7640
nugentg@landcareresearch.co.nz

Bovine tuberculosis (TB) was once a major emerging disease in New Zealand livestock and wildlife, with over 1700 cattle and deer herds infected in 1994. TB can be maintained by farmed cattle and deer but also by wild possums and possibly ferrets. However, an intensive $80m p.a. programme combining test and slaughter of cattle with intensive pest control (in particular, of possums) had reduced the number of TB infected herds to 68 by February 2011. The national aim is to eradicate TB from wild animal populations from 2.5 million hectares (~10%) of New Zealand by 2026. This paper outlines the progressive and ongoing development of the 'TB suppression' and 'Proof of Freedom' systems needed to: first, eliminate TB from livestock and all wildlife hosts as quickly and cheaply as possible; and second, to provide an objective probability of the likelihood that TB has been eliminated from an area. We present the approaches being used, and highlight the complex resource-allocation questions involved.

A major emerging issue is when to start the surveillance required to 'prove' TB absence. Surveillance alone often does not greatly reduce the risk of TB persistence, so money is wasted if this is started too early. Conversely, applying further possum control after TB has disappeared is equally wasteful. A series of case studies are presented to illustrate contrasting scenarios (e.g.; comparing farmed areas with abundant livestock and unfarmed areas where only wildlife are available as host and sentinels) and the different tactics being used.

MANAGING HIGH RISK INVASIVE ANIMALS IN VICTORIA

Paul Major, Dana Price Miranda Green**,**
Department of Primary Industries, Biosecurity Victoria, 402 – 406 Mair Street, Ballarat, Victoria, 3350
paul.j.major@dpi.vic.gov.au

Biosecurity Victoria, a division of the Department of Primary Industries (DPI), is responsible for the management of high risk invasive animals in Victoria. The aim of the High Risk Invasive Animal project is to provide Victoria with increased capacity and capability to prevent and eradicate new high risk invasive animal species as they occur within the state.

For the purposes of this project, high risk invasive animals include species of reptiles, amphibians, mammals and birds that are not already established in the wild in Victoria. These species may have been detected within the illegal pet trade, have known incursions in Victoria or other jurisdictions, are categorised as a threat by the Vertebrate Pests Committee or listed on the Live Import List (DEWHA), or listed on the ARAZPA census.

DPI receives a number of reports annually of suspected high risk invasive animals from members of the public, community groups and government agencies. A Response Plan has been developed to ensure that reports of high risk invasive animal species in the wild are effectively responded to and managed. Following report verification, a site specific Incursion Action Plan is developed to guide the implementation of surveillance and control.

Two case studies illustrate the management issues involved;

In June 2009 an Asian black-spined toad was found alive in a shipping container used to export chemicals from Victoria to New Zealand. Trace-back of the movement history of the container prior to loading in Victoria gave no explanation as to where the toad had come from. Although the Asian black-spined toad is recognised as a strictly tropical species, the possible arrival of any exotic amphibian in Victoria is a potential biosecurity risk. DPI's aim was therefore to confirm the presence or absence of this toad species at the loading site in Victoria.

A project to eradicate Red-eared slider turtles from Elsternwick Park Lake in suburban Melbourne has recently achieved localised eradication. Red-eared slider turtles were initially reported at the site in late 2008. A detector dog was used at the lake in October 2009. No evidence of breeding was found, so intensive trapping of the lake was then conducted over a period of seven weeks between November 2009 and December 2010. One adult female turtle was removed from the lake during this period, however two further individuals of this species were identified at the site. In February 2010, after exhausting all previous control methods, DPI engaged a contractor to remove the two remaining individuals by shooting. This resulted in successful eradication of the remaining Red-eared slider turtles at the lake.

KEY AREAS FOR RABBIT CONTROL ON PROPERTY IN REGIONS AND NATIONALLY

David Berman, Susan Fuller and Michael Brennan
RWPARC, Biosecurity Queensland, DEEDI, Tor St Toowoomba, Qld 4350

The daunting and costly task of controlling rabbits over whole properties, regions or Australia-wide makes us reluctant to conduct conventional control such as warren ripping which could complement biological control. We have demonstrated that by targeting key areas on properties it is possible to influence rabbit populations over much larger surrounding areas for a fraction of the cost of treating the entire property. This paper suggests that we can also identify and target key areas at the regional and even national levels.

In south east Queensland there are areas with high densities of warrens and consistently high rabbit densities. Genetic work suggests that these areas are the source of most of the rabbits that have invaded the Darling Downs Moreton Rabbit Board 'rabbit free' area. Controlling these source areas may prevent future invasions, thus benefiting the surrounding region. In south west Queensland and northern South Australia there are at least two major drought refuge areas for rabbits. Controlling rabbits at these two places may restrict the rabbit population over the entire region.

At the national level the area where historical records of the distribution of rabbits overlap with records collected by community members via RabbitScan on the internet, correspond with areas where the highest warren density was reported by RabbitScan respondents. These areas represent a fraction of the area occupied by rabbits in Australia and are potentially key areas that we could target to achieve greater control of the Australian rabbit population for a reduced cost.

NON ROCKET SCIENCE RABBIT CONTROL – DEFENDABLE OUTCOMES FROM A MARRIAGE OF SCIENCE, STRATEGY AND LEGISLATION

John Matthews, Ryan Cooke, Brett Harrison
Biosecurity Victoria
Department of Primary Industries, 915 Mount Napier Road, Hamilton, Victoria, 3300
john.matthews@dpi.vic.gov.au

In Victoria, rabbit management programs are informed by, supported and implemented using transparent decision and legislative frameworks. While fundamental rabbit control options have not progressed far over the last 35 years, achieving "long term rabbit control" across large areas of the landscape has advanced through a science/community based planning model.

Government investment in rabbit management is focussed on protecting and enhancing priority natural resource assets. Catchment based Invasive Plant and Animal Management Strategies strongly advocate the Victorian Biosecurity Strategy and inform investment decisions for regional rabbit management in Victoria.

Victoria has developed a participatory rabbit control model incorporating extension, incentives and compliance. Success at a landscape scale has always been dependent on several key elements; the accurate application of appropriate control techniques, correct timing, established threshold targets and participation.

Results from Victoria's 17 long term rabbit monitor sites together with national research have informed the establishment of appropriate rabbit density thresholds for each catchment. Through a robust monitoring, evaluation and reporting framework, outcomes from successful rabbit management are described as improvements to catchment condition. This framework allows both the DPI and Catchment Management Authorities to articulate what is meant by "long term control" to all stakeholders who have an interest in rabbit management.

Rabbit control programs commence with extension to clearly articulate the expectation of land manager participation and the consequences of failure to achieve the required standard of control. All land managers within a target area are treated equally and without prejudice. As a matter of course, Victoria uses the legislative framework in rabbit management programs and regularly tests relevant law relating to pest management through the Victorian court system.

The integration of science and compliance with sound strategy protects and enhances effective rabbit control by ensuring full participation. The role of compliance to support pest management in Victoria is an evolving process. Since 1998 DPI has achieved 98% voluntary participation in rabbit control. This model ensures that the overwhelming majority of landholders who meet their legislative responsibilities are protected and those who fail to act are actively managed.

RESTORING NATIVE LANDSCAPES: THE IMPORTANCE OF RABBIT CONTROL

Ivor Stuart[1], Tony Arthur[2], Steve McPhee[3], Tim Bloomfield[4], Noel Vincent[5], Michael Lindeman[1] and Dave Forsyth[1].
[1]Arthur Rylah Institute for Environmental Research, 123 Brown Street, Heidelberg, VIC 3084
[2]CSIRO Ecosystem Sciences, GPO Box 284, Canberra, ACT, 2601
[3]Agricultural Technical Services P/L.
[4]Grow West Program Co-ordinator, Port Philip and Westernport Catchment Management Authority
[5]"Ingliston" Station Farm Owner
ivor.stuart@gmail.com

Decision making about rabbit management is constrained by a poor understanding of the economic and environmental costs and benefits of on-ground actions. We describe the impact of best practice rabbit management on the survival of planted native vegetation in the upper Werribee River region, near Bacchus Marsh, Victoria. In early 2010, baiting with 1080 oats reduced the rabbit population from 85 to 6 rabbits per spotlight km. Heavy earth moving equipment also destroyed ~1400 warrens at a density of 6-11 warrens ha-1. Five small pockets were not ripped, deliberately leaving areas of higher rabbit density and compared with similar areas of controlled low densities to assess the impact of rabbits on the growth and survival of guarded and un-guarded seedlings (*Allocasuarina verticillata*, *Acacia pycnantha*, *and Eucalyptus viminalis*). Preliminary results indicate survival did not differ within guarded seedlings relative to rabbit density however, the non-controlled revegetated areas were significantly impacted by rabbits both in terms of total tree mortality and in suppression of growth. The project will be a practical guide for farmers and government agencies to improve landscape recovery and re-emphasises the importance of integrated pest management.

INTERACTION OF MYXOMATOSIS AND RABBIT HAEMORRHAGIC DISEASE IN WILD RABBIT POPULATIONS

Glenn Fulford [1], Xing Lee[1], David Berman[2] and Grant Hamilton[1]
[1] Faculty of Science and Technology, Queensland University of Technology, 2 George St, Brisbane, Qld, 4001
[2] Robert Wicks Pest Animal Research Centre, 203 Tor Street, Toowoomba, QLD 4350
g.fulford@qut.edu

Increasing resistance of rabbits to myxomatosis in Australia led to the exploration of Rabbit Haemorrhagic disease (RHD) as a possible control agent. While the initial spread of Rabbit Haemorrhagic Disease (RHD) in Australia resulted in widespread rabbit mortality in affected areas, the possible population dynamic effects of RHD and myxomatoisis operating within the same system have not been well explored. Here we present early mathematical modelling work examining the interaction between the two diseases. While further model development is needed, our work to date suggests that: 1) the diseases are likely to interact via their impacts on rabbit abundance levels; and 2) introduction of RHD can suppress myxomatosis prevalence, but extinction of myxomatosis is unlikely within the timescale of a few years.

ANOTHER BIOLOGICAL CONTROL FOR RABBITS?

Greg Mutze[1], Bob Henzell[2] and Brian Cooke[3]
[1]BiosecuritySA, GPO Box 1671, Adelaide SA 5001
[2]PO Box 276, Uraidla SA 5142
[3]University of Canberra, Building 3, Level D, Canberra ACT 2611

Despite the reductions in rabbit numbers that followed the introduction of rabbit haemorrhagic disease (RHD) in 1995, rabbits remain a severe environmental and agricultural pest across about two thirds of the Australian continent. Rabbit populations are now recovering from the impact of RHD, as they did earlier from myxomatosis, and rabbit damage is increasing further. This paper briefly examines some aspects of the case for seeking further biological control agents for rabbits (Henzell *et al*. 2008), by posing the following questions: are biological agents merely a short-term fix that distract effort from proper application of proven conventional control methods?; is there any realistic prospect of finding further agents or were myxomatosis and RHD complete flukes that are unlikely to be repeated?; what impact would a new biocontrol need to make to be worth the effort?; are there known rabbit pathogens that might be useful?; and, if we were to seek new biocontrols for rabbits, where and how would we start to look for them?

References:

Henzell, R.P., Cooke, B.D. and Mutze, G.J. (2008) The future biological control of pest populations of European rabbits, Oryctolagus cuniculus. *Wildlife Research* 35, 633-650

A LONG-TERM STUDY OF THE IMPACT OF RABBIT HAEMORRHAGIC DISEASE (RHD) AND MYXOMATOSIS ON RABBIT POPULATION DYNAMICS IN AN AGRICULTURAL AREA OF SOUTH AUSTRALIA

Ron Sinclair[1], David Peacock[1], John Kovaliski[1], Damien Fordham[2], Greg Mutze[1] and Lorenzo Capucci[3]
[1] Biosecurity SA, GPO Box 1671, Adelaide, SA 5001
[2] School of Earth and Environmental Sciences, The University of Adelaide, Australia 5005
[3] Istituto Zooprofilattico Sperimentale della Lombardia, Brescia, Italy
ron.sinclair@sa.gov.au

In 1996, a year after the initial spread of RHD across South Australia, we began a regular mark-recapture study of a relatively isolated population of rabbits on Turretfield Research Centre situated in a cereal production, livestock grazing and wine grape growing area 60 km north of Adelaide with an annual average rainfall of 470 mm. Rabbits are live-trapped, generally over 5 days at 2-3 month intervals, and blood is collected for testing for antibodies to both RHD (using cELISA, IgM, IgA, and IgG iso-ELISAs) and myxomatosis. Some 2500 individual rabbits have been trapped on 15 warrens spread over the 12 ha site and 6000 blood samples examined for antibodies using the 5 tests. During each of the 10 RHD epizootics that have occurred on the site, carcases have been located and identified to determine relative mortality rates in different groups within the population. Liver or bone marrow samples have been collected for genetic sequencing of the virus.

In the first 10 years of the study, RHD caused full-blown epizootics only in spring and only every second year (with one exception). However, since 2006 there has been an epizootic each year. Despite this, the population appears to be slowly increasing. In addition, until 2008, mortality rates of susceptible challenged rabbits and the proportion of rabbits surviving infection were relatively constant (70-80% and 20-30%, respectively) but morbidity rates were variable (56-98%). However, in 2008, mortality fell to 45% and the proportion of rabbits surviving challenge and sero-converting increased to almost 60%. Since then, mortality rates have increased again and the proportion of rabbits surviving infection has fallen.

Myxomatosis outbreaks have been even more erratic, with periods between epizootics exceeding 2.5 years, and their impact has, like the RHD epizootics, been variable. None-the-less, modelling using Program Mark indicates that myxomatosis has had a very important impact on the population, especially through its effect on recruitment.

These results are discussed in the light of widespread reports of a resurgence in rabbit numbers, the development in rabbits of resistance to RHD, changes in virulence of the RHD virus, and proposed release of 'new' strains of the virus under the RHD-Boost program.

GENOMES OF AUSTRALIAN AND OVERSEAS ENDEMIC STRAINS OF RABBIT HAEMORRHAGIC DISEASE VIRUS (RHDV)

John Kovaliski [1], Ron Sinclair[1], David Peacock[1], Greg Mutze[1], Tanja Strive[2]and Pedro Esteves[3]
[1] Biosecurity SA, GPO Box 1671, Adelaide, SA 5001
[2]CSIRO Ecosystem Sciences, GPO Box 1700, Canberra, ACT 2600
[3] Faculdade de Ciências da Universidade do Porto, Porto, Portugual
john.kovaliski@sa.gov.au

We have collected tissue samples for virus extraction from rabbits that died during natural outbreaks of RHD from across Australia since 1995. More than 3,000 tissue samples have been collected from field epizootics through cooperation of the general public, staff of State and Territory government departments, and CSIRO. Samples have also been collected from 10 sequential annual or biannual epizootics at our Turretfield rabbit research site near the Barossa Valley, SA and a smaller number from sequential outbreaks in the Flinders Ranges National Park, SA.

RHDV is a positive single-stranded RNA molecule of 7437 nucleotides in length. In common with most published phylogenetic analyses of strains of the virus, we have examined a 300bp section of the gene that codes for the capsid protein VP60. To date, we have sequenced this small part of the virus in 299 samples and compared the sequences with that of the original Czech strain that was released in Australia in 1995. The analysis has separated the strains into 6 distinct groups or branch taxa. One of the groups, containing strains from Europe, Asia and the Americas is clearly distinct from all the Australian strains. However an Italian strain from 1990 is grouped in one of the Australian branches which contains the original Czech strain, as well as other strains obtained from WA and SA in 1996 and 1997. The other 4 branches are grouped in a pattern related to year of sample collection rather than geographical location.

We have sequenced the whole genome for a small number of recently collected Australian strains and compared the VP60 region of these with published genomes of overseas RHDVa, (variant pathogenic) strains. These Australian strains fall into a single group with the originally imported Czech strain and the Italian strain referred to above. The maximum difference between strains within the group is 6.6% with Australian strains differing from the Czech strain by no more than 4%. The Australian group differs from the overseas RHDVa group by 10%.

This study is vital to our understanding of how the virus is evolving under Australian conditions in Australian rabbits, to guide selection of new RHDV variants for release under the RHD-Boost program, and to facilitate monitoring of the persistence and spread of any new variants that are released to assist in the battle to reduce rabbit damage in Australia.

PRELIMINARY CHARACTERISATION OF THE NON-PATHOGENIC AUSTRALIAN RABBIT CALICIVIRUS RCV: IMPLICATIONS FOR BIOCONTROL

Tanja Strive[1,2], Marlene Jahnke[1,2], Eddie Holmes[3,4], Peter Kerr[1,2], June Liu [1,2] and John Wright[1,2]
[1]CSIRO Ecosystem Sciences, GPO Box 1700, Canberra, ACT, 2601
[2]Invasive Animals CRC, Bldg 3, University of Canberra, Bruce, ACT 2617
[3]Center for Infectious Disease Dynamics, Department of Biology, the Pennsylvania State University, University Park, Pennsylvania 168023
[4]Fogarty International Center, National Institutes of Health, Bethesda, Maryland 208924
tanja.strive@csiro.au

Rabbit Haemorrhagic Disease Virus (RHDV) is widely used in Australia and New Zealand to control feral rabbit populations. In some areas, notably the more temperate zones of Australia, RHDV is less effective, which is believed to be a result of circulating endemic caliciviruses that are related to RHDV, but non-pathogenic and that can provide some level of cross immuno-protection to lethal RHDV infection. Such a virus has recently been discovered and was designated Rabbit Calicivirus Australia 1 (RCV-A1)[5].

Evolutionary analysis of 36 strains of RCV-A1 isolated from 11 different sites revealed that RCV-A1 arrived in Australia with the first rabbits approximately 150 years ago. Six different groups of RCV-A1 were defined, each showing strong population subdivision. Divergence events visible in the RCV-A1 phylogenies likely reflect key moments in the history of the European rabbit in Australia, most notably the bottlenecks in rabbit populations induced by the impact of the two viral biocontrol agents used on the Australian continent, myxoma virus and RHDV[6].

Experimental infection studies were also conducted to determine the extent of cross protection conveyed by RCV-A1. Protection rates were up to 40% but varied with inoculation regimes. Interestingly, the protective effect appeared to be temporal, indicating that there may be a window of opportunity for RHDV infection to still be applied effectively in areas where RCV-A1 is present. Studies are now underway to determine the distribution and seasonal occurrence of RCV-A1 in order to better understand the epidemiology and interaction of the two caliciviruses in Australia.

References

[5]Identification and partial characterisation of a new Lagovirus in Australian wild rabbits.

Strive T, Wright JD, Robinson AJ. Virology. 2009 Feb 5;384(1):97-105.

[6]Evolution and phylogeography of the nonpathogenic calicivirus RCV-A1 in wild rabbits in Australia. Jahnke M, Holmes EC, Kerr PJ, Wright JD, Strive T.J Virol. 2010 Dec;84(23):12397-404.

Abstracts - Day 3

(In Program Order)

ANOTHER INCONVENIENT TRUTH: HOW MUCH PEST CONTROL WILL IT TAKE TO HALT THE DECLINE IN BIODIVERSITY?

Dave Choquenot and Mick Clout
Centre for Biodiversity and Biosecurity, University of Auckland and Landcare Research, New Zealand.

A range of ecological drivers have been linked to biodiversity loss in New Zealand and Australia. However, in structurally intact areas managed primarily for biodiversity conservation, pest animals are consistently identified as the primary ongoing cause of decline. Our understanding of the control measures necessary to mitigate some specific impacts of pest animals has increased steadily over the past 30 years. While the accumulation of this knowledge has helped identify strategies that effectively protect some highly threatened species, it has done little to noticeably mitigate the broader loss of biodiversity. In this paper we will highlight recent analyses of the response of a range of biodiversity indicator species to current investment in threat management across New Zealand's conservation estate. These analyses are based on relationships between these responses and weed and pest abundance (so-called pressure state response indicators), and indicate that current expenditure on threat management would have to increase between 9 and 25 times to plausibly halt the decline in New Zealand's biodiversity. While there is no similar analysis for Australia, the story is likely to be the same. This sobering reality has obvious and critical implications for how we approach the conservation of biodiversity in these countries, but also for how we identify and resources future pest animal research. Demands for increases of this scale in public expenditure to conserve biodiversity are unlikely to be supported by communities or the politicians they elect. This means that alternative sources of funding must be secured and biodiversity targets rationalised by refocusing the strategic goals of conservation. In terms of pest animal research, the sensitivity of key pressure-state response indicators should be used to prioritise knowledge needs in the context of projected regional and national biodiversity goals.

RODENT OUTBREAKS AND EXTREME WEATHER EVENTS: A SOUTHEAST ASIAN AND AUSTRALIAN PERSPECTIVE

Grant R. Singleton[1], Nyo Me Htwe[1], Andrew D. Nelson[1], Peter R. Brown[2]
[1]Irrigated Rice Research Consortium, International Rice Research Institute, Philippines
[2]CSIRO Ecosystem Sciences, GPO Box 284, Canberra, ACT, 2601 Australia
g.singleton@irri.org

Since 2007, rodent outbreaks in Asia, from bamboo masting, have led to severe food shortages in Mizoram (India), Chin State (Myanmar), Chittagong Hill Tracts (Bangladesh), and upland provinces of Lao PDR. In Laos, emergency food assistance was required for 85,000-145,000 people. These outbreaks have affected highly vulnerable and food insecure families. In 2009-2011, high rodent losses also occurred in lowland irrigated rice-based systems in the Philippines, Myanmar and Indonesia, not related to bamboo masting. In 2009 in the Ayeyarwaddy delta, 2.6 million rats were collected in 3 months through community action in five townships. In 2011, there are reports in Australia of outbreaks of the long haired rat, *Rattus villosisimus*, and the house mouse, *Mus domesticus*, in central Australia; and of the house mouse in southeastern Australia.

In recent reviews of rodent outbreaks (Singleton et al. 2010a,b), three general systems were identified that influence the food supply of rodents in significantly different ways. One is life-cycle or evolution-driven in the form of plant masting events. Outbreaks triggered by masting, including bamboo and beech forests, are examples of this system. The second is climatic; these include outbreaks driven by changes in abiotic conditions alone (aseasonal or unusual rainfall events, or major climatic events such as El Niño or La Niña). These are irregular and rodent populations respond rapidly to the peaks in increased food availability. The third is anthropogenic responses associated with extreme climate events or market forces with outbreaks driven by changes in cropping systems. These are driven directly by anthropogenic responses to calamitous events such as cyclones, high rainfall, and drought, or responses to shortfalls of production of staple crops.

In Australia, the high rainfall in southeast Australia over the past 18 months has led to high rodent numbers. We will provide a brief update of mouse plague predictions for Southeastern Australia based on two models, and the existing surveillance in place for mouse populations. In southeast Asia a massive outbreak of rodents in the Ayeyarwaddy delta in 2009 and 2010 was associated with a calamitous weather event, cyclone Nargis, which occurred 15 months prior to the outbreak. We will present findings supporting the association between the effects of cyclone Nargis and the subsequent rodent outbreaks. We contend that climate change and extreme climatic events will increase the impacts of rodents on agricultural production in coming years.

References:

Singleton, G.R., Belmain, S.R., Brown, P.R., and Hardy, B. (2010 a). Rodent outbreaks – ecology and impacts. Los Baños (Philippines): International Rice Research Institute. 289p.

Singleton, G.R., Belmain, S.R., Brown, P.R., Aplin, K.P., and Htwe, N.M. (2010b). Impacts of rodent outbreaks on food security in Asia. *Wildlife Research* 37: 355-359.

INVASIVE RODENTS: THEIR ECOLOGY, IMPACTS AND MANAGEMENT

Chris R. Dickman
Institute of Wildlife Research, School of Biological Sciences, University of Sydney, NSW 2006
chris.dickman@sydney.edu.au

Less than 5% of the world's 2280 described species of rodents can be considered invasive in the sense that they routinely exploit new habitats, and only a handful of these can be defined as invasive aliens that have colonized new regions. The most successful colonists, such as *Rattus rattus*, *R. norvegicus*, *R. exulans* and *Mus musculus*, have usually hitched rides with people to achieve their new destinations. In this presentation I first compare aspects of the reproductive biology and ecology of invasive and non-invasive rodents, and show that invasive species differ little in these respects from their non-invasive counterparts. The ability to tolerate human disturbance for prolonged periods appears instead to be a key prerequisite for 'invasiveness'. I then review the range of impacts of invasive rodents, from their effects in agro-ecosystems, on stored crops and other human resources, to their usually deleterious effects on native fauna and flora. These latter impacts have been particularly severe in island ecosystems, contributing to multiple extinctions of birds and mammals in the Pacific and Indian Ocean regions over the last century. Finally, I consider how invasive rodents can be managed and when management should be attempted. In general, management may work if there are tools available to reliably and sustainably reduce the abundance of the target species of invasive rodent, if impacts on non-target species are acceptably low, and if there are net benefits to be gained from reducing damage to human endeavours or biodiversity values. The most effective and widely used management tool at present is the poison bait, but new and innovative approaches such as the trap-barrier system and assisted returns of native species may help to reduce reliance on poisons in future. A less obvious and seldom-addressed question is whether invasive species have integrated into their new systems so successfully that their removal or management may now have negative consequences. I provide a case study example of how reduction of numbers of the house mouse *M. musculus* on Australian offshore islands had both positive and negative consequences for endemic species of insular small vertebrates, and introduce a preliminary framework that allows *a priori* prediction of the effects of management in different contexts.

PRINCIPLES UNDERPINNING BEST PRACTICE MANAGEMENT OF THE DAMAGE DUE TO PESTS

Mike Braysher[1], Glen Saunders[2] and Tony Buckmaster[1]
[1]Institute For Applied Ecology, University of Canberra 2601
[2]NSW Department of Industry and Investment, Forest Rd, Orange, NSW 2800

Braysher 1993 published a Managing Vertebrate Pests Principles. The principles were developed during a review of past and current pest management and were used to guide the development of a series of management guidelines for our major vertebrate pests, the Bureau of Rural Sciences, Managing Vertebrate Pests series. The principles have been refined through subsequent experience in working with stakeholders to implement best practice management of pest animals including as an interim refinement in Braysher and Saunders 2003 . Here we present the seven principles that we consider underpin best practice management of pest animals.

- A pest is human construct
- All key relevant stakeholders need to be actively engage and consulted
- Rarely can pests be eradicated
- Consequently most pest management needs to focus on the outcome, reduction in damage, not just killing pests.
- Whole of system approach is required to managing the damage due to pests.
- Most pest management occurs in a system where our knowledge is imperfect.
- An effective monitoring and evaluation strategy is an essential component.

Together, the principles comprise the strategic approach to pest management. In our presentation we will explain the rationale behind these principles and illustrate them with examples.

Braysher, M. (1993) *Managing Vertebrate Pests Principles and Practices*, Bureau of Rural Sciences, Canberra.

Braysher, M. and Saunders G., (2003) *'PESTPLAN – A guide to setting priorities and developing a management plan for pest animals.'* Natural Heritage Trust, Commonwealth of Australia, Canberra.

COMMUNITY ACTION TO AID THE SURVIVAL OF HODDED PLOVERS AND SMALL NATIVE MAMMALS ALONG THE CAPE LIPTRAP COAST

Kate Williams
South Gippsland Landcare Network,
PO Box 419 Leongatha VIC 3953
katew@wgcma.vic.gov.au

Community concern over the threats posed by the European fox (*Vulpes vulpes)* to native fauna, including predation and the spread of disease, prompted the Friends of Venus Bay Peninsula Inc to initiate a fox control program in 2007 in their local area. They realised that to achieve a marked decline in fox numbers, a landscape-scale program was needed and in 2008 the target area was expanded. The expanded project, facilitated by the South Gippsland Landcare Network in partnership with Parks Victoria and a range of stakeholders, was developed with a community led focus. The main objective was to increase fox management activities amongst land managers with properties adjoining the Cape Liptrap Coastal Park. Freehold land equated to 5000ha of the total 9000ha project area. At the time of the project's inception best management practice on freehold land was short term annual baiting for the protection of lambs and calves. To encourage land managers to effectively manage fox numbers beyond a short term annual program, permanent control points, using integrated control methods were established on their properties. Control points were maintained over the course of the 2 year project. Land managers were also supported to remove invasive plant species that provided harbour, primarily boxthorn (*Lycium ferocissimum)*. To ensure sustained long term management beyond the projects completion, barriers to the adoption of control methods were addressed. The main barriers to the adoption of control include; the need for a 1080 endorsement, the costs and resources associated with fulfilling legal obligations with regard to the use of 1080 baits. The initiatives adopted by Landcare to engage and promote best practice management across all land tenure for sustained, long-term community driven fox management are discussed in this paper.

MONITORING PEST CONTROL IMPACT ACROSS THE GOONOO LANDSCAPE USING REMOTE CAMERAS: RESULTS AND LESSONS LEARNT

Alison L. Towerton[A], Trent D. Penman[B], Rodney P. Kavanagh[B], Christopher R. Dickman[A], Rhett Robinson [C] and Cameron Chaffey [D],
[A]Institute of Wildlife Research, School of Biological Sciences A08, University of Sydney, NSW 2006, Australia
[B]Forest and Rangeland Ecosystems, NSW Industry and Investment, Beecroft, NSW 2119, Australia
[C]Central West Livestock Health and Pest Authority, Dubbo, NSW
[D]NPWS, NSW Department of Environment, Climate Change and Water, Dubbo, NSW
alison.towerton@gmail.com

The red fox *Vulpes vulpes* is a widespread pest in southern Australia and is subject to control over large areas using poison baits to protect both agricultural and ecological assets. Foxes and their prey are often cryptic or in low densities, making it difficult to quantify the efficacy of control programs. We explored the use of remote cameras to estimate the activity and spatial occupancy of foxes and potential mammalian and avian prey species before and after poison baiting in the Goonoo region, central New South Wales.

Camera traps were set at 48 sites in forest and cleared areas, on and off tracks, during autumn 2009 to examine camera placement. In subsequent monitoring periods, we placed camera traps in forest and cleared areas, on tracks only, at 100 sites across an area of around 440,000 ha during winter 2009, and autumn and winter 2010. We examined camera trap rates of all species detected and the activity and site occupancy of a selected subset of species before and after poison baiting.

Camera traps indicated greater levels of fox activity on vehicular tracks than off them, with this difference being more marked in forest than in cleared agricultural land. Fox activity and occupancy were greater in agricultural land than in forest, with no effect of baiting detected. Thirty-five other mammal and bird species were identified from photos, with activity for most being greater on tracks than off. At the landscape scale no clear effects of fox-baiting were detected on foxes or potential prey species by either activity or occupancy. The lack of a baiting effect may reflect rapid recolonisation by foxes from unbaited areas, as bait placement is generally clustered in agricultural land, or the ready availability of alternative food (lambs or lamb carcasses) in some cleared areas.

Our results demonstrate that remote cameras provide a simple means of monitoring changes in fox activity and occupancy at the landscape level, and that these measures have great potential to quantify the success or otherwise of fox control campaigns on both pest and prey species.

EXPLORING THE CAPACITY OF NRM ORGANISATIONS TO SUPPORT INVASIVE ANIMAL MANAGEMENT NOW AND INTO THE FUTURE

Jessica Marsh, Annette Brown and Chris Lane
Invasive Animals Cooperative Research Centre and
Vertebrate Pest Research Unit, NSW Industry & Investment
jessica.marsh@industry.nsw.gov.au, jessica.marsh@invasiveanimals.com

Across Australia, there are 56 natural resource management regions. The regions are based on physical catchments or bioregions and were established from 2000 to 2004 by the Commonwealth and State/ Territory governments. Each NRM organisation has the ability to play a critical role in invasive species management, education and awareness as all land across Australia falls within one of the 56 specified regions.

Each NRM region has been reviewed with regard to their invasive animal management history, current targets, designated staff, resources, and future plans to tackle their individual invasive species issues. Understandably, each NRM agency has a different suite of issues to deal with including extreme weather events, complicated mixes of pest species and environments, varied land tenure, peri-urban issues, high staff turnover, and competing priorities. The workings of NRM agencies are explored and issues that play a role in both decreasing and increasing regional NRM agency capacity, especially in the invasive species management field, are revealed.

CHALLENGES IN MANAGING VERTEBRATE PESTS IN PERI-URBAN AREAS

Sheree Edwards
Adelaide & Mount Lofty Ranges Natural Resources Management Board, Adelaide Lobethal Road, Lobethal SA 5241
sheree.edwards@adelaide.nrm.sagov.au

Managing vertebrate pests in peri-urban areas does not come without its challenges. With urbanisation and the change in the demographic of landholders in areas such as the Adelaide Hills, it is becoming increasingly difficult to engage and involve landholders in coordinated and outcome based vertebrate pest management programs. Natural Resource Management (NRM) officers in the Adelaide Hills are faced with many challenges when implementing pest management programs including the availability of low-risk and effective control options, landholder attitudes and capabilities.

Property sub-division and the lure of a tree change are attracting increasing numbers of landholders with limited skills and knowledge in vertebrate pest management. It is common for landholders to have limited ability to be involved in control programs because of their close proximity to townships; with specific reference to the use of registered poisons such as 1080 and the use of firearms (Maller et al. 2007). This increases reliance on alternative control methods which are ad-hoc, less effective and less economical.

Often landholders in the Adelaide Hills have off-farm income with some being absent or only visiting the property on weekends. In these instances, individuals have limited ability to manage vertebrate pests as they're not present to undertake adequate control and monitoring activities or to prioritise the issue. Given the average turnover of property ownership is 7 years; it is an on-going challenge to engage enough landholders in NRM programs but more specifically long-term landscape scale pest management programs (Hyde. 2007).

With public pressure and legislative responsibilities driving NRM Boards to manage vertebrate pests, it is important that these challenges are seen as opportunities to develop meaningful education and engagement programs to involve more landholders in vertebrate pest management. The Adelaide & Mount Lofty Ranges NRM Board's Land Management Program incorporates a District Officer model of delivery with an active education program to achieve landscape scale engagement of landholders in NRM programs.

References:

Hyde, B (2006). Biodiversity of the Edge, *Commonwealth of Australia*: 1-4.

Maller, C., Kancans, R. and Carr, A (2007). Biosecurity and Small Landholders in Peri-urban Australia, *Bureau of Rural Sciences.*

COMMUNITY AND LANDHOLDER PARTICIPATION IN THE FERALSCAN PROJECT

Peter West, Chris Lane and Jessica Marsh
Industry & Investment NSW and Invasive Animals CRC, Forest Rd, Orange, NSW 2800
peter.west@industry.nsw.gov.au

Citizen science programs are becoming increasingly popular and provide an important role in raising awareness, education, community engagement, and data gathering. The FeralScan collaborative project builds on the popular RabbitScan citizen science project of 2009, by providing a community space for recording data on pest animals across Australia. Community groups, land managers and landholders are encouraged to participate by recording sightings, damage data and control activities in their local area onto the FeralScan website (www.feralscan.org.au). Recorded data is then collated to provide a regional and national overview of pest animals and the problems they cause.

The FeralScan program hosts a series of species websites and a centralised Google mapping application with customised settings for defined user groups. It helps to build information on pest animal distribution and abundance, damage and control activities by individuals/groups. It challenges previously known information, addresses data and information gaps, and provides a tool for community surveillance – helping to detect and report potential range expansions, new and emerging species, and emerging pest animal problems.

Importantly, FeralScan promotes accessibility to concurrent pest animal websites, such as www.feral.org.au, and provides a mechanism for site users to connect with other landholders and local pest control organisations. FeralScan provides a unique facility for real-time reporting of sightings, damage and control information. The project aims to empower individuals and community groups with the capacity to collect data, and contribute to pest animal management programs and decision-making. By targeting landholders, community groups, landcare groups, NRM regional bodies and local councils, FeralScan aims to build community interest and participation in local pest animal management activities.

FeralScan provides the opportunity to integrate community and formalised government pest animal datasets to provide regionally specific data on pest animals and the problems they cause. Outcomes from the first six months of FeralScan will be presented and future applications discussed. FeralScan is primarily funded through the Australian Pest Animal Research Program and provides a unique partnership between government, industry, business, landholders and community.

INTEGRATED PEST MANAGEMENT OF THE COMMON CARP IN THE AMERICAN MIDWEST

Peter Sorensen and Przemek Bajer
Department of Fisheries, Wildlife and Conservation Biology
1980 Folwell Avenue
University of Minnesota
St. Paul, Minnesota 55108
psorensen@umn.edu

The common carp is one of the most abundant and destructive invasive fish in both North America and Australia where it has severely damaged hundreds of thousands of hectares of shallow-water ecosystems. Carp control in North America presently focuses on using a combination of nonspecific fish poisons (rotenone) and water-drawdowns, and for the most part has had little sustainable success. However, we recently discovered that carp population abundance in the Midwest has little density dependence because recruitment is driven by seasonal fluctuations in spawning habitat that disrupt the ability of native fish to prey on young carp (Bajer & Sorensen 2010). This insight has permitted us to initiate an experimental integrated pest management (IPM) scheme that focuses on targeted adult removal using both Judas fish and pheromones while we simultaneously suppress carp recruitment by balancing native fish populations in carp spawning habitat. A model describes and guides this process and it has been able to suppress carp populations to about 10% of their initial levels in three 200 ha local lakes for several years at low cost. During this time significant improvements in water quality have also been noted and there has been no recruitment of carp. The scheme is now being expanded to new watersheds. (Funded by the Invasive Animals Cooperative Research Centre, The Minnesota Environment and Natural Resources Trust Fund, Riley Purgatory Bluff Creek Watershed District, and the Ramsey-Washington Metro Watershed District).

DECISION SUPPORT TOOL FOR THE MANAGEMENT OF FRESHWATER FISH INCURSIONS IN AUSTRALIA

Silvana Acevedo, Stephen Saddlier, Pam Clunie and Renae Ayres
Department of Sustainability and Environment
Arthur Rylah Institute for Environmental Research

There are currently no national emergency response arrangements for freshwater fish incursions in Australia. An IACRC project recently completed by the Arthur Rylah Institute (ARI) aimed to provided direction regarding the development of a national emergency response plan.

A recommendation from this report was to develop a Decision-Support Tool for the Management of Freshwater Fish Incursions. This was considered necessary due to the current ad hoc approaches to new incursions which were often unclear in their purpose and lacked comprehensive documentation, monitoring and follow up. It was also clear that staff involved in dealing with incursions vary considerably in their knowledge of invaders and the appropriate management options available. A decision support tool will clearly document the range of complex issues which should be considered to best manage fish incursions, and facilitate staff having access to relevant, targeted information.

The development of a web-based decision-support tool commenced at ARI in August 2010. The format of this tool follows a question/answer format, where the user is progressively led through a series of questions on species capture (or sighting), waterbody physical characteristics and site management. Many of these questions are answered using drop-down boxes with options to assist user operation. A range of online tools will be available to assist managers in determining the feasibility of eradication or containment using a range of control techniques.

The tool would assist managers by:

- Maximising speed of response – critical in the early stages of incursions
- Enabling logical consideration of all management options
- Facilitating communication and consistency of approaches between agencies
- Ensuring shared learnings from past experiences
- Providing comprehensive planning documentation.

This tool will not be a complete repository of information on the management of invasive fish species and users may be directed to additional websites containing more specific information (such as detailed ecological information on fish species), thereby reducing information replication. What this tool will provide, will be a practical reporting framework which provides information in the form of recommendations (and limitations) of what can and cannot be achieved under a new incursion scenario at a particular location. It is envisaged that this tool will form the basis on which a range of additional tools and components can be added in the future to assist in the management of an invasive fish incursion. The generic nature of this tool may also be suitable for a range of other invasive species.

The tool will form an important part of the IA CRC PestSmart Toolkit – Pest Fish.

CHALLENGES AND FUTURE PRIORITIES FOR FRESHWATER ORNAMENTAL PEST FISH MANAGEMENT IN NSW

Melissa Walker, Bob Creese, Jane Frances
Port Stephens Fisheries Institute, Locked Bag 1, Nelson Bay, NSW 2315

Since European settlement in Australia, NSW freshwater ecosystems have been subjected to both deliberate and accidental release of non-native fish species. In recent years it is often the release is of unwanted ornamental pet fish, by community members who don't realise the potentially significant impacts of their actions. Where these releases result in the successful establishment of a non-native species, native fish can become threatened by competition with, or predation from, the non-native fish. If these impacts, or others such as habitat modification, are serious or widespread, the non-native species can become classed as a 'pest'. Over the last 10 years populations of many different ornamental fish species have been recorded in natural or man-made waterways in NSW. We document several recent case studies, only one of which has resulted in successful long-term eradication.

It is therefore important to prevent further spread of existing populations of pest fish, and to prevent new non-native species being introduced into NSW waterways. Research, control and management of pest fish usually require more resources than is available within one government agency. Ideally, therefore, such activities need to take advantage of support from local communities, local governments and external funding bodies. A communication initiative with key stakeholders and community groups in NSW aims to engage them in the protection of freshwater ecosystems and the prevention of further releases of potential pest fish into NSW waterways. Additional collaborative efforts in the management and control of freshwater pest fish in NSW are discussed.

DOES STOCKING AUSTRALIAN NATIVE PREDATORY FISH PROVIDE A CONTROL OPTION FOR INVASIVE EUROPEAN CARP (*CYPRINUS CARPIO*)?

Katherine Doyle[1,2], Gimme Walter[1], Daryl McPhee[3]
University of Queensland, St Lucia[1],
Invasive Animals Cooperative Research Centre[2],
Bond University, Gold Coast[3]
katiedoyle190@hotmail.com

Stocking activities support a number of vital objectives in fisheries management, including native fish enhancement, improved water quality (biomanipulation), recreational fishing and biological control. We examined the potential for stock enhancement of Australian native fish to control invasive European carp (*Cyprinus carpio*) through predation. We selected two factors for quantification that may influence predation rates on carp; prey size and relative abundance, and the habitat type in which a predator forages. In tank trials, Murray cod (*Maccullochella peelii peelii*), golden perch (*Macquaria ambigua*) and Australian bass (*Macquaria novemaculeata)* had no significant preference for any particular species offered. When offered carp of varying sizes, golden perch and Australian bass consumed the smallest carp available, whereas Murray cod showed no size preference. In Australian rivers, adult carp select inundated macrophytes in shallow, peripheral marginal habitats that are relatively free from predators to spawn. Juvenile carp therefore have the opportunity to grow rapidly in these habitats and soon reach a size that is free from predation by gape-limited predators. Predators with a preference for smaller carp may not have any impact on reducing carp populations. In mesocosm trials, Murray cod prey preferences were altered by the available habitat type, but there were still no strong preferences for carp when native prey were available. These results suggest that foraging activities and predation rates in aquatic systems are influenced by particular combinations of abiotic factors, such as habitat type and complexity, and biotic factors such as prey size and food availability. Evaluation of prey preferences under varying conditions is crucial prior to stocking predators for biological control to avoid potentially devastating and irreversible impacts on non-target species.

ELECTROFISHING CONTROL OF AN INVASIVE TILAPIA (OREOCHROMIS MOSSAMBICUS) POPULATION IN NORTHERN AUSTRALIA

Paul Thuesen[1 2], D. John Russell[1 2] and Fiona Thomson[1 2]
[1]Northern Fisheries Centre, Queensland Department of Employment Economic Development and Innovation, PO Box 5396, Cairns Qld 4870
[2]Invasive Animals Cooperative Research Centre, University of Canberra ACT 2617
paul.thuesen@deedi.qld.gov.au

Combating the spread of invasive fish is problematic, with eradication rarely possible and control options varying enormously in their effectiveness. In two small impoundments in north-eastern Australia, an electrofishing removal program was conducted to control an invasive tilapia population. We hypothesised that electrofishing would reduce the population density of *Oreochromis mossambicus* (Mozambique tilapia), thereby limiting the risk of their downstream spread into areas of high conservation value. We sampled the impoundments by electrofishing monthly for 33 months. Over this period, there was an 87% decline in catch per unit effort (CPUE) of mature fish, coupled with a corresponding increase of 366% in the number of juveniles, suggesting a density-dependent response in the stock–recruitment relationship for the population.

Temperature was inversely related to CPUE ($r = 0.43$, lag = 10 days), implying greater electrofishing efficiency in cooler months. The reduction in breeding stock is likely to reduce the risk of spread and render the population vulnerable to other control measures such as netting and/or biological control. Importantly, the current study suggests routine electrofishing may be a useful control tool for invasive fish in small impoundments when the use of more destructive techniques, such as piscicides, is untenable.

SUCCESSFUL ERADICATION OF EUROPEAN CARP FROM LAKE CRESENT, TASMANIA

Chris Wisniewski
Inland Fisheries Service, PO Box 575, New Norfolk TAS 7140
chriswi@ifs.tas.gov.au

European carp, *Cyprinus carpio,* were found in lakes Crescent and Sorell in 1995. Early containment measures restricted movement and subsequent surveys across the State indicate that these lakes provided their entire range. Twelve years of concerted fishing effort by the Inland Fisheries Service has resulted in the complete eradication of feral carp from the 2305ha Lake Crescent with the removal of the last female in the autumn of 2007. It has taken a further four years of monitoring and surveys to be able to declare this lake carp free. Building a thorough understanding of carp behaviour under the local environmental conditions has enabled the development of a fully integrated approach. This includes using selective techniques at various times in their life cycle to produce optimal population reduction along with spawning prevention and sabotage. The battle to eradicate carp from the larger 5310ha Lake Sorell continues but is now more focussed. Radio tracking and odour donor carp are now standard techniques deployed. The IPM techniques developed in the successful eradication of carp from Lake Crescent will be used in eradicating carp from Lake Sorell and elsewhere.

Key words: Eradication, containment, physical removal, integrated approach.

PUTTING THE PEST MANAGEMENT PUZZLE TOGETHER - LANDHOLDER PERSPECTIVES ON NATIONAL COORDINATION AND THE NECESSITY TO ACCESS INFORMATION IN ORDER TO FACILITATE CHANGE IN WILD DOG MANAGEMENT

Greg Mifsud
National Wild Dog Facilitator, Invasive Animals CRC,
Fraser Barry, Landholder Representative Gippsland Wild Dog Management Group

Wild dogs, which include feral domestic dogs (*Canis lupus familiaris*), dingoes (*C. l. dingo*) and their hybrids, are considered major pests in Australia, with impacts on agriculture estimated at $48.5 million (Gong et al 2009). These figures however are extremely conservative and subsequent studies within Queensland and Victoria estimate that wild dog impacts on the grazing industry are as high as $67 and $21 million respectively (Hewitt 2009 and Lightfoot 2011). In addition to direct financial losses, these pests increase physical and emotional stress to producers, have a significant impact on native fauna and can transmit disease to both animals and humans (McLeod 2004).

The Invasive Animals Cooperative Research Centre and its stakeholders identified these issues in 2007 and in response initiated the project "Facilitating the Strategic management of wild dog throughout Australia". This project now in its fourth year has generated significant forward momentum with regards to wild dog management throughout the country delivering information on best practice management and establishment of community based wild dog management programs. However generating community involvement in pest management programs and adoption of best practice remains a challenge and often requires a significant cultural shift amongst stakeholders. Communication and access to information is the key to facilitating this shift however producers and land managers are often at a loss as to where this information can be found. By contrast individuals in these communities are often influenced by folklore and old wives tails which in the absence of any other valid information are regarded as fact resulting in long term disruption to community based management programs.

The advent of the IA CRC project "Facilitating the strategic management of wild dogs throughout Australia", the presence of an independent national facilitator and the National Wild Dog Management Advisory Group has provided the avenue by which individuals and community groups can access information on current best practice management. Information is required to dispel myths and encourage participation in management programmes. Perspectives on the benefit of this project and how access to this information has influenced changes in wild dog management within the Victorian wild dog programme will be discussed by a landholder representative of the Gippsland Wild Dog Management Group.

References

Hewitt, L 2009, *Major economic costs associated with wild dogs in the Queensland grazing industry*, Blueprint for the Bush, Queensland State Government, Brisbane.

Gong W, Sinden J, Braysher M and Jones R 2009, *The economic impacts of vertebrate pests in Australia*, IA CRC, Canberra.

Lightfoot, C. 2011, *Social Benefit Cost Analysis – Wild Dog Management in Victoria*, Victorian Department of Primary industries, Melbourne

McLeod R 2004, *Counting the cost: Impact of Invasive Animals in Australia 2004*, Cooperative Research Centre for Pest Animal Control, Canberra.

EMPOWERMENT OF COMMUNITY MEMBERS IN THE SOUTH EAST NSW WILD DOG MANAGEMENT PLAN PROCESS

Andrew Miners
61 Wason Street, Milton, NSW, 2538
andrew.miners@lhpa.org.au

The gazettal of the Pest Control Order Number 2 in 2001 and the release of *Guidelines for Preparing a Working Plan to Manage Wild Dogs* (Fleming & Harden 2003) instigated the development of wild dog management plans across NSW. These plans posed both a challenge and an opportunity for community members affected by wild dogs to engage with Crown land managers regarding the management of wild dog populations. Unintentionally landholders had the benefit of being able to bring generations of knowledge to the table, as they had managed the same land prior to it being gazetted as National Park or State Forest. In the South East of NSW, the meetings set down to design the management plans became a protracted and fierce battleground. Meeting after meeting was attended by the farming community members and they learnt through the experience to deal with the bureaucracy and the methods of engagement required to further the goal of keeping the wild dogs out of their paddocks. A few key dog affected landholders('key drivers') embraced this opportunity and have developed engagement skills that have levelled the playing field with the result that, all stakeholders are equal in the planning and decision process. This remarkable 'David and Goliath' battle has taken years to unfold and many lessons have been learnt. This paper seeks to describe how the 'key drivers in the SE N.S.W wild dog management plans have challenged inhibiting policies and perceptions, and how they have turned a bureaucratic process into a democratic and practical set of plans It will also disclose how 'key drivers' in South East NSW have developed procedures and processes in and out of planning meetings to capture the historical information that each plan should be based upon, how they created an open and transparent atmosphere, fostered a culture of working as a team across all stakeholder groups, and developed the ownership of the plan by the entire working group. The future of the SE NSW Wild Dog Management Plans are however threatened by the lack of succession planning for when the established key drivers hang their hats up. Currently the key drivers who have developed and installed the processes that have been created are still active in planning meetings to oversee and protect these processes. The question remains that when these key drivers are no longer engaged, will the management plans suffer as a result? By capturing the procedures and processes that have been designed in SE NSW, there will always be a valuable reference about how it was done and what was learnt. From this reference, future 'key drivers 'can start on the front foot with the knowledge and experience of their predecessors.

References:

Fleming P, Harden B (2003) Guidelines for Preparing a Working Plan to Manage Wild Dogs

WIDE-SCALE PREDATOR CONTROL IN HAWKES BAY: COMMUNITY INVOLVEMENT IN CONSERVATION

Wendy Ruscoe[1], Rod Dickson[2], Campbell Leckie[2], Jan Hania[3] and Al Glen[1]
[1] Landcare Research, PO Box 40, Lincoln 7640, New Zealand
[2] Hawkes Bay Regional Council, Private Bag 6006, Napier, New Zealand
[3] Department of Conservation, Marine Parade, Napier, New Zealand
ruscoew@landcareresearch.co.nz

Increasing concern for biodiversity protection by ratepayers in the Hawkes Bay (on the east coast of New Zealand's North Island) has lead to the establishment of a regional council resourced 'predator control programme'. Community groups and landowners who wish to protect native biodiversity (usually forest remnants within a greater pastoral area) are provided technical support and infrastructure to carry out site-specific pest control. The level of resourcing depends on technical feasibility, level of community support and ecological significance of the site. So far there are over 100 people involved in 23 programmes providing habitat and species protection, and environmental education and advocacy. A condition of the council funding is the collation of pest animal trap catch data for each site. Unfortunately, biodiversity monitoring is not taking place so it is not known if pest control on these individual forest remnants is having the desired benefit, given that both the pests (rodents, cats, mustelids, lagomorphs, ungulates) and native species (birds and invertebrates) can be highly mobile. Landcare Research, in collaboration with the Hawkes Bay Regional Council, Department of Conservation and other community and education groups, are preparing to expand this effort by designing a widescale (~8000 ha) predator control programme that can sit along side current intensive site-based control. At the same time we will recommend suitable native biodiversity 'indicators' that can be monitored to measure the biodiversity benefit of the programme. Indicator species will be those that are known to be threatened by pests and for which monitoring techniques have been developed. Although this expansion will be agency and externally funded, the end goal is to have a programme in place that the local community can run and used as a prototype for other community conservation initiatives.

TWENTY YEARS OF SUCCESSFUL COMMUNITY POSSUM CONTROL

Steve Ellis
Taranaki Regional Council
Private bag 713 Stratford 4332, New Zealand
steve.ellis@trc.govt.nz

Possums are the most significant pest in the Taranaki region. As a consequence, for the purposes of protecting animal health, agricultural production and environmental values, the Taranaki Regional Council have declared them to be pests in its *Pest Management Strategy for Taranaki: Animals*.

For a couple of decades now, the community has confirmed and re-iterated the need to control possums as a matter of priority. Considerable public investment has underpinned the control of possums, which involves the Council providing a range of direct control and regulatory services.

Because of the sheer scale of the problem, including the high possum numbers, the Council early on adopted a long term solution to their control – the Self-help Possum Control Programme. The Taranaki Regional Council initiated the Self Help Programme in 1992 as a result of a TB outbreak in the coastal area of Rahotu. The concept was immediately successful both in community support and the effectiveness of the control.

The Self-help Possum Control Programme essentially involves the Council undertaking the initial possum control, 'knocking' numbers down to very low levels, and thereafter applying rules requiring the land occupier to maintain possums at those low levels. In bite size chucks the Programme has been incrementally expanded over time to cover new areas and now covers the whole of the Taranaki ring plain. The size of the Programme is significant – it is the largest in the country covering 225,000 ha and involving approximately 3,750 landowners who are successfully maintaining low possum numbers.

Facilitating and supporting the land occupier's control of possums is a major component for the ongoing success of the Programme. Maintenance must be undertaken by the land occupier. The Council monitors, provides advice and co-ordinates maintenance. Where necessary, it also enforces rules to undertake control.

The Programme is not about the Council taking ownership of the problem (and assuming all the costs). Instead it is about empowering and supporting the community.

This presentation will look in more detail at New Zealand's longest running and largest community-led possum control programme. We will discuss the need for community support, sensible rules and a willingness to enforce them. The importance of information gathering and technology and the role of contractors will also be covered.

COMMUNITY-ACTION TO TACKLE AN INVASIVE PEST: THE SUCCESSFUL CANBERRA MODEL

Bill Handke
President, Canberra Indian Myna Action Group Inc.

Indian (or Common) Mynas (Acridotheres tristis) have become a highly visible and noisy pest species in urban areas along the Australian east coast and inland. People generally have a strong aversion to these introduced birds: this stems from the significant environmental threat posed by mynas to native wildlife and the fact that they are a major nuisance in urban areas due to their noisy manner and their habit of fouling backyard living areas (eg patios and barbeque areas).

Trapping has proven to be a highly successful method of control, or at least in significantly reducing mynas numbers. The most successful experience of trapping Indian Mynas has taken place in Canberra where trapping has significantly reduced myna numbers over a four year trapping program: reducing them from being the 3^{r} most common bird in the Canberra / Queanbeyan district in 2006 to the 14th in 2009.

The key to success has been community-action, based on community education, high profile promotion and organizational networking. Rather than relying on government to undertake a formal control program, the Canberra community has undertaken its own grassroots massive backyard trapping program: with 1,130 members (some 900 with easy-to-make traps) the Canberra Indian Myna Action Group (CIMAG) has set a new model for dealing with a major pest species.

The Canberra model has some core features that have been critical to success. These include community education, dev eloping an informed and concerned community, networking with core community groups (eg RSPCA) and opinion leaders, a straight forward strategy able to be implemented by individuals with little effort and little cost, low cost group administration and an easy means of disposal of trapped birds.

The innovative program has now spawned over 26 such community movements across eastern Australia, but with a twist developed by CIMAG to reflect the different circumstances in states with local councils. The approach, an integrated Community-Local Government Model, provides a low cost, high impact strategy by local government to facilitate a community-action program.

The lessons from Canberra are readily applied to other urban communities and for similar urban pest species.

IS WESTERN VICTORIA SOUTH AUSTRALIA'S NULLARBOR? KEEPING COMMON (INDIAN) MYNAS OUT OF SOUTH AUSTRALIA

Peter Bird
Biosecurity SA, Box 1671 Adelaide SA 5064
peter.bird@sa.gov.au

The Common (or Indian) Myna *Acridotheres tristis* was introduced to Melbourne in 1862 and quickly colonised the city and suburbs. Further introductions assisted the successful near-continuous colonisation of 3,000 km of eastern Australian seaboard Melbourne to Cairns. Yet 148 years later, mynas have not colonised much of central and western Victoria. Several characteristics are identified which help explain their conservative spread and provide hope that their populations can be slowed, halted or even reversed.

Mynas are:

Sedentary: a dumpy body and short broad wings are not built for a roaming lifestyle. While mynas still have the capacity to fly reasonable distances, they tend not to. Dispersal is mostly very incremental with cumulative rates of spread west of Melbourne less than 1 km/yr.

Commensal: mynas are closely tied to humans and their cities, towns and intensive agriculture. They avoid open grasslands and closed forest habitats. Much of western Victoria is either too open or too closed for comfort. Dispersal is via modified edge habitats associated with arterial transport routes and using farm houses etc. as stepping stones. Commensalism aids detection and enables low-cost, backyard control methods.

Climatically ill-matched: bioclimatic models suggest that cold, wet and windy western Victoria is ill-suited to warmth loving mynas. Mynas do OK in townships where warmer microhabitats and high quality foods buffer against climatic extremes, but they struggle to bridge the intervening areas.

Social: mynas are flockers, especially in cooler months when they congregate in conspicuous post-breeding roosts. Flocks are more easily detected than individuals and trapping and other control methods can exploit social behaviours.

Unpopular: mynas have a range of bad habits which put them near the top of the people's choice awards as Australia's most unpopular pest. They raid orchards & pet bowls, make noise & smell, poo on stuff, block gutters with their nests and drive native birds out. Universal unpopularity helps when recruiting support for community control programs.

Conspicuous: mynas are loud in every respect. They are distinctive, noisy, terrestrial, confiding, commensal, social and extrovert, all of which aids detection.

Controllable: The Canberra Indian Myna Action Group and other groups have shown that community based programs utilising volunteer backyard trappers can be extraordinarily successful in reducing myna numbers. Control at nest boxes and shooting in rural areas are likely to be useful supplementary techniques, especially to deal with trap shy individuals.

The fact that mynas have a number of 'Achilles heels' gives some hope that buffer zones can be identified and the brakes put on their spread. If nothing else then at least a discussion needs to be had, rather than simply accepting the inevitable if no action is taken.

BIOLOGY, MANAGEMENT AND CONTROL OF INVASIVE TILAPIA IN NORTHERN AUSTRALIA

D. John Russell[12], Fiona Thomson[12], Paul Thuesen[12] and Trent Power[1]
[1]Queensland Department of Employment, Economic Development and Innovation,
Northern fisheries Centre, PO Box 5396, Cairns, Q., 4870
[2]Invasive Animals Cooperative Research Centre, University of Canberra ACT 2617
john.russell@deedi.qld.gov.au

Two species of tilapia, *Tilapia mariae* and *Oreochromis mossambicus*, have been progressively colonising watercourses in Queensland and Western Australia since the early 1970s. If left unchecked, both species have the potential to cause losses to biodiversity by rapidly increasing their population sizes and dominating native fish faunas. Current control measures are mostly restricted to public education, limited spot eradications using chemicals, fishing and the installation of expensive screens. The Invasive Animals Cooperative Research Centre jointly funded a detailed study of invasive tilapia populations to identify potential vulnerabilities in their life history that could be exploited to manage infestations. During this study over 8000 fish from both species were sampled from established populations in north-eastern Queensland. The samples were used to determine reproductive seasonality, movements, fecundity, age structure, size- and age-at-first maturity and the prevalence of stunting. These data were also used in the development of a model to determine and demonstrate the efficacy of various management scenarios on tilapia populations. Finally, a 'toolkit' that will contain relevant information on invasive populations of tilapia including their biology, ecology, impacts and management is being developed for use by a wide cross-section of interested stakeholders.

GENETIC OPTIONS FOR THE CONTROL OF INVASIVE VERTEBRATES: CURRENT STATE OF THE ART

Ronald Thresher
CSIRO Marine and Atmospheric Sciences and the Australian Invasive Animal Cooperative Research Centre,
GPO Box 1538, Hobart, Tasmania
Ron.Thresher@csiro.au

Over the last decade, Australian and overseas scientists have been examining a number of different options for reducing pest populations through use of (potentially) species-specific genetic technology. These technologies divide into three broadly different areas: (1) a virally-vectored genetically modified agent that sterilises the pest, (2) genetic modifications that are stocked via carriers into the target population, reducing its fertility or increasing mortality, and (3) genetic constructs that render stocked individuals sterile while retaining their reproductive competitiveness. This talk outlines the theoretical underpinnings of the different approaches, the situations for which each was developed and in which each might be effective, and their logistical, social and technological constraints. It also summarises the state-of-development of each technology, which ranges from, essentially, production ready and demonstrated as viable through to conceptually feasible, but largely unexplored experimentally.

KOI HERPESVIRUS (KHV): ITS POTENTIAL AS A BIOLOGICAL CONTROL AGENT FOR CARP IN AUSTRALIA

Kenneth A McColl[1], Agus Sunarto[1], Lynette M Williams[1], Paul Brown[2], Dean Gilligan[3], Keith Bell[4], Iain East[5], **Mark StJ Crane[1]**
[1]AAHL Fish Diseases Laboratory, Australian Animal Health Laboratory, CSIRO Livestock Industries,
Private Bag 24, Geelong, VIC 3220
[2]Fisheries Victoria, Department of Primary Industries, Marine and Freshwater Fisheries Research Institute,
Private Bag 20, Alexandra, VIC 3714
[3]Batemans Bay Fisheries Centre, Fisheries and Ecosystems Research, Department of Industry and Investment,
PO Box 17, Batemans Bay, NSW 2536
[4]K & C Fisheries Global Pty Ltd, PO Box 1269, Sale, VIC 3853
[5]Epidemiology Program, Office of the Chief Veterinary Officer, Department of Agriculture, Fisheries and Forestry,
GPO Box 858, Canberra ACT 2601
kenneth.mccoll@csiro.au

Evaluation of the feasibility of using Koi Herpesvirus (KHV), also known as Cyprinid Herpesvirus 3 (CyHV-3), as a biological control agent for carp in Australia is currently being undertaken at the high level bio-secure facility located at the Australian Animal Health Laboratory, CSIRO Livestock Industries, Geelong (McColl et al 2007). The project aims to demonstrate that the lineage of common carp present in Australian waters is susceptible to infection and disease when exposed to KHV. Ideally, use of KHV as a biological control agent should induce high mortality in carp under Australian conditions while other species of aquatic animals remain refractive to infection and/or disease.

As part of the project, a number of tools, qPCR specific for KHV, virus isolation in cell culture, immunoassays for detection and identification of KHV were established to facilitate this research. Thus it has been shown that carp sampled from Australian waters are highly susceptible to infection and disease, carp hybrids appear to be less susceptible and other species of finfish are refractory to infection. It is likely that demonstration of resistance to infection by a range of other key species of aquatic animals will be required before use of KHV as a control agent can be considered.

Recent progress on other aspects of the project, survey of carp for related viral infections, preliminary survey to determine prevalence of carp hybrids in SE Australian waterways, as well as plans for further research will be presented.

References

McColl KA, Sunarto A, Williams LM and Crane MStJ. 2007. Koi herpesvirus: dreaded pathogen or white knight? Aquaculture Health International Issue 9 May 2007 Pp 4-6.

THE IDENTITY, FUNCTION AND APPLICATION OF A FEMALE SEX PHEROMONE IN THE COMMON CARP

Peter Sorensen and Hangkyo Lim
Department of Fisheries, Wildlife and Conservation Biology
1980 Folwell Avenue
University of Minnesota
St. Paul, Minnesota 55108
psorensen@umn.edu

Pheromones, chemical cues that pass between members of the same species, have long been used to control insects and appear to have similar potential to control invasive fishes. This study first investigated the possibility that female carp release sex pheromones that attract males, and then explored what they might be and how they could be produced. Initial laboratory studies established that male carp do not recognize sexually-active female carp unless they can smell them (i.e. there is pheromone). Laboratory maze experiments next established that ovulated, sexually active female carp release a potent sex attractant which is species-specific. Chemical fractionation found that this odor has both polar and non-polar components and that prostaglandin F2a (PGF2a) is the primary compound in the later fraction. However, while we found that PGF2a is potent on its own (10-11 Molar detection threshold), we also discovered that full activity is only achieved when it is added to the polar fraction (whole fish body odor). Accordingly, we developed osmotic pump implants to continuously introduce PGF2a into donor fish so that they naturally excrete it along with the polar components of the pheromone to effect 120super-normal pheromone release. This technology is both inexpensive and nontoxic, and can produce potent plumes for up to two weeks which are active when diluted over 10,000 times. Field studies that have placed implanted female carp into Midwestern lakes which contain radio-tagged male carp find that pheromone donors attract large numbers of carp from distances of up to 50 m to within a few m of trap/release points. Similar results are also reported from Tasmanian lakes. Trap-netting is now being developed to capture to localized aggregations of adult carp induced by pheromone donors. We conclude that sex pheromones have the potential to serve as an important component of targeted integrated pest management strategy for invasive carp. (Funded by the Invasive Animals Cooperative Research Centre).

UNDERSTANDING TILAPIA DISPERSAL, DIURNAL MOVEMENTS, AND HABITAT USAGE IN NORTHERN AUSTRALIA

Fiona E. Thomson[1 2], D. John Russell[1 2], and Paul Thuesen[1 2]
[1]Northern Fisheries Centre, Queensland Department of Employment Economic Development and Innovation, PO Box 5396, Cairns Qld 4870
[2]Invasive Animals Cooperative Research Centre, University of Canberra ACT 2617
fiona.thomson@deedi.qld.gov.au

Mozambique tilapia (*Oreochromis mossambicus*) is one of the world's top 100 most invasive alien species. We are currently using acoustic telemetry to characterise intra-waterbody movements and habitat usage of a population in a small weir in northern Australia. Tag retention rates for three different types of approximately 7 mm diameter replica transmitters (externally attached, internally implanted, and internally implanted with an external whip antenna) were determined in a three month tank trial experiment. All externally attached tags were shed during the experiment and 80% of fish with internally implanted tags with external antenna died. *O. mossambicus* with internally implanted tags were found to have the highest tag retention and survival rates. Following this trial, ten mature fish (five males and five females) were surgically implanted with acoustic telemetry tags (Vemco© VP9) that also incorporated a pressure sensor to gauge fish depth. Tagged fish are currently being tracked in the weir system using fixed receiver stations (Vemco© VR2W). The results of this study will increase our understanding of the diurnal movements, dispersal and habitat usage of *O. mossambicus* in tropical Australian impoundments and will assist in the design of more effective management and control programs.

SOCIAL RESEARCH AND OTHER STRATEGIES TO REDUCE THE RISK OF THE PEST FISH TILAPIA ESTABLISHING IN THE MURRAY-DARLING BASIN

Debra Ballagh[2], Jane Frances[2] and Danielle Stewart[1]
[1]Fisheries Queensland, Department of Employment, Economic Development & Innovation
[2]Industry & Investment NSW
Murray Darling Basin Authority

Tilapia is the common name given to fish from the genera *Oreochromis*, *Sarotherodon*, *Serranochromis* and *Tilapia*; all from the Cichlidae family. These varieties of tilapia were previously traded in the Australian aquarium industry. They are now considered to be one of the world's worst 100 invasive species.

Tilapia are extremely hardy fish with highly efficient breeding strategies (including mouthbrooding), simple food requirements and flexible habitat preferences. In recent years, the Mozambique mouthbrooder (*Oreochromis mossambicus*) has established successful breeding populations in southern Queensland and has the potential to survive over winter and reproduce in the warmer months in the Murray-Darling Basin. If tilapia were to establish in the basin it would be considered a major threatening process to the recovery and survival of freshwater fish species and the general habitat health. Its rate of spread, both in Queensland and internationally, suggests that a single incursion has the potential to lead to invasion of the entire basin. As the species is now found in southern Queensland, the risk of invasion southwards into the Murray-Darling Basin is high. Measures are urgently needed to prevent this occurrence.

This project aims to reduce the risk of tilapia incursion and/or establishment in the Murray-Darling Basin by undertaking initiatives to investigate social attitudes, provide community education, enhance the response capability of agencies and stakeholders, and provide prediction and monitoring tools and actions. Some of the objectives and methods used in this project are discussed with particular reference to the role of social research.

RODENTICIDE USE IN RODENT MANAGEMENT IN THE UNITED STATES: AN OVERVIEW

Gary Witmer and John Eisemann
USDA/APHIS/WS, National Wildlife Research Center, 4101 Laporte Avenue, Fort Collins, CO 80521-2154 USA
gary.w.witmer@aphis.usda.gov

Rodents occur worldwide and have adapted to most types of ecosystems. Rodents provide many important ecosystem functions and while most rodent species do not cause serious damage problems, a small number of species do. Rodent-caused damage includes crop and stored food consumption and contamination, forestry and nursery damage, rangeland damage, ornamental plant damage, property damage, cable and irrigation pipe damage, disease transmission, and, when introduced to islands, damage and even extinction of native flora and fauna. Many tools are used to reduce rodent populations and damage. Rodenticides are an especially important tool in rodent management. Many types of active ingredients and formulations are available for different species and situations. Rodenticides and their use are regulated by the U.S. Environmental Protection Agency (EPA) and authorized State agencies. Following regulatory review, the approved label dictates how the product must be used and who has authority to use the product. All labels contain mitigation measures to reduce the risk to workers, consumers, pets, livestock, non-target animals and the environment. Recently, the EPA has been re-evaluating many of the major rodenticides as part of the periodic re-registration process. To reduce the number of accidental exposures by children and impacts to non-target wildlife, the EPA has proposed new mitigation measures to reduce the hazards of certain rodenticides that are used in and around homes and other buildings. If implemented as proposed, these mitigation measures may affect the availability of some of the most common rodenticides. Research is underway to evaluate potential new rodenticides such as sodium nitrite.

FACTORS THAT INFLUENCE MOUSE INFESTATION AND DAMAGE LEVELS IN GRAIN CROPS: LANDHOLDERS' PERSPECTIVES

Greg Mutze
BiosecuritySA, GPO Box 1671, Adelaide SA 5001

Mouse plagues cause irregular but severe damage in dryland grain production enterprises of southern Australia. The frequency of mouse plagues and crop losses appears to be increasing, probably due to reduced tillage in cropping systems, stubble and trash retention, and reduced livestock numbers in mixed farming systems, all of which increase the food and cover available to mice. In 2010, a severe plague of mice affected →20,000 km of central and western Eyre Peninsula in South Australia, and smaller areas in central South Australia. Mice caused widespread damage to recently-sown winter crops, including wheat, barley, canola, peas and lentils. There was substantial variation in damage within and between farms. Grain-growers generally considered that crop damage had been much greater than in previous severe mouse plagues, but opinions varied about agronomic causes and remedies. This paper reports preliminary findings from a survey of landholders to determine which factors had been most influential in promoting high mouse numbers in paddocks and/or managing those infestations to establish crops. Landholders considered infestations to have been higher, all other things being equal, where the previous year's (2009) grain yields had been exceptionally high, where hail or wind damage dropped maturing heads before harvest, where more grain had been spilled at harvest, on sandy or stoney soils vs. heavier soils, in stubbles vs. pastures, in ungrazed vs. grazed stubbles or pastures, adjacent verge areas with heavy nut-grass or spear-grass cover, in tall standing stubbles vs. those that had been knocked down in summer by rolling, slashing, prickle-chaining, disc-chaining or burning, and in crops with any persistent weed problems. In infested paddocks, mouse damage at sowing was reduced by early sowing, increased sowing depth (4-6 cm vs. 1-3 cm), incorporating stubbles before or at sowing, and in cereals sown into canola stubble vs. canola sown into cereal stubble. Estimated yield losses during crop establishment in the worst infested crops on each farm varied from 0-70%, and averaged 30%, with much of the variability attributed to the timing and efficacy of baiting. Baiting efficacy was improved by baiting at or immediately after sowing vs. 4 days to a week later, use of registered zinc phosphide products at recommended rates vs. other approaches, and effective summer weed control, especially of melons (i.e. persistent weed problems were considered to have increased mouse numbers and also made them harder to control with bait). This information has been made available through meetings of growers and agronomists, and through web-based fora, to help management the high potential for mouse damage in the 2011 cropping season.

POPULATION DYNAMICS OF HOUSE MICE IN QUEENSLAND GRAIN-GROWING AREAS

Tony Pople[1] and Peter Cremasco[2]
[1]Biosecurity Queensland, Department of Employment, Economic Development and Innovation,
GPO Box 46, Brisbane Qld 4001
[2]Department of Primary Industries, Parks, Water and Environment, PO Box 46, Kings Meadows Tas 7249
tony.pople@deedi.qld.gov.au

Regular trapping of mice at the same sites on the Darling Downs in southern Queensland has been undertaken since 1974. This has provided an index of abundance over time that can be related to rainfall, crop yield and area, winter temperature and past mouse abundance. Other sites have been trapped over a shorter time period elsewhere on the Darling Downs and in central Queensland, allowing a comparison of mouse population dynamics and cross-validation of models predicting mouse abundance.

On the regularly-trapped transect on the Darling Downs, damaging mouse densities occur every second year and a plague every four years, but there has been no detectable increase in mouse abundance over the past 35 years. High mouse abundance on this transect is not consistently matched by high abundance in the broader area, even for nearby locations, so monitoring the transect does not provide a warning system for the Darling Downs. However, a predictive model developed from the transect data can forecast future mouse abundance, but there is uncertainty in the prediction. The model includes autumn-winter rainfall in the previous year, overlooked as predictor of mouse abundance in previous analyses of these data, but well recognised as an important predictor of mouse abundance in cropping areas in southern Australia. Local (i.e. farm-based) monitoring of mouse abundance in spring can indicate the potential for an outbreak as part of a model rather than any threshold such as 1% trap success which is unreliable.

BITE BACK – A COMMUNITY BASED WILD DOG MANAGEMENT PROGRAM IN THE ARID ZONE OF SOUTH AUSTRALIA

Heather Miller
SA Arid Lands Natural Resources Management (NRM) Board

South Australia lists the dingo (*Canis lupus dingo*) as a declared pest when it exists south of the Dog Fence. While control was once focused on a buffer zone near to the exclusion fence, it has now become necessary to manage this pest in a larger area of pastoral lands, where incursion of wild dogs, and subsequent population increases and resultant predation have reduced viability for many sheep farms. Declining labour in the region and the mosaic of land use for sheep, cattle and conservation pose special problems for wide-scale control programs.

Funds from the SA Sheep industry and Arid Lands NRM Board were applied to a 3 year program named "Bite back" to:

- Establish local groups across tenure boundaries
- Coordinate local bait preparation and training days
- Improve awareness of the problem and the various means to address it using an integrated approach involving all available control techniques as appropriate
- Survey and monitor wild dog populations both numerically and geographically
- Promote the program through broadcast and printed media channels

One objective was to reduce reliance on *ad-hoc* reactive approaches and move all participants towards a strategic approach involving a sustained program to achieve the best possible landscape-scale outcomes. The program has an element of sustained empowerment that will lead to "ownership" of the control measures by participants and hopefully a continuation of the program beyond the initial funding period.

In its first year 84% of landowners in the worst affected areas were involved and in subsequent years an additional 62% of landowners in three adjacent areas were engaged. The total area of management in Bite Back now exceeds 250,000 square km (an area equivalent to the size of Victoria). The program is integrated with national initiatives including the National Wild Dog Advisory group and the state level coordinating bodies. The program acknowledges the inputs of an unwavering group of sheep farmers and has generated an improved understanding of, and increased capacity to address, wild dog problems at a landscape scale.

BENEFITS OF APPLIED GENETICS TO INVASIVE PEST ERADICATION AND MANAGEMENT PROGRAMS

Jane Oakey
Biosecurity Queensland, Health and Food Science Precinct,
PO Box 156, Archerfield, QLD 4108
jane.oakey@deedi.qld.gov.au

Biosecurity Queensland is faced with the notoriously difficult tasks of understanding pest incursions and subsequent eradication or management. Pest species often behave differently in new territories and data observed from native or previous sources cannot be relied upon to provide accurate assessments and predictions of the pest population in Queensland. The application of a fit-for-purpose Queensland genetic program provides real and definitive information providing detailed detection, breeding and movement data invaluable to the successful eradications of invasive pests from our environment. This presentation will discuss the benefits of the genetic work, and their incorporation into a number of Biosecurity Queensland programs aiming to eradicate class 1 pests in Queensland.

A demonstration of molecular surveillance tools will be illustrated with techniques that Biosecurity Queensland have developed for the task in hand, and used to resolve some of the problems that may arise from conventional surveillance methods. Examples of marine and terrestrial pest surveillance will be shown where genetic tools can be used to detect the presence of a pest, even where the pest itself is not sighted.

Additionally, the role and advantages of genotyping techniques to determine and understand the spread of pests through application of population genetics and forensic-like methods will be presented. This is supplemented with examples from a number of exotic and invasive animal and plant pest programs. Numbers of incursions, development of new clusters, relatedness between samples and parentage testing have all been used by Biosecurity Queensland to enhance studies and understanding of spread of pests.

Finally, some of the issues encountered with the implementation of quality management to techniques that were previously considered to be research tools only will be presented.

ASSESSING THE SOCIAL IMPACTS OF WILD DOG MANAGEMENT

Patty Please[1], Saan Ecker[1] and Darryl Maybery[2]
[1]Australian Bureau of Agricultural and Resource Economics and Sciences (ABARES), GPO Box 1563, Canberra ACT 2601
patty.please@abares.gov.au and saan.ecker@abares.gov.au
[2] Department of Rural and Indigenous Health, Monash University, PO Box 973, Moe, Victoria, 3825
darryl.maybery@monash.edu

It is widely reported that farmers experience mental and emotional impacts as a result of wild dog attacks on their livestock. Previous studies have indicated a high level of social-psychological impact but there has been a lack of quantitative measurement to define the severity of that impact.

This paper details the framework, progress and initial results of a social impact assessment of wild dog management being undertaken as part of a larger integrated study to assess the agricultural, environmental and social benefits of investing in wild dog management. The social impact assessment has two main components: 1) analysis of social impact data from the national survey 'Understanding stakeholders' attitudes towards the adoption of new pest control methodologies', which includes livelihood and stress impacts; and 2) an in-depth qualitative and quantitative enquiry into the psychological/stress impacts of wild dogs on a sample of individuals in three case study areas. This will assist in assessing traumatic responses to wild dog critical events in comparison with other critical or traumatic events like bushfires.

The social impact information derived from this project will be combined with information on productivity losses and other economic impacts, potentially supporting future resourcing decisions associated with the wild dog issue.

ASSESSING THE RETURNS ON INVESTMENT IN WILD DOG MANAGMENT: A BROADER ANALYTICAL FRAMEWORK

Santhi Wicks, Kasia Mazur, Benjamin Buetre, Saan Ecker, Patty Please, Bertie Hennecke, Clay Mifsud
Australian Bureau of Agricultural and Resources Economic and Sciences (ABARES), GPO Box 1563, Canberra ACT 2601
santhi.wicks@abares.gov.au

Wild dogs are one of the vertebrate pest animals that have become established in many locations across Australia. Previous studies assessing the impacts have concentrated on valuing the commercial effects of wild dogs. This paper details the methodology and data requirements to build an integrated framework to assess the agricultural, environmental and social benefits of investing in wild dog management, to help in prioritising future investments in the management of this pest animal. The framework contains three components; an economic assessment of the impacts on agriculture, a non-market valuation approach for quantifying the environmental and social impacts and methodology for integrating these values within the cost-benefit (CBA) framework.

SUNSET ON BLUESKY NON-INDIGENOUS ANIMAL INDUSTRIES: AN OUTLINE OF PROPOSED AMENDMENTS TO THE NON-INDIGENOUS ANIMALS REGULATION 2006

Nathan Cutter, Lee Cook,
Industry and Investment NSW, 161 Kite St, Orange NSW 2800

Non-indigenous animals are a feature of everyday life for many Australians. Most pets and agricultural animals as well as many of the amphibians, reptiles, birds and mammals housed in zoos, wildlife parks and private facilities located throughout NSW consist of non-indigenous species. Many non-indigenous animals introduced to Australia pose significant potential risks to agriculture, the environment and in some instances human health and safety.

Non-indigenous animals kept in NSW are partly regulated through the Non-Indigenous Animals Act 1987 and the dependent Non-Indigenous Animals Regulation 2006. The Act's main purpose is to control and regulate the entry of higher risk non-indigenous animals into NSW and the movement and keeping of those animals within the state. Other significant regulatory controls are applied via the Exhibited Animals Protection Act 1986 and its associated subordinate legislation.

Appropriate regulation of non-indigenous animal species has the potential to reduce the risk of non-indigenous animals establishing populations in the wild and causing damage to the environment, agriculture and community assets. In NSW all regulations are reviewed and remade every 5 years to ensure they are still reasonable and appropriate for meeting the objectives of the enabling Act.

As part of this process the NSW Government is reviewing the Non-Indigenous Animals Regulation this year and the proposed amendments will go on public exhibition before being made. Some proposals for amendment will aim to reduce the risks posed by non-indigenous animals and bring the Regulation in line with national standards. The following are examples of just two of the proposals to improve the Regulation:

NSW currently licenses people to keep and breed the Northern Palm Squirrel, Funambulus pennantii which is scheduled as a high-risk category non-indigenous species. Within this legal environment business ventures have developed to breed and sell Northern Palm Squirrels to the public, capatilising on a current exemption from licensing for privately kept, sterilised and suitably identified Northern Palm Squirrels. The proposed amendments to the Regulation will remove the exemption from keepers of Palm Squirrels to require a licence in order to reduce such demand and reduce the risk of escape of breeding populations of Palm Squirrels from operations supplying this market.

Similarly, a significant industry in American Bison, Bison bison appears to be developing as a growing number of people seek bison to train cutting horses and as bison breeders look at marketing of bison meat. The development of such "industries" significantly increases the potential for bison to escape and to become feral. As with the Northern Palm Squirrel, American Bison have been identified as posing an extreme risk of establishing such feral populations. For this reason amendments are proposed to increase controls on the keeping of American Bison consistent with their identified risks.

AN EMERGENCY RESPONSE TO A NEW EXOTIC INVASIVE VERTEBRATE IN AUSTRALIA - THE DRAFT NATIONAL ENVIRONMENTAL BIOSECURITY RESPONSE AGREEMENT (NEBRA)

Mr Andrew Copp[1], Mr Damian McRae[1], Dr Julie Quinn[1], Dr John Virtue[2]
[1] Australian Government, Department of Sustainability, Environment, Water, Population and Communitities
[2] Department of Primary Industries and Resources of South Australia

The draft National Environmental Biosecurity Response Agreement (NEBRA) proposes a framework for how Commonwealth and state and territory governments are to respond to a nationally significant biosecurity incident from a pest (vertebrate or invertebrate), weed or pathogen impacting on Australia's environment or social amenity. It has been used as a template to inform the national significance of two emergency responses for invertebrates (red imported fire ant and electric ant in Queensland). A detection of a new exotic invasive vertebrate pest species would require an assessment of the level of risk and national significance to the environment, people and business. This presentation will look at the degree of preparedness, emergency response and organisational arrangements needed to effectively respond to a national emergency response to a new detection of a significant vertebrate pest species.

[1] Australian Government Department of Sustainability, Environment, Water, Population and Communities

[2] Australian Government Department of Agriculture, Fisheries and Forestry

[3] Department of Primary Industries and Resources of South Australia

VICTORIAN APPROACH TO PREVENTION AND PREPAREDNESS FOR INVASIVE ANIMALS

Simon Martin, Gina Paroz, Susan Wisniewski, Melinda Corry
Department of Primary Industries, Spring Street, Melbourne VIC 3001

What can we learn from a decade of investment in operations to seize, intercept and accept surrendered and found 'at large' high risk invasive animals in Victoria? What can 10 years of data relating to the interception of invasive animals at our borders tell us about our strategic approach to preventing the establishment of new invasive animals in Victoria in the future?

A whole lot.

By using what we know about the existing and identified pathways for invasive animal introduction we can aim to strengthen our surveillance for potential threats of the future. By describing our overall approach to prevention and being able to demonstrate to the community that by planning for potential incursions and by being prepared, we are allocating appropriate and relevant resources toward meeting our prevention and preparedness goals. We can also engage with those who can help us to enhance our structured surveillance programs, to look where we might not have looked, or had the resources to look before.

To extend this further we can incorporate the learnings from species risk assessments, with the ability to plan for potential incursions prior to them ever occurring. We can document the steps that would be taken should prevention fail (despite our best efforts) and an incursion occur. We can develop and follow stringent response procedures to ensure that early actions are undertaken and are monitored for success. With a clear and documented approach to prevention and preparedness in Victoria, we are better able than ever before to minimise the establishment of potential high risk animal invaders.

How we are working towards this under the "Extending Victoria's prevention and early response capability for new and emerging species" project will be discussed.

INCURSIONS AND INTERCEPTIONS OF EXOTIC VERTEBRATES IN AUSTRALIA

Wendy Henderson[1], Mary Bomford[1] and Phillip Cassey[2]
[1]Invasive Animals Cooperative Research Centre, University of Canberra, ACT 2601
[2] University of Adelaide, Adelaide SA 5005

Of the 81 species or more of exotic vertebrates established in Australia, over 30 are considered pests (Bomford and Hart 2002). The accidental or illegal import, and the illegal keeping, of live exotic vertebrates pose risks of introducing further pests in the future. Environmental releases hasten the spread of already established exotic populations, increasing the risk of threats to native species, domestic animals and people. Preventing and minimising such incursions is clearly of significant benefit to Australia.

Records of environmental incursions and interceptions (seized, surrendered, stolen, smuggled and stowaway animals) have been collected for exotic vertebrates on a national scale from the past decade. The variation in reporting by different agencies, and the range and numbers of species that have been reported will be presented. Assessments of species' establishment and pest potential will be discussed. Continued vigilance, improved communication and tighter regulation will be the keys to preventing further incursions and minimising the chances of new pest species establishing here.

Reference:

Bomford, M. and Hart, Q. (2002). Non-indigenous vertebrates in Australia. In '*Biological Invasions: Environmental and Economic Costs of Alien Plant, Animal, and Microbe Invasions.*' (Ed. D. Pimental.) CRC Press, New York. Pp 25– 44.

FROM PETS TO PESTS – ASSESSING & MANAGING HIGH RISK PET SPECIES

Jaap Knegtmans, Erik Van Eyndhoven
Ministry of Agriculture and Forestry, P O Box 2526, Wellington 6140, New Zealand
jaap.knegtmans@maf.govt.nz

Pets are those animals kept for companionship and amusement. While pets are highly valued by society, there are many examples worldwide of pet species that established in the wild and have become invasive. In New Zealand strict controls apply to the legitimate new introductions of pets from overseas, but for most of the 1500+ pet species currently in New Zealand there are limited barriers to their possession or trade. Problematically, not all of these species have been subject to formal biosecurity risk assessments. Evidence is emerging that several pet species in New Zealand could establish in the wild. This could lead to additional impacts on environmental, economic, social/cultural and human health values, and greater pest management expenditure. The parasites and pathogens hosted by these species are also of concern. The Pet Trade Project is a partnership initiative involving industry and biosecurity agencies, tasked with addressing the key knowledge gaps and finding enduring ways to mitigate the biosecurity risks posed by pets. The aims and objectives of the project and how central and regional government and the pet industry are working together are discussed.

ESCAPE OF EXOTIC SPECIES FROM ZOOS: A HISTORICAL REVIEW AND FUTURE RISK MANAGEMENT MEASURES

Carolyn Hogg
Zoo and Aquarium Association,
PO Box 20, Mosman, NSW 2088.
carolyn@zooaquarium.org.au

Historically acclimatization societies, private individuals and zoological gardens were responsible for the acquisition and importation of exotic species into Australia. The role of acclimatization societies and zoos differed greatly in that zoos were established to showcase exotic species to the public, whilst the philosophy of acclimatization societies was to "make the settlers feel more at home". There is some belief that zoos are the pathway for future establishment of exotic species in Australia. A historical overview of escapes from Australian zoos was conducted to ascertain the potential areas of risk from zoo-based exotic species. The Zoo and Aquarium Association Australasia is the peak body for the zoo and aquarium industry in the region. The Association's intent is to bring our members together to act as one in furthering education, research and conservation, in addition to maintaining and developing professional standards and best practice. Currently there are 38 exotic species licences in Australia of which 30 institutions (79%) are members of the Association. In order to become a member of the Association, institutions need to show industry best practice in the welfare and holding of animals, financial viability and succession planning. To further facilitate the risk management of zoo-based exotic species, a series of species management practices have been implemented, such as the use of captive management plans and the transaction of managed species to non-Association institutions.

THE ROLE OF PROPAGULE PRESSURE AND THE ONGOING RISK OF EXOTIC BIRDS TO AUSTRALASIA

Dr Phill Cassey
School of Earth & Environmental Sciences, University of Adelaide, SA 5005

The acclimatisation societies of New Zealand and Australia were among the most active in the British Empire with the aim of "*the introduction, acclimatization and domestication of all animal, birds, fishes, and plants, whether useful or ornamental*". The quality of records that were maintained by these societies and subsequently summarised in the secondary literature has meant that this dataset is one of the most highly analysed for any single regional set of an exotic taxon. The influence that this dataset has had on the study of exotic birds is profound. I will discuss how representative the particular set of birds introduced to Australia and New Zealand were for other regions and how ongoing studies can help inform future research and management of invasive birds generally.

AUSTRALIA'S SUSCEPTIBILITY TO ESTABLISHMENT BY NON-INDIGENOUS REPTILE SPECIES: A PREDICTIVE MODELLING APPROACH

Dustin Welbourne
University of NSW @ ADFA, Northcott Dr, Canberra ACT, 2600

Invasive species pose significant social, economic, and environmental impacts; and as global anthropic ubiquity increases non-indigenous flora and fauna are reaching lands that hitherto were geographically isolated. Recent research into invasive species and climate change relationships has emphasized this concern and stressed the urgency to pre-emptively recognise species that have a higher potentiality of establishment. Although legislation prohibits the keeping of non-indigenous reptile species (NIRS) in Australia, many NIRS are confiscated yearly from private collectors and thus pose a significant establishment threat. Despite this, little research has been conducted to assess Australia's susceptibility to establishment by NIRS. This study applies predictive spatial modelling techniques to ten NIRS to produce habitat suitability maps under current and future climate scenarios. Furthermore, this study will ascertain most likely areas of initial establishment by the ten NIRS, which will be critical information for implementing future management procedures.

ARE VERTEBRATE PESTS A DISEASE RISK FOR COMMERCIAL PIGGERIES?

Hayley Pearson[1 2 3], Steven Lapidge[2], Marta Hernández-Jover[1], Jenny-Ann Toribio[1]
[1]University of Sydney, Faculty of Veterinary Science, 425 Werombi Rd, Camden, New South Wales, 2570
[2]Invasive Animal Cooperative Research Centre, 48 Oxford Street, Adelaide, South Australia 5061
[3]Australian Pork Limited, Deakin, ACT 2600
hayley.pearson@sydney.edu.au

Disease introduction resulting from close contact between commercial and feral animals can be devastating to agricultural production causing losses up to billions of dollars (Meuwissen et al. 1999; Productivity Commission 2002). Understanding interactions between free-ranging wildlife and domestic pigs, and the potential for transmission of pathogens, is essential to reduce risk of disease introduction into commercial piggeries and improve on-farm biosecurity practices. This project seeks to quantify the likelihood of pathogen transfer from wildlife that frequent piggeries to the commercial pigs. A nationwide survey of commercial pig producers was conducted in 2007 to identify wild and feral animal species commonly seen on farm. Wild animal incursion was reported by 145 of the 170 (85%) piggeries that responded to the postal survey. Birds were the most commonly observed wildlife in piggeries (78.6%), followed by feral cats (61%) and rodents (46%). As the role of feral cats in piggeries had already been well studied, three other key invasive species, European starlings, rats and feral pigs, were targeted in three separate studies, to identify pathogens that could potentially be transmitted from these species to domestic pigs. Pathogens important for the pig industry in terms of production and/or zoonotic infection were targeted in each survey:

- 473 European starlings were trapped and sampled for Salmonella, *Escherichia coli* and Campylobacter over 2008 and 2009. Fifty were sampled for Avian Influenza, West Nile Virus and Newcastle's Disease Virus in 2008.
- 300 rats were trapped and sampled for *Brachyspira hyodysenteriae*, Salmonella, *Lawsonia intracellularis* and *Brachyspira pilosicoli* in 2009.
- 80 feral pigs have been sampled to date for Leptospirosis, Brucellosis, *Lawsonia intracellularis*, *Mycoplasma hyopneumoniae* and *Actinobacillus pleuropneumoniae* in feral pigs in 2010. Seven pigs have been collared with GPS tracking devices.

Data from the surveys, literature and expert opinion will inform a risk assessment evaluating exposure of each of the pathogens mentioned above to commercial pigs. Results of the exposure assessment will provide information to the pork industry on the level of potential risks from wildlife interactions and opportunities for risk mitigation.

References:

Meuwissen, M. P. M., Horst, H. S., Huirne, R. B. M., and Dijkhuizen, A. A. (1999). A model to estimate the financial consequences of classical swine fever outbreaks: principals and outcomes. *Preventative veterinary Medicine* 42, 249-270.

Productivity Commission. (2002). Impact of a Foot and Mouth Disease Outbreak on Australia. Research Report, AusInfo, Canberra, ACT, Australia.

Abstracts - Day 4

(In Program Order)

EFFECTIVENESS OF ZINC PHOSPHIDE, CHOLECALCIFEROL, AND CHOLECALCIFEROL/ COUMATETRALYL COMBINATION BAITS IN REDUCING HOUSE MOUSE POPULATIONS IN MATURING WHEAT CROPS

Luke K.-P. Leung, Rebecca Diete, Natalie Waller, Anthony R. Pople*
School of Animal Studies, University of Queensland, Gatton, QLD, 4343
*Robert Wicks Pest Animal Research Centre, PO Box 102 Toowoomba QLD 4350

Currently, the only registered rodenticide for in-crop control of house mice in Australia is 2.5% zinc phosphide bait. There is a need to develop an alternative registered rodenticide for this control because of concern that phosphide (or phosphine) residues could possibly lead to an import ban of Australian cereal grains by overseas countries. This study aimed to determine the effectiveness of alternative baits in reducing house mouse populations in maturing wheat crops.

Each bait and a non-toxic control bait was tested at three mouse densities by introducing 6, 12 and 24 captive wild mice into a 15x15m mouse proof enclosure. Bait was applied at 1 kg ha-1 when the wheat was at the doughy stage. The percentage of bait remaining on the ground was recorded for three days. Pre- and post-baiting population size was enumerated by live-trapping.

The survival of mice in pens treated with 2.5% zinc phosphide bait and 0.12% cholecalciferol/0.075% coumatetralyl combination bait differed significantly from the survival of mice in the control pens, indicating that these baits are effective. But the survival rates (0.488 and 0.615) were higher than the nominal rates (t0.3) generally required for registration of rodenticide bait. However, zinc phosphide is already registered for use in all crop growth stage. The survival of mice in pens treated by low- (0.4%) and high-dose (0.75%) cholecalciferol was not significantly lower than the survival of mice in the control pens, indicating that these baits are not effective.

Only 30% of zinc phosphide and 15% of combination bait remained on the ground one hour post-baiting around sunset. The effectiveness of these baits may be improved by increasing their availability to mice by spreading bait at night. The density of mice did not significantly affect bait effectiveness. The effectiveness of combination bait should be tested in immature crops to achieve a lower survival rate required for registering this bait as an alternative rodenticide for in-crop control of mice.

OPTIMISING THE PALATABILITY AND LONGEVITY OF STOAT BAITS

Samantha Brown[1], Bruce Warburton[1], Penny Fisher[1] and Craig Bunt[2]
[1]Landcare Research, PO Box 40, Lincoln 7640, New Zealand
[2]AgResearch, Lincoln Research Centre, Private bag 4749, Christchurch 8140, New Zealand
browns@landcareresearch.co.nz

In New Zealand, introduced stoats (*Mustela erminea*) are significant predators of kiwi chicks (*Apteryx* spp.) and other native bird species. Trapping for stoat control is currently undertaken, but imposes logistical and cost constraints on the frequency and area over which stoat impacts can be mitigated. Additional stoat control tools that are cost effective on a broad field-scale are urgently needed. To address this issue, we sought to identify a highly acceptable stoat bait formulation with an extended field life that could be used for delivery of appropriate poisons. In feeding trials with wild-caught stoats, we screened six different meat bases and →20 different humectant, preservative, binder or palatant compounds for acceptance and palatability. The most acceptable bait base was fresh rabbit mince. Significant differences in bait acceptance between female and male stoats were found, with moisture content of bait identified as an important factor for acceptability overall. A humectant–preservative combination of polyethylene glycol (PEG 20,000) and sorbitol in rabbit mince was identified as optimal, with over 80% acceptance by both male and female stoats and higher palatability (73.5%) than plain rabbit mince. This bait combination was acceptably 'long life' with 80% of stoats eating PEG + sorbitol bait that had been aged for 28 days. This bait formulation thus has useful application in current stoat control programmes especially providing a potential bait for future delivery of selective poisons, such as para-aminopropiophenone, to manage field populations of stoats. Field assessment of the uptake of this bait formulation by stoats is required to confirm its utility.

PROTECTING AGRICULTURE AND THREATENED SPECIES INTERNATIONALLY THROUGH THE USE OF A HUMAN FOOD PRESERVATIVE

Steven Lapidge[1], Jason Wishart[1], Linton Staples[2], Charlie Eason[3], Duncan MacMorran[3], Kathy Fagerstone[4], Gary Witmer[4], Tyler Campbell[4] and John Eisemann[4].
[1]Invasive Animals Cooperative Research Centre, 48 Oxford Terrace, Unley SA 5061.
[2]Animal Control Technologies Australia P/L, PO Box 379, Somerton, Victoria 3062.
[3]Connovation Research, PO Box 58613, Auckland 2141, New Zealand.
[4]USDA National Wildlife Research Center, 4101 LaPorte Ave, Ft Collins, Colorado USA 80521.
steven.lapidge@invasiveanimals.com

In 2005 the Pest Animal Control CRC discovered the potential of sodium nitrite, a common meat preservative that prevents botulism, to be a quick acting, low residue and reversible toxicant for feral pigs. Pigs are particularly sensitive to nitrite-induced methaemoglobinemia as they have a pharmacological weakness in low levels of methaemoglobin reductase, the enzyme required to reverse the effects of nitrite toxicosis. Over the last five years a great deal has been achieved in obtaining funding and a patent to continue and protect the research, formulating nitrite, conducting pen and field trials, assessing the humaneness of the toxicosis, predicting primary and secondary poisoning hazards to non-target species and compiling a registration dossier. Collaboratively and simultaneously nitrite is being developed for feral pig and possum management in New Zealand, and is currently being pursued for wild hog management in America. As nitrite possesses most of the ideal properties of a modern toxicant - human safety, highly toxic to target species, bait deliverable, humane, low/no residues, biodegradable, reversible (antidote), affordable, comprehensive toxicology data available and publicly acceptable - it is currently being investigated for managing a range of invasive species worldwide. This talk will detail progress to date and future plans.

DEVELOPMENT AND REGISTRATION OF A NEW TOXICANT BAIT FOR WILD DOG AND FOX CONTROL

Simon Humphrys[1], Glen Saunders[1,2], Linton Staples[3], Jane Littlejohn[4], Johann Schröder[5]
[1] Invasive Animals Cooperative Research Centre, 48 Oxford Terrace Unley SA 5061
[2] Department of Industry and Investment, Vertebrate Pest Research Unit, Orange NSW
[3] Animal Control Technologies Australia, Vic 3062
[4] Australian Wool Innovation, Sydney NSW 2000
[5] Meat and Livestock Australia, North Sydney 2060
simon.humphrys@invasiveanimals.com

Poisons continue to be the most cost-effective method used for extensive pest animal management and are a necessary mainstay in the management of wild dogs and foxes across Australia. While sodium fluoroacetate (1080) has proven to be a reliable and highly targeted active ingredient for bait manufacture, there is no antidote and the dose which kills a fox poses a risk to all but the largest working dog. This risk prevents some landholders from adopting or participating in effective predator control programs. Ideally, any new chemical control should be more toxic to target species than a majority of non-targets, have a humane and rapid mode of action, be active orally, have a long shelf-life, and be complimented by an antidote. Para-aminopropiophenone (PAPP) exhibits all these characteristics and has been extensively tested for its target species, non-target species and environmental toxicity over the past 8 years. This testing has resulted in registration applications being submitted to the APVMA for the active and 2 new products; a manufactured wild dog bait (DOGABATE®) and a manufactured fox bait (FOXECUTE®) and the development of a readily available antidote package (BLUE HEALER®) to provide additional safety. A feature of the PAPP development for foxes is that it may be possible to reduce the risks to dogs from the dose used to control foxes and this adds further to safety.

The aim of this considerable body of research is the approval of the first new chemical active to manage the impacts of wild canids in over 50 years. While subject to final regulatory review, the availability of an additional predacide will give greater flexibility to land managers already participating in wild canid management. It will also provide an opportunity for increased participation in management programs where the balance between reducing the impacts of wild canids and the accidental poisoning of pet/working dogs has prevented the use of baits in the past. A summary of the key outcomes of this research will be discussed in light of the available data and registration guidelines to give transparency to the assessment process and the anticipated timeframes for product approval.

RESEARCH, DEVELOPMENT AND REGISTRATION OF NEW TOXINS, AND ALTERNATIVE DELIVERY SYSTEMS

Charles Eason[1,2], Helen Blackie[1], James Ross[1], Lee Shapiro[2], Shaun Ogilvie[1], Elaine Murphy[3], Steve Hix[2], Ray Henderson[4], Duncan MacMorran[2].

[1] Centre for Wildlife Management and Conservation, Faculty of Agriculture and Life Sciences, Department of Ecology, Lincoln University, PO Box 84, Canterbury 7647, New Zealand.

[2] Connovation Research, Auckland, New Zealand; Lincoln University, Lincoln, New Zealand

[3] Department of Conservation, Christchurch, New Zealand

[4] PestTech, Leeston

charles.eason@lincoln.ac.nz

Over the last three decades, considerable effort has been put into improving and refining the use of sodium fluoroacetate (1080). Its use in New Zealand comes under considerable scrutiny. Whilst there are no "silver bullet" replacements for 1080 a suite of effective and acceptable tools are being developed to reduce over-reliance on 1080 or brodifacoum, and to provide greater flexibility. Research on the relative humaneness, persistence and secondary poisoning risk associated with several new toxins and bait formulations will be presented alongside details relating to their registration status in New Zealand. Significant advances have been made in the last 12 months with the registration of a cyanide pellet (Feratox®), a low dose cholecalciferol bait, para-aminopropiophenone, sodium nitrite and zinc phosphide (MZP). Full registration of microencapsulated zinc phosphide (MZP) for possums, para-aminopropiophenone (PAPP) for stoats, Feratox® for Bennett's wallabies, solid diphacinone bait and a low dose cholecalciferol paste is nearly complete. For example, for PAPP, the final assessment was made by the New Zealand Environmental Risk Management Authority (ERMA) in February 2011. Registration of the trade name product for PAPP is now awaiting finalisation following confirmation of ERMA approval. Following on from new toxin and product registrations a new focus will increasingly be on species specific resetting toxin delivery systems to complement conventional baits.

FIELD EFFICACY OF THE CURIOSITY® BAIT FOR FERAL CATS AT MAINLAND SITES

Michael Johnston[1], Dave Algar[2], Michael O'Donoghue[3], Jim Morris[3] and Frank Gigliotti[4]
[1] Department of Sustainability and Environment, PO Box 137, Heidelberg, VIC 3084
[2] Department of Environment and Conservation, PO Box 51, Wanneroo, WA 6946
[3] Scientec Research Pty Ltd, 71 Yarra Street, Warrandyte, VIC 3113
[4] General Dogs Body Technical Services, PO Box 1087, Belvedere Park, LPO Seaford, VIC 3198
michael.johnston@dse.vic.gov.au

A para-aminopropiophenone ("PAPP") toxicant formulation is being developed as part of a new tool for the management of feral cat populations. The toxicant formulation is encapsulated within a degradable polymer providing a robust pellet that is itself implanted inside a moist meat sausage bait. This pelletised toxicant delivery method, patented as Curiosity®, has been demonstrated to reduce exposure of non-target fauna to bait delivered toxicants. A series of field evaluations of the Curiosity® bait have now been undertaken at four island sites and two mainland sites.

This paper will report on the outcome of the two mainland studies undertaken at Wilsons Promontory National Park (VIC) and Cape Arid National Park (WA) with respect to the baiting efficacy on populations of feral cats and non-target species.

The next steps in the development of the Curiosity® bait will also be outlined.

THE EFFICACY OF PAPP DELIVERED FROM MECHANICAL EJECTORS FOR FOX MANAGEMENT

David Dall[1], Karen Harland[2], Rob Hunt[3] and Ricky Spencer[2]
[1]Pestat Pty Ltd, LPO Box 5055, University of Canberra, Bruce ACT 2617
[2]School of Natural Sciences, University of Western Sydney, Hawkesbury, NSW 2753
[3]NSW Dept of Envt, Climate Change & Water, PO Box 733, Queanbeyan, NSW 2620
david.dall@pestat.com.au

We present results of the first field trials to test the use of mechanical ejector (ME) devices to deliver the canid-selective toxicant para-aminopropione (PAPP) for fox management. Trials used 300 mg of PAPP in a carrier solvent, presented in standard ME capsule format. Three field studies in widely separated locations across south-eastern Australia each demonstrated reductions in fox activity at sites where ejectors were deployed, as compared to nearby areas where no active management was undertaken. Some trials incorporated a newly-developed long-life polymer-based ME baithead that includes the FeralMone® fox attractant product. Those heads have been shown to remain intact and attractive to foxes for more than 6 weeks under field conditions, and can thus support deployment of MEs as a long-term, low-maintenance fox management device. Desktop assessment suggests that in the longer term a continuous ME deployment could be cheaper to implement than the 'pulse-baiting' approach now widely practised. Trials of MEs in fox-free areas recorded investigations of the device by non-target species, but no activations.

NEW INITIATIVES IN PREDATOR CONTROL TOOLS

Helen Blackie[1], Charles Eason[1, 2], Duncan MacMorran[1, 2], Ian Woodhead[3], Olaf Diegel[4] and Elaine Murphy[5]
[1] Centre for Wildlife Management and Conservation, Faculty of Agriculture and Life Sciences, Department of Ecology, Lincoln University, PO Box 84, Canterbury, NZ
[2] Connovation Research Ltd, Auckland, NZ
[3] Lincoln Ventures Ltd, PO Box 133, Lincoln, NZ
[4]Auckland University of Technology, Private Bag 92006, Auckland, NZ
[5] Department of Conservation, Christchurch, NZ
helen.blackie@lincoln.ac.nz

To achieve continued suppression or local eradication of predator populations, species specific systems capable of eliminating pests over long timeframes with very little human intervention provide an optimal solution. Recent developments in New Zealand pest control include resettable, long-life, toxin delivery systems for invasive mammals. The efficacy of these devices, which deliver a spray of paste to the abdomen, which is then licked and eaten, has been confirmed in cage trials with stoats and weasels using the toxin para-aminopropiophenone (PAPP). Recently, these innovative toxin delivery devices were deployed in a field trial in West Otago to target stoats. This presentation will describe the results from these trials as well as outline the development of similar long-life toxin delivery systems for successfully targeting a variety of other pest species. The invention of new pest management tools requires the integration of animal ecology, toxicology and design engineering to provide effective techniques for reducing populations of pest species for long durations.

EXPLOITATION OF A RIPARIAN VEGETATION BY FERAL PIGS IN SOUTHWEST WESTERN AUSTRALIA

Peter Adams, Trish Fleming and Stan Fenwick
Veterinary and Biomedical Sciences, Murdoch University, South Street, Murdoch WA 6150
p.adams@murdoch.edu.au

The movements and habitat use of feral pigs over a mixed landscape of native forest and improved pasture were examined using GPS tracking collars over a six month period. Collars were fitted to six feral pigs (3 male, 3 female) trapped along a 3 km section of a river valley system. Calculated home range sizes varied from 0.5 km (nursing sow) to 13.5 km (adult boar) using the minimum convex polygon method. Home range size, overlap and habitat use by each of the collared pigs was investigated for temporal variation. Nocturnal activity of pigs showed a preference for watercourses and cleared paddocks which presumably provided foraging opportunities. Diurnal (rest) sites were largely away from riparian areas and may reflect greater shelter opportunities up slope (since riparian vegetation is reasonably open at these sites). Home range overlap between collared pigs during the study period indicated a potentially high degree of interaction between these individuals. Sows with overlapping home ranges spent the majority of time in close proximity to each other as well as one of the boars (77% to 91% of location fixes recorded as occurring within 50m of other collared pigs). However one boar was not observed to interact with any of the other collared pigs despite substantial overlap in home range of these animals. Management issues related to control of feral pigs in southwest Western Australia are discussed in relation to these findings.

FERAL PIGS IN THE TROPICS: IMPACTS AND SOLUTIONS

Jim Mitchell
Biosecurity Queensland.
P.O. Box 187 Charters Towers Q. 4820.

Feral pigs are perceived as a significant threatening process to a number of rare or endangered species and vulnerable ecosystems, some of which occur in the tropics of north Queensland. However, there is still a distinct lack of quantitative information on these threats and, in particular, there is a scarcity of information in relation to dry tropical savanna ecosystems. Recent research in north Queensland has attempted to document the threats that feral pigs pose to a range of tropical habitats and species.

Feral pigs have been found to have a negative impact on the ecological condition of ephemeral lagoons. Pig foraging activities caused major destruction to aquatic macrophyte communities, which were the preferred food resource. The destruction of macrophyte communities and upheaval of wetland sediments in unprotected wetlands significantly reduced water clarity and had effects upon key water quality parameters such as dissolved oxygen availability. Diggings also contributed to a major increase in aquatic nutrient levels. Research has also shown that feral pigs pose a serious threat to threatened marine turtle species. On some turtle hatching beaches, 100% predation rates on turtle nests have been reported. The rare Jardine River tortoise is also believed to be under significant threat from feral pig predation. A range of other rare and endangered species found in the tropics is also perceived to be threatened by feral pigs.

Management of pigs in the tropics is difficult due a range of logistic, financial and social considerations unique to tropical habitats. However, a number of large scale feral pig management programs have recently been implemented by organisations in Cape York. These programs include large scale aerial surveys conducted throughout Cape York over the past seven years, aerial shooting programs for exotic disease surveillance and to protect rare and endangered marine turtle species, and baiting programs throughout National Parks and aboriginal communities. Results from these programs and recent research will be discussed.

ENVIRONMENTAL IMPACTS OF FERAL PIGS: A REVIEW OF PLANT AND SOIL RESPONSES TO PIG DISTURBANCE IN NATURAL ECOSYSTEMS

Amanda Elledge [1, 2, 3, 6] Clive McAlpine [3], Peter Murray [4] and Iain Gordon [1, 2, 5]
[1] CSIRO Ecosystem Sciences, Townsville, QLD, Australia;
[2] Invasive Animals Cooperative Research Centre, Bruce, ACT, Australia;
[3] The University of Queensland, School of Geography, Planning and Environmental Management, St Lucia, QLD, Australia;
[4] The University of Queensland, School of Animal Studies, Gatton, QLD, Australia;
[5] The James Hutton Institute, Scottish Crop Research Institute, Dundee, United Kingdom;
amanda.elledge@uqconnect.edu.au

Worldwide, feral pigs are one of the most widely distributed terrestrial mammals. Environmental impacts, as a result of their rooting foraging behaviour, are common and can affect the composition, structure and function of ecosystems. This paper is one of the first comprehensive reviews of feral pig impacts in natural ecosystems that spans both their native and introduced range. We reviewed the environmental response of plants and soils from 35 studies where undisturbed and pig disturbed areas have been compared, or alternatively, recovery has been assessed with the exclusion or removal of feral pigs. Overall, pig disturbance led to reduced plant species richness and cover but results for the density of seedlings were highly variable. There were also variable results among studies that had assessed soil fertility and soil invertebrates. We discuss factors that contribute to issues of comparability among studies, including the population dynamics of feral pigs, food availability and local climatic conditions. Future research that focuses on the recovery of habitat following pig disturbance should consider applying a more broad ecological assessment to include plant, soil and invertebrates variables, as they are critical components of ecosystem function and regeneration success.

BIODIVERSITY IMPACTS OF FERAL PIGS IN A TEMPERATE RAINFOREST ECOSYSTEM

Cheryl Krull [1], Bruce Burns[1], Dave Choquenot[2], and Margaret Stanley[1].
[1]Centre for Biodiversity and Biosecurity, University of Auckland, Private Bag 92019, Auckland
[2]Landcare Research, Private Bag 92170, Auckland
cherylkrull@xtra.co.nz

Feral pigs (*Sus scrofa*) are globally widespread, inhabiting a diverse range of environments. Concerns have been raised about their impact on native plants and animals, broader influence on ecological processes, and the transmission of pathogens, especially the newly discovered Kauri root rot disease (*Phytophthora* taxon *Agathis*). This study evaluated the biodiversity impact associated with ground disturbance by pigs in a temperate rainforest ecosystem, located in the North Island of New Zealand. Ground disturbance may affect vegetation through direct removal, but also indirectly through modification of the below ground subsystem and soil characteristics. This paper describes the spatial extent of ground disturbance by pigs within the ecosystem, and uses exclosure plots established in recently disturbed areas to assess the rates of rooting and recovery. The direct and indirect effect of ground disturbance on vegetation diversity and a number of key soil characteristics are also presented. The results of this study will be linked to models predicting the response of ground disturbance to pig control in order to assist managers in identifying control regimes that protect key biodiversity traits.

ERADICATION OR SUSTAINABLE HARVEST? QUANTIFYING FERAL PIG ABUNDANCE USING A DISTANCE SAMPLING APPROACH

Peter Adams[1], Robert Huston[2] and Ken Pollock[3]
[1]Veterinary & Biomedical Sciences, Murdoch University, South St, Murdoch WA 6150
[2]Dept of Environment and Conservation, Perth Hills District, Mundaring WA 6073
[3]Centre for Fish and Fisheries, Murdoch University, South St, Murdoch WA 6150
p.adams@murdoch.edu.au

Feral pig management in southwest Western Australia primarily revolves around trapping programmes initiated by government agencies and community groups during the drier summer months of the year. In the northern jarrah forest, these efforts are typically responsible for removing between 200 and 300 feral pigs from primarily water catchment areas each year. In the absence of reliable population monitoring it is unknown whether this seasonal removal of feral pigs is providing an overall reduction in population size or if it represents a sustainable harvest. As such, Distance Sampling was employed in an effort to estimate feral pig abundance in the northern jarrah forest from dung samples collected from transects across six trapping areas. In addition, removal methods were also used to estimate feral pig population size based on the known number of feral pigs removed from each area over recent years. Effectiveness of current control techniques in reducing impacts and controlling feral pigs in the northern jarrah forest are discussed.

REGISTRATION EFFORTS IN THE UNITED STATES TOWARDS DEVELOPING A FERAL SWINE TOXICANT

John D. Eisemann[1], Steven Lapidge[2], Phillip Morrow[3], Kathy Fagerstone[1], Jeanette R. O'Hare[1], and Linton Staples[3]
[1]USDA National Wildlife Research Center, 4101 LaPorte Ave, Ft Collins, Colorado USA 80521.
[2]Invasive Animals Cooperative Research Centre, 48 Oxford Terrace, Unley SA 5061.
[3]Animal Control Technologies Australia P/L, PO Box 379, Somerton, Victoria 3062.
John.D.Eisemann@aphis.usda.gov

In 2010 the USDA Animal Plant Health Inspection Service (APHIS) entered into a Cooperative Research and Development Agreement (CRADA) with Invasive Animals Cooperative Research Centre (IACRC) of Australia. The focus of the CRADA is to promote the development of sodium nitrite as the active ingredient in a toxic bait preparation for feral swine management in the United States. This talk will highlight the cooperative relationship among APHIS, IACRC and Animal Control Technologies, Australia in bringing the product to market. The U.S. pesticide registration process will be outlined and various aspects of the process will be highlighted to illustrate the difficulties facing vertebrate pesticide product registration in the U.S., even one that has a favourable risk picture like sodium nitrite. In the past five years, the U.S. Environmental Protection Agency has entered into data sharing agreements (registration harmonisation agreements) with New Zealand and Australia. These agreements have set the stage for the three-way collaboration to develop sodium nitrite by allowing the submission of data and regulatory reviews from these countries, expediting EPA's regulatory review process, and significantly reducing the total cost to register the product. Through these efforts, we hope to conduct a field efficacy trial of the feral swine bait and bait station in early 2013, and ultimately submit a request for full product registration in late 2014.

ECONOMIC ASSESSMENT OF THE BENEFITS AND COSTS OF A NEW FERAL SWINE MANAGEMENT TOOL

Stephanie Shwiff[1], Steven Lapidge[2], and Aaron Anderson[1]
[1]USDA/APHIS/WS National Wildlife Research Center
[2]Invasive Animal CRC
National Wildlife Research Center
4101 LaPorte Ave
Fort Collins, CO 80521
(970) 266-6150
Stephanie.A.Shwiff@aphis.usda.gov

Invasive feral swine combine a number of characteristics (e.g. high mobility, high fecundity, destructive behavior, reservoir of diseases, etc) that make them one of the most serious wildlife threats to agriculture, health and human safety and biodiversity. There are currently no toxicants registered for use against feral pigs in the US, however there are three registered in Australia. In 2005, the Invasive Animals Cooperative Research Centre identified sodium nitrite as a suitable new toxin. This new toxin (trademarked name HOG-GONE®) has several advantages relative to those currently in use including being more efficacious, safer to use and handle, and more humane, as well as having an accepted antidote and presenting less risk to non-target species. This presentation will discuss the methodology to estimate the benefits and costs of the hypothetical deployment of sodium nitrite in Texas. Texas has a large (2 million) feral pig population that is distributed throughout much of the state and causes extensive damage to agriculture and property. A benefit-cost analysis of the deployment of sodium nitrite in Texas provides information necessary for the process of registering this toxin for use in the US and assists in choosing the most cost-effective management strategy to control feral pig populations.

DEVELOPMENT OF THE HOGHOPPER: A FERAL PIG SPECIFIC BAIT DELIVERY DEVICE

Jason Wishart and Steven Lapidge
Invasive Animals Cooperative Research Centre, 48 Oxford Tce, Unley, South Australia, Australia
jason.wishart@invasiveanimals.com

One of the most common broad-scale techniques used to control feral pigs in Australia is toxic baiting, as it is relatively cheap and it can provide efficient population reductions. However, toxic baiting is not without its risks, as some wildlife species can be attracted to the bait substrates used which may lead to non-target poisoning. Baiting programs can also be labour intensive, often requiring daily bait replenishment. As such, many remote feral pig affected areas are baited improperly or they are omitted from baiting campaign all together. During 2007, the Invasive Animals Cooperative Research Centre (IA CRC) with support from the Bureau of Rural Sciences initiated a project to rectify these shortfalls. The objective of the project was to develop a feral pig-specific bait delivery device (the HogHopper™) that could target unique feral pig attributes such as reach, size and strength to prevent non-target access during baiting. The HogHopper™ was also designed to hold sufficient bait to eliminate daily operator requirements, making it suitable for baiting remote environmentally sensitive areas. After several years of extensive pen and field testing in a variety of feral pig affected habitats (rangeland, tropical rainforest and alpine), the IA CRC has been able to create an optimal final article-of-commerce that is ideal for Australian conditions. The HogHopper™ is comprised of a series of aluminium panels that fasten together to create a light weight (25kg) fully enclosed aluminium box (70cm long x 70cm high x 60cm wide). Situated within the aluminium box is self feeding bait hopper that can hold large quantities of bait material. To access this bait material, a feral pig is required to lift a 3 kilogram door (one positioned at either end of the device) with its snout. This particular method of access was chosen as feral pigs characteristically use their snout to lift and dig when foraging for food and are able to do so with incredible force whereas native species cannot. This presentation will discuss the steps that have taken the HogHopper™ from the drawing board to the market place.

AUSTRALIAN PEST ANIMAL RESEARCH PROGRAM (APARP)

Stefanie McCowen, Steve Walters, Osman Mewett and Bertie Hennecke
Australian Bureau of Agricultural and Resource Economics and Sciences
GPO Box 1563, Canberra ACT 2601
stefanie.mccowen@daff.gov.au

Vertebrate pests, such as rabbits, foxes, wild dogs, birds, pigs, goats and horses now make up about ten per cent of Australia's mammal fauna. They have adapted and spread into most of Australia's agricultural systems and natural environments. None have been eradicated, despite considerable effort.

The Australian Pest Animal Research Program (APARP) was established in 2008–09 under the Australian Government's Caring for our Country initiative to fund research and extension projects that develop and promote improved approaches to the management and monitoring of agricultural pest animals. Since 2008–09, the program has funded 25 projects collectively worth $2.1 million. These projects have ranged from developing best practice guidelines for the use of guard dogs for the protection of livestock in Australia, to the development of web-base community reporting, education and extension tools for landholders and community groups. The current funding arrangement under Caring for our Country is effective to 2012-13 and is administered through the Australian Bureau of Agricultural and Resource Economics and Sciences.

APARP aims to:

- develop integrated, strategic approaches to manage the impacts of nationally significant pest animals on agriculture
- improve the effectiveness of control techniques and strategies for reducing pest animal impacts on agriculture
- produce guidelines and extension materials for the best practice management of nationally significant pest animals
- quantify the benefits of pest animal management.

APARP, together with the Invasive Animals CRC, is one of the major initiatives through which the Australian Government fulfils its coordination, extension and research and development roles in relation to pest animal management under the Australian Pest Animal Strategy.

"THE TOOLBOX" – ENCOURAGING THE DEVELOPMENT OF NEW TOOLS AND BEST PRACTICE

Sherman Smith[1], Kate Littin[1] and Bruce Warburton[2]
[1]Ministry of Agriculture and Forestry, PO Box 2526, Wellington 6140, New Zealand
[2]Landcare Research, PO Box 40, Lincoln 7640, New Zealand
sherman.smith@maf.govt.nz

Pest managers rely on a range of "tools" to protect crops, conservation values, animal health, and public amenity values. The tools include not only the devices such as traps or poisons but also the best practice applications and strategies for using them and the standards and regulations that guide their use. The sharing of information about these tools, including information about the way they are used and restrictions on their use, is often ad hoc and uncoordinated. This makes it difficult to identify gaps in knowledge and areas where novel tools are needed, especially in light of changing social and environmental concerns. Also, ad hoc and uncoordinated approaches to best practice development and sharing mean that use is not as effective as it could be and users might not even be aware that some alternatives exist. New Zealand recently launched a Pest Management National Plan of Action to address the recognised weaknesses in the status quo and to manage, as part of an ongoing need, the development and maintenance of tools needed for effective pest management. It establishes a coordinated system of managing the toolbox. The goal is to have a single point-of-entry portal giving access to an integrated, central toolbox. This will allow easier access to information about tools, easier identification of gaps in the toolbox and associated research needs, and early detection of future risks to the toolbox – all of which is great news for pest managers. But how do we get there? What makes a good toolbox? How can the toolbox remain current? And what can be done to encourage all stakeholders to participate in the project and to ensure research will fill the identified gaps? We will outline the current status of the toolbox and consider the challenges such integration might pose.

HOW DO GUARDIAN DOGS 'WORK'

Lee Allen and Damian Byrne
Robert Wicks Pest Animal Research Centre, Biosecurity Queensland,
Department of Employment, Economic Development and Innovation, PO Box 102, Toowoomba
lee.allen@deedi.qld.gov.au

We report the movements of eight maremma guardian dogs and five wild dogs on Dunluce Station, Australia's most northern sheep property west of Hughenden in north Queensland. While most guardian dogs have high fidelity to the sheep they protect or the paddocks to which they are assigned, others range up to 14 kilometres away visiting other sheep flocks and guardian dogs. Wild dogs were found to frequent adjacent paddocks and even traverse the paddocks containing maremmas and sheep without any losses being detected. Aggressive encounters between wild dogs and maremmas appear to occur infrequently and there is evidence that maremmas may work cooperatively by responding to vocalisations of other maremmas stationed in paddocks nearby. However, contrary to our hypothesis, maremmas do not 'work' by defended territories that are avoided by wild dogs. Of five wild dogs collared on Dunluce, four showed movements within sheep paddocks or adjacent paddocks. One had 19.5% of its GPS locations within the area traversed by maremmas. Sixty-six incursions of wild dogs into the area traversed by sheep and maremmas were recorded over a six month period. On occasions wild dogs spent up to five hours in paddocks with sheep and maremmas or up to two days in adjacent paddocks without confrontation. We conclude maremmas are acting defensively and 'guarding' sheep from wild dog attacks but are not 'patrolling' paddocks or overtly 'chase off' wild dogs that intrude into or come near sheep.

REGISTERING AN ANTIDOTE FOR THE TREATMENT OF INDUCED METHAEMOGLOBINAEMIA

Simon Humphrys[1], Bob Piggot[2], Greame Brown[3]
[1] Invasive Animals Cooperative Research Centre, 48 Oxford Terrace Unley SA 5061
[2] Bioquiv Pty Ltd, Mittagong NSW 2575
[3] University of Sydney, Faculty of Veterinary Science Sydney NSW 2006
simon.humphrys@invasiveanimals.com

Poisons continue to be the most cost-effective method used for extensive pest animal management and are a necessary mainstay in the management of rodents, rabbits, wild dogs, foxes, and feral pigs across Australia. Australia's reliance on a very limited number of chemicals, especially for the control of predators and feral pigs is an unacceptable risk and the development of new actives that can supplement our usable options is a high research priority. Chemical candidates should ideally be more toxic to target species than a majority of non-targets, humane and rapid in action, orally active, have a useful shelf-life, and be complimented by an antidote. Using these key criteria, 2 new chemical actives; para-aminopropiopheone (PAPP) and sodium nitrite (SN) have been selected for development and once registered will be available in commercially manufactured baits to control wild canids and feral pigs respectively.

Both these actives induce methaemoglobinaemia, which at high levels (→80%) starves the body of oxygen and leads to a generally unremarkable death. Methylene blue administered intravenously (i.v.) or orally (p.o.) at therapeutic doses can reverse this effect even in the very late stages of toxicosis. We describe the pivotal studies in domestic dogs that have led to effective i.v. and p.o. treatment of chemically induced methaemoglobinaemia with methylene blue and the treatment recommendations and contraindications arising from these studies. We also layout the registration process and discuss use pattern scenarios that this new antidote may permit in light of their overall risk profile to non-targets and public health.

SECONDARY POISONING RISK FOR DOGS EATING POSSUMS KILLED WITH SODIUM NITRITE

Lee Shapiro[1], Charles Eason[1,2], Don Arthur[3], Duncan MacMorran[1]
[1] Connovation Research, Auckland, NZ
[2] Centre for Wildlife Management and Conservation, Faculty of Agriculture and Life Sciences, Department of Ecology, Lincoln University, PO Box 84, Canterbury, NZ.
[3] Rolleston Vets, Rolleston, NZ
lee.s@connovation.co.nz

To investigate secondary poisoning risks of sodium nitrite (SN) to dogs, carcasses of poisoned possums were offered to dogs as their only food source. Caged possums were poisoned with bait containing SN and the carcasses retained. Carcasses and batches of minced possum were immediately snap frozen at -20ºC. Eight dogs were obtained from a pound. 4 dogs were presented with a whole possum carcass. Each dog was presented with a second possum when the first had been eaten. The remaining 4 dogs were fed meat and viscera separated into 3 separate batches as follows: i) minced meat fed for two days, ii) followed by vital organs (heart, liver, lungs and kidneys) fed for two days, and then iii) a combined sample of stomach, including stomach content and intestines, for 2 days. The effects on the dogs and risk of secondary poisoning compared with other vertebrate pesticides will be discussed.

THE MYSTERIOUS CASE OF THE DISAPPEARING POO: FOX SCAT DEGRADATION IN TASMANIA

Bill Brown[1], Robbie Gaffney[1], Mathew Pauza[1], Candida Barclay[1], Anna MacDonald[2] and Stephen Sarre[2]
[1]Fox Eradication Branch, DPIPWE, 134 Macquarie St, Hobart, Tas, 7000.
[2] Wildlife Genetics Lab, Institute for Applied Ecology, University of Canberra, ACT 2601

Carnivore scat surveys and DNA analysis are currently the only reliable method of finding evidence of the presence of foxes in Tasmania. Scat surveys are conducted by both people and fox scat detection dogs, and to date 57 scats containing fox DNA have been found over a large area of Tasmania. Understanding the rate at which fox scats degrade within the Tasmanian environment is integral to the Fox Eradication Program for two reasons: to allow better interpretation of data from scat surveys; and to establish the optimum lag time between completing baiting and beginning monitoring for survivors.

We report on a field based study. Our aims were to determine the time period for which;

. Scats look like scats (people detection)?
. Scats smell like scats (dog detection)?
. Fox DNA persist in scats (DNA confirmation)?

Our goal is to use these data to determine the time lag necessary for monitoring following a baiting operation?

In this study, 27 scats were placed in the field in July 2010 at 9 sites across Tasmania. All scats were regularly monitored for physical changes over their 'field life'. Additionally, three scats were randomly collected from each site at set time intervals to test whether the dogs were able to detect any fox scent and whether the laboratory could detect fox DNA. Collection continued until all scats were collected or recorded as gone.

Results for the winter trial indicate that all scats were either collected or gone by Day 91. Only 13.0% of scats were visually recognisable as carnivore scats by Day 63. All scats were detected by at least one dog up to Day 14 and recognition only declined to 78.9% by Day 63. Scat dogs were able to detect 59.5% scats in the field at greater than 91 days, including scats that had been buried by invertebrates and scats that were not detected or recognised by people. Of all scats or scat fragments analysed for the presence of fox DNA (ranging from Day 1 to Day 91) 99.3% returned positive results.

These scat degradation trials indicate that in Winter a period of at least 63 days is required post 1080 baiting before monitoring for fox scats is undertaken by people to provide confidence that scats found can be attributed to surviving or reinvading foxes. Scat detection dogs will be able to detect some scats in excess of three months old therefore a method of distinguishing these scats from those deposited post-baiting is required. The majority of scats older than 63 days will only be detectable by dogs. Time in the field is not a limiting factor in the recognition of scats from DNA.

MANAGING ENVIRONMENTAL PESTS: WHEN DELVING INTO THE PAST TEACHES US ABOUT SQUIRRELS, MONGOOSE AND CURRENT PESTS TO GUIDE OUR UNDERSTANDING AND CONTROL EFFORTS

David Peacock
Biosecurity SA, GPO Box 1671, Adelaide, SA 5001
david.peacock@sa.gov.au

In his 2009 paper, Dan Simberloff highlights how our capacity and attitude to the eradication of pest species is impacted by the poor record of successes in the literature (Simberloff 2009). Similarly, we make pest management decisions and research conclusions based on the current understanding we have of the origin, release events, and historical and current impacts of pest species, and known species control successes. Eric Roll's research efforts, in the book 'They All Ran Wild' (Rolls 1969), is, for example, an oft cited text to guide our current decision making. However, recent reviews of historical literature, especially with recent advances with digitisation, continue to provide insights into pest species and their management that both challenges and furthers our current understanding.

In this paper I will discuss how the discovery of a grey squirrel release and eradication in Adelaide (South Australia; Peacock 2009), the extent of mongoose releases in Australia and their failure to establish (Peacock and Abbott 2010), the colonisation of Australia by foxes and how it compares to the reported loss of quolls (including by disease), and reinforcement of the understanding that Barwon Park (Victoria) was not Australia's only primary rabbit release site, improves our capacity to both understand and manage environmental pests, including their colonisation rates, impacts and genetic origins.

References:

Peacock, D. and Abbott, I. (2010). The mongoose in Australia: failed introduction of a biological control agent. *Australian Journal of Zoology* **58**, 1-23.

Peacock, D. E. (2009). The grey squirrel *Sciurus carolinensis* in Adelaide, South Australia: its introduction and eradication. *The Victorian Naturalist* **126**, 150-155.

Rolls, E. (1969). They All Ran Wild. Angus and Robertson: Australia.

Simberloff, D. (2009). We can eliminate invasions or live with them. Successful management projects. *Biological Invasions* **11**, 149–157.

INVADING DEER AND COYOTES THREATEN WOODLAND CARIBOU POPULATIONS IN NORTHEASTERN ALBERTA

A. David M. Latham[1, 2], M. Cecilia Latham[2], Mark S. Boyce[2] and Stan Boutin[2]
[1]Landcare Research, PO Box 40, Lincoln 7640, Canterbury, New Zealand
[2]Department of Biological Sciences, University of Alberta, Edmonton, Alberta T6G 2E9, Canada
LathamD@landcareresearch.co.nz

Woodland caribou (*Rangifer tarandus caribou*) populations have declined throughout most of North America. Historically, caribou existed in the boreal forest by using different habitat to moose (*Alces alces*) which are a more common prey of wolves (*Canis lupus*), a shared predator. Spatial separation of caribou and moose reduced predation risk for caribou as secondary or incidental prey. However, recent evidence suggests that human-caused habitat change and global warming have resulted in prey and predator enrichment and altered predator-prey dynamics. We assessed the effect of invading white-tailed deer (*Odocoileus virginianus*) as a novel alternative prey, and coyotes (*C. latrans*) a novel predator, on the dynamics of the caribou-moose-wolf system subsequent to industrial expansion in the region in the late-1990s. Observable white-tailed deer increased 17.5-fold from the mid-1990s to the mid-2000s, whereas moose remained unchanged. Wolf numbers also increased from approximately 6 to 11.5/1,000 km. Scat analysis indicated that wolf consumption of moose declined substantively during this time period, whereas use of deer increased markedly replacing moose as the primary prey of wolves. Caribou increased 10-fold in the diet of wolves. Preliminary results indicated that invading coyotes were associated with human footprint; however, some individuals showed selection for caribou-preferred habitats. Coyote diet consisted primarily of small mammals and white-tailed deer (neonate and adult). Neonate caribou was rare in coyote diet. Coincident with prey and predator enrichment, caribou population trends in the region changed from stable to declining. We suggest that caribou declined in the southerly extent of their range because high deer densities resulted in a numeric response by wolves and consequently higher incidental predation on caribou. Invading vertebrates can alter native predator-prey dynamics in complex ways, such that management actions to conserve threatened species may need to include the control of native predators and prey in addition to invasives.

AGRICULTURAL AND ENVIRONMENTAL IMPACTS OF WILD DEER IN VICTORIA, AUSTRALIA

David M. Forsyth[1], Naomi Davis[2] and Michael J. Lindeman[1]
[1]Arthur Rylah Institute for Environmental Research, 123 Brown Street, Heidelberg, VIC 3084
[2]Department of Zoology, University of Melbourne, VIC 3010
dave.forsyth@dse.vic.gov.au

Four deer species have established wild populations in Victoria: Sambar Deer (*Cervus unicolor*), Fallow Deer (*Dama dama*), Red Deer (*Cervus elaphus scoticus*) and Hog Deer (*Axis porcinus*). These species are managed as game, but there is interest in understanding their agricultural and environmental impacts. During 2007-2010 work was undertaken to better understand the agricultural and environmental impacts of deer in Victoria. We report the results of this work, which was commissioned by the Department of Sustainability and Environment (DSE), Department of Primary Industries, and Parks Victoria. The agricultural impacts of deer were identified by summarising the responses to questions given in Authority To Control Wildlife (ATCW) permits issued to landholders by DSE to control deer on their properties. The number of permits issued to control deer increased greatly during the 2000's. Most permits (76%) were issued for Sambar Deer, followed by Red Deer (24%), Fallow Deer (20%) and Hog Deer (2%). The main reasons given by holders of ATCW permits for wanting to control deer were preventing damage to the following agricultural values: pasture, fruit, grapevines, vegetables (especially potatoes), pine and other trees, native tree revegetation, and flowers and foliage. Most landholders considered that shooting deer with the aid of a spotlight was the most cost-effective way of minimising the agricultural impacts of deer, and most of this control was provided free-of-charge to the landholder by sporting shooters through the ATCW permit system. To help understand some of the environmental impacts of the most widely distributed deer species, we evaluated the diets of 102 Sambar Deer harvested in Victoria. We identified 106 plant species in the diet. Shrubs/trees dominated the diet, followed by grasses and ferns. No Victorian Rare or Threatened species were identified in the rumens. Nine non-indigenous plant species were identified, including large numbers of Blackberry (*Rubus fruticosus*) seeds. Sambar Deer in Victoria are generalist feeders, with the ability to utilise grasses and/or browse. The ways in which the information gained in these studies has been used by government will be discussed.

CANE TOAD'S ACHILLES' HEEL: EXCLUDING TOADS FROM ARTIFICIAL WATERS CAN PREVENT THEIR SPREAD INTO ARID REGIONS

Mike Letnic[1], Daniel Florance[2], Jonathan Webb[2], Tim Dempster[3] and Michael Kearney[3]
[1]Hawkesbury institute for the Environment, University of Western Sydney
[2]School of Biological Sciences, University of Sydney
[3]School of Zoology, University of Melbourne

Many biological invasions do not occur as a gradual expansion along a continuous front, but result from the expansion of satellite populations that become established at "invasion hubs". Although theoretical studies indicate that targeting control efforts at invasion hubs can effectively contain the spread of invasions, few studies have demonstrated this in practice. In arid landscapes worldwide, humans have increased the availability of surface water by creating artificial water points (AWP) such as troughs and dams for livestock. By experimentally excluding cane toads (*Bufo marinus*) from AWP, we show that AWP provide a resource subsidy for non-arid adapted toads and serve as dry season refuges and thus invasion hubs for cane toads in arid Australia. Using data on the distribution of permanent water in arid Australia and the dispersal potential of toads, we predict that systematically excluding toads from AWP would reduce the area of arid Australia across which toads are predicted to disperse and colonize under average climatic conditions by 38% from 2,242,000 km to 1,385,000 km. Our study shows how human modification of hydrological regimes can create a network of invasion hubs that facilitates a biological invasion, and confirms that targeted control at invasion hubs can reduce landscape connectivity to contain the spread of an invasive vertebrate.

RE-DEFINITION OF THE PEST STATUS OF FERAL PIGS: PUBLIC ATTITUDES TOWARD THEIR IMPACTS AND CONTROL PRACTICES

Kana Koichi[1], Alison Cottrell[2], Kamaljit Kaur[3] and Iain J. Gordon[4]
[1, 2]School of Earth & Environmental Sciences, James Cook University, Townsville QLD
[1]Invasive Animals Cooperative Research Centre, Canberra ACT
[1,3]School of Marine and Tropical Biology, James Cook University, Townsville QLD
[4]The James Hutton Institute, Craigiebuckler, Aberdeen, AB15 8QH United Kingdom

Historically, feral animals have presented problems in Australia because they conflict with human interests or causes serious damage to a valued resource such as agriculture and biodiversity. However, feral animal problems and their management strategies have been defined too narrowly, focused on the ecological problems without dealing with the complexity of the human dimensions such as public perceptions of these 'pest' animals (English & Chapple, 2002). Public perceptions are integral to pest management because what determines their pest status is how people perceive them (Olsen, 1998). Problematically, there is a lack of primary research on public attitudes toward pest animals in Australia (Fitzgerald et al., 2007; Wallis et al., 2009). This research attempted to address this gap in the knowledge in the Wet Tropics region, Queensland, with a case study by focusing on public opinions about feral pigs rather than primarily on pigs themselves as the problem.

This research investigated various stakeholders' perspectives through in-person interviews and self-administered surveys, including general local residents and special interest groups such as farmers, pig hunters, government officers, tourism operators, tourists and Aboriginal rangers. The results showed that the commonly perceived costs of pigs needed to be redefined because the costs of pigs varied among and within stakeholder groups. Firstly, we found the majority of the stakeholders believed in the commonly perceived costs of pigs as an environmental pest in the rainforest. However, some stakeholders such as farmers and pig hunters used pigs as a scapegoat to justify their own practices. Secondly, the commonly believed costs of pigs as an agricultural pest needed to be corrected because damage was sporadic and locally intensive. The potential impacts of pigs on tourists' rainforest experience were also negligible because of tourists' lack of knowledge about the presence of pigs as well as rare sightings of pig diggings in the rainforest. Rather, some stakeholders derived socio-economic benefits from pigs. Pigs were an 'entertainment' factor for tourists who viewed them as a 'wild' animal and served as a source of food for Aboriginal people in remote areas and as a recreational opportunity for pig hunters. These benefits need to be considered in management to reduce conflicts with these stakeholders. Given the public attitudes toward the costs and benefits of pigs as well as social acceptability and cost-effectiveness of different control measures, this research provides policy recommendations for pig management.

References:

English, A. W., & Chapple, R. S. (2002). *A Report on the Management of Feral Animals*. Hurstville: the New South Wales National Parks and Wildlife Service.

Fitzgerald, G., Fitzgerald, N., & Davidson, C. (2007). *Public attitudes towards invasive animals and their impacts*. Canberra: Invasive Animals Cooperative Research Centre.

Olsen, P. (1998). *Australia's Pest Animals: New Solutions to Old Problems.* Sydney: Kangaroo Press and Bureau of Resource Sciences.

Wallis, A.,Kelly, A., Salzmann, S., Gilligan, D., & Hartwell, D. (2009). *Benchmarking social attitudes to river health and carp management in the Lachlan River Catchment, NSW.* Victoria: Deakin University.

ENABLING EFFECTIVE FERAL CAT CONTROL ON KANGAROO ISLAND

Andrew Bengsen, John Butler and Pip Masters
Kangaroo Island Natural Resources Management Board, 35 Dauncey St, Kingscote SA 5223
andrew.bengsen@uqconnect.edu.au

Feral cats pose a threat to native species on Kangaroo Island, including endangered species, and have substantial economic impacts on the Island's primary producers. There is strong community support for the implementation of effective cat management on the Island, but the development and implementation of a strategic cat control program has been constrained by several deficiencies. These include establishing a reliable method for monitoring changes in cat abundance and a lack of information about temporal and spatial variation in landscape use by feral cats. Our studies sought to overcome these limitations.

We evaluated a camera-trapping method for estimating cat population abundances over 36 km of farmland area using robust capture-mark-recapture (CMR) models based on the identification of individuals using coat patterns. We also examined landscape use by cats in bush and pastoral settings, and the implications of these patterns for the design of effective cat control programs, using 16 GPS-collared cats.

Camera-trapping and CMR modelling provided a useful method for monitoring changes in the abundance of feral cats, identifying an estimated 55 % population decline following a two week trapping program. However, the magnitude of the decline was limited by movement of new cats into the area. GPS-tracking showed that cats occupied home ranges of about 6 km (median 100% MCP), and traversed up to 41 different properties (median = 6). By combining home range and abundance estimates, we obtained estimated densities of 0.7 cats km^{-} before control, and 0.4 cats km^{-} after. Cats tended to use heavily-treed areas within their home ranges more often than open or recently (← 5 yr) burned country.

Information gained from these studies will enable the development of strategic feral cat control programs for the Island. The camera-trapping and CMR methods can be used to monitor the efficacy of control programs in reducing the abundance of cats, and also should be useful in other regions. Robust CMR models also allow the estimation of the potential for short-term population recovery through re-invasion.

Our results highlight the importance of coordinating control activities across adjacent properties and at large spatial scales, to ensure that all cats using a given area have the potential to be controlled, and to reduce re-invasion. Future work will use an adaptive management approach to understand the effects of cat control programs on cat populations, small mammal communities, and sheep production.

The project was funded by the State Government of South Australia and the Invasive Animals Cooperative Research Centre.

GETTING THERE FIRST: A NEW METHOD FOR ESTIMATING RANGE EXPANSIONS OF INVASIVE SPECIES

Grant Hamilton and Rune Rasmussen
Biogeosciences, Faculty of Science & Technology QUT, GPO Box 2434 Brisbane, QLD 4001, Australia
g.hamilton@qut.edu.au

To optimise control efforts for an invading species it is critical to know where the invasion is headed, and how long it will take to get there. Making these predictions in real landscapes is challenging because the invasion process and the landscape across which invasions occur are both complex and estimating the parameters of the range expansion. Until now, estimating the characteristics of an invasion has typically meant unduly simplifying the ecology of the invasion process and grossly simplifying features of the landscape across which the invasion occurs. We demonstrate a novel method for the estimation of invasion parameters across a heterogeneous landscape using Approximate Bayesian Computation (ABC). Using this method, it is possible to preserve the essential components of the ecological process that we need to understand for better management, as well as the landscape that will make each invasion unique.

CHANGES IN POSSUM SPATIAL BEHAVIOUR FOLLOWING A CONTROL OPERATION: IMPLICATIONS FOR CONSERVATION AND BOVINE TUBERCULOSIS MANAGEMENT

Belinda I. Whyte, James G. Ross, Helen M. Blackie
Centre for Wildlife Management and Conservation, Lincoln University, PO Box 84, Lincoln 7647, New Zealand
belinda.whyte@lincolnuni.ac.nz

The Australian brushtail possum (*Trichosurus vulpecula*) was first introduced into New Zealand in the 1800s to establish a fur trade. As time has progressed, it has become apparent that the possum has a number of adverse effects on native flora and fauna due to its opportunistic and varied diet. In addition, the possum is also responsible for transmitting bovine tuberculosis (*Mycobacterium bovis*) to cattle and deer. Consequently, numerous control operations are undertaken within New Zealand at a cost of millions of dollars, for both conservation and bovine tuberculosis management. The goal of these operations is to significantly reduce population densities, but it is inevitable that some individuals survive. It is unknown whether these survivors change their spatial behaviour in response to lower population densities. Current follow-up control methods generally do not account for any changes in spatial behaviour following initial control, largely due to limited research regarding this issue. If spatial behaviour does change, this may be inhibiting our ability to manage this species efficiently for conservation purposes and to eliminate areas of persistent bovine tuberculosis infection. Consequently, our research investigated whether possum home-range characteristics, pasture use and den-site use, changed following an experimental control operation in a forest fragment in Mid Canterbury. Possums were fitted with collars containing Global Positioning System and VHF devices, to establish movement patterns through space and time. Several movement parameters changed following control, such as home-range size and home-range overlap. This research highlights the need to update national and local control strategies to account for this change in behaviour. For example, the effectiveness of spatial models predicting the transmission of bovine tuberculosis would be increased by incorporating the recorded changes in home-range size and overlap following initial control.

IDENTIFICATION OF INDIVIDUAL WILD POSSUMS FROM BITE MARKS

Shaun Ogilvie[1], Keisuke Sakata[1], Adrian Paterson[1], James Ross[1], Charles Eason[1,2]
[1] Centre for Wildlife Management and Conservation, Faculty of Agriculture and Life Sciences, Department of Ecology, Lincoln University, PO Box 84, Canterbury 7647, New Zealand.
[2] Connovation Research, Auckland, New Zealand.
sakatak@lincoln.ac.nz

New Zealand's brushtail possum (*Trichosurus vulpeculа*) abundance is monitored by the trap-catch method where the proportion of traps catching possums is used to index its abundance. The comparatively new waxtag® method where the proportion of interfered tags is similarly used as an abundance index has advantageous properties, including its minimal risk to non-target fauna, low operational cost, and ease of use. However, unlike the trap-catch method, the bait can be interfered with by many individual animals of multiple species, and likewise a single individual can interfere with multiple baits, which is an intrinsic drawback to the method, confounding the results due to an unknown probability of multiple interference of bait. We addressed the issues by identifying the responsible species and individual animals from the bite marks left on the waxtags. Possum and rodent bite marks were defined by measuring single tooth-mark widths. A novel method to identify individual animals was developed by applying the forensic toolmark examination principle to microscopic features observed on the bitemarks. This demonstrated that bitemarks can be used to reliably identify individual animals.

MONITORING BENNETT'S WALLABY IN NEW ZEALAND

Alastair Fairweather[1], Neil Bolton[2] and Mark Beardsley[2]
[1] Department of Conservation, PO Box 516, Hamilton 3434, New Zealand
[2] Department of Conservation, Private Bag, Twizel 7944, New Zealand
afairweather@doc.govt.nz

Bennett's wallabies (*Macropus rufogriseus rufogriseus*) were liberated into the Hunter Hills, South Canterbury in 1874. Since then their range has expanded to cover approximately 350, 000 ha of the South Island. Within their range, they are considered to impact on biodiversity and agricultural values. At high densities they browse almost all plant species. In tall tussock grasslands this results in creation of short matted turf, moss swards and bare ground, and in remnants of native forest the severe depletion of the understorey. Agricultural impacts include damage to pasture, green food crops, and the establishment phase of exotic forests. Control of Bennett's wallabies is carried out using toxins or shooting. In areas where livestock is absent, cereal-based pellets containing sodium fluoroacetate (1080) are aerially applied or 1080 gel is placed on the leaves of palatable foliage. Alternatively, wallabies are shot by teams of shooters using dogs to flush wallabies from cover, or from a helicopter.

Currently there are two main methods of monitoring Bennett's wallabies in New Zealand - day inspections (Guilford Scale) and faecal pellet counting. The Guilford Scale is a visual assessment of faecal pellet abundance, tracking and wallaby sightings, and ranges from 1 to 5. It is used to establish whether a control threshold has been reached, but cannot be used to provide an estimate of percent kill. Standing crop faecal pellet counts measure the relative population density and are more precise and quantitative than the Guilford Scale. While this method can be used to determine percent kill following pest control operations, it is labour intensive, time consuming and costly.

Here we report on a two year trial to investigate the applicability of helicopter-based double counting for Bennett's wallabies.. Our data indicate that under New Zealand field conditions the method is repeatable, will give a simple index of wallaby density and is suitable for monitoring percent kill. While it is unlikely to replace the Guilford Scale for determining control thresholds, we believe that the method is suitable for providing an efficient and effective method of monitoring wallaby control operations.

APPLYING REMOTE AUDIO TECHNOLOGY TO WESTERN AUSTRALIA'S STARLING ERADICATION CAMPAIGN

Campbell, S., Parr, R., Gray, G., Martin, G. and Woolnough, A.
Department of Agriculture and Food
Vertebrate Pest Research Section
100 Bougainvillea Ave Forrestfield, WA 6058
scampbell@agric.wa.gov.au

The process of locating and removing remaining individuals can often be the most expensive and time consuming component for any established pest control campaign. Remote detection technology can help reduce these costs by providing relatively cheap, ongoing surveillance, often in inhospitable areas, to help locate otherwise hard to find individuals.

The Western Australian (WA) government has proactively managed one of the world's worst invasive species, the common starling *Sturnus vulgaris*, since it was first detected at the border in the early 1970s. Consequently, the density of starlings in WA is low, however remaining birds are wary, cryptic and notoriously difficult to locate. Research and development has played an important role in the control campaign against starlings in WA and our current work aims to provide a cost-effective operational tool that increases starling surveillance both spatially and temporally.

We purchased 50 Song Meter-2 Terrestrial Packages (SM2-TP; Wildlife Acoustics, Massachusetts) in March 2010 and placed them at strategic locations throughout the South Coast region of WA in June 2010. Based on feedback from experienced field staff, the SM2-TP units were spread over 12 sites, the majority being swamps with a known history of starling occupation. Each unit has a detection radius of approximately 200 – 300 meters, and between one to nine units are present at each site. Daily sampling is focussed around dawn and dusk but also includes 10 min samples every hour, allowing each unit to run off four D-cell batteries for 7 - 8 weeks, using four 16GB SD memory cards to near capacity. One unit has been set aside for extension activities with a local primary school, and of the remaining 49 units; seven have ceased functioning due to water damage and between 15 – 40% of units have stopped recording earlier than anticipated each month due to internal condensation problems. Subsequently we have taken steps to improve the weather-standing capabilities of the units and have since downloaded over eight Terabytes of recordings. Such large volumes of data present the next challenging step, which is to automate the data review process.

We have compiled a comprehensive reference library of starling calls, predominantly from individuals in South Australia. Amongst much variable, yet skilful mimicry, we have identified two distinctive 'starling call signatures'. Colleagues in New Zealand will use these distinctive call components to develop an automated starling recogniser using Markov modelling techniques that will be capable of processing large volumes of field recordings. The use of remote detection technology therefore has the potential to become an important tool in WA's starling control campaign, ensuring we detect and respond early to any future starling incursions.

MITOCHONDRIAL DNA OFFERS UNIQUE INSIGHTS INTO INVASION HISTORY OF THE COMMON STARLING

Lee Ann Rollins[1], Andrew P. Woolnough[2], Ron Sinclair[3], Nick J. Mooney[4] and **William B. Sherwin[1]**.
[1] Evolution & Ecology Research Centre, UNSW, Australia
[2] Department of Agriculture and Food Western Australia,
[3] Biosecurity South, Australia
[4] 2 Torrens Road, Richmond, TAS 7025, Australia
l.rollins@unsw.edu.au; w.sherwin@unsw.edu.au

Mitochondrial DNA (mtDNA) can be a powerful genetic marker for tracing origins and history of invasive populations. Here we use mtDNA to address questions relevant to the understanding of invasion pathways of common starlings (*Sturnus vulgaris*) into Western Australia (WA) and discuss the utility of this marker to provide information useful to invasive species management.

Mitochondrial sequence data indicate two geographically restricted genetic groups within Australia. Evidence of dispersal from genetically distinct sources outside the sampled range of starlings in Australia suggests increased vigilance by management agencies may be required to prevent further incursions from widely separated localities.

Overall, genetic diversity in Australia was lower than in samples from the native range. Within Australia, genetic diversity was lowest in the most recently colonized area in the west, indicating that demographic bottlenecks have occurred in this area.

Evidence of restricted dispersal between localities on the edge of the range expansion (ERE) in WA and other Australian sampling localities suggests that localised control within the ERE may be effective in preventing further range expansion.

Signatures of spatial and demographic expansion are present in mismatch analyses from sampling localities located at the ERE, but neutrality indices did not support this finding, suggesting that the former may be more sensitive to recent expansion. Additionally, mismatch analyses support the presence of admixture, which is likely to have occurred pre-introduction.

We compare our findings with those from a microsatellite study of the same samples, and discuss how the mtDNA analyses used here offer valuable and unique insights into the invasion history of introduced species.

THE USE OF TRAP-NEUTER-RELEASE (TNR) AS A MANAGEMENT STRATEGY FOR FERAL CATS AND OTHER SPECIES

Mandy Paterson
RSPCA Qld, PO Box 6177, Fairfield Gardens, Qld 4103
mpaterson@rspcaqld.org.au

Trap-neuter-release (TNR) is seen by many, particularly in the United States, as a viable and humane management strategy for feral cats. TNR involves capturing most of the cats in a colony, desexing them and returning them to their home range. Other preventative medical procedures are usually undertaken at the same time such as vaccination and deworming. Also, each colony has a caretaker group which provides ongoing management involving regular feeding, and capturing and desexing any new animals joining the colony. There is scientific evidence suggesting that feral cats managed in such colonies in this way enjoy improved welfare and roam over a smaller home range, therefore having a reduced impact on local wildlife. However, not all evidence supports TNR. Some research suggests cats do not necessarily have improved welfare, they still hunt and kill wildlife, and the awareness that TNR programs exist in an area may affect the behaviour of local residents. In Europe, Asia, Africa and Australia (indigenous communities) similar programs, although often not called TNR, are practiced for so called stray, street or community dogs. This paper takes a 'big picture' view of TNR and examines the practice from various perspectives. It concludes that there is no simple answer to whether TNR should be the management practice of choice for feral cats and other animals. All pest management is complex and no simple or simplistic answer is currently available and probably never will be.

PROJECT KAKA: INTEGRATED PEST MANAGEMENT IN A NEW ZEALAND FOREST CONTEXT

Jack Mace, James Griffiths, Ben Reddiex
Department of Conservation, PO Box 5086 Lambton Quay, Wellington 6145
jmace@doc.govt.nz

New Zealand's indigenous species assemblages evolved in the absence of mammalian predators. Human-mediated colonisation by invasive mammals over the past 800 years has caused widespread extinction and decline amongst New Zealand's native species. Proactive conservation management is required in order to halt and ideally reverse biodiversity decline.

The New Zealand Department of Conservation has implemented Project Kaka, a landscape-scale integrated pest management programme over 22,000 hectares the Tararua mountains of New Zealand's lower North Island. Project Kaka aims to protect indigenous biota and incorporates three key elements:

1. Ongoing control of invasive brushtail possums (*Trichosurus vulpecula*), ship rats (*Rattus rattus*), and stoats (*Mustela erminea*) using aerially distributed sodium fluoroacetate;
2. Research to quantify the effectiveness and impact of pest control on native species communities;
3. Community relations to build support for the programme and disseminate the results.

This is a multi-agency research project involving central and regional government, a crown research institute, and the private sector. This research will provide scientifically robust data to demonstrate the necessity and effectiveness of pest control within New Zealand's forest ecosystems.

Project Kaka is discussed in the context of various challenges including fostering and maintaining multi-agency co-operation, conflicting resource demands, and public opposition to the use of toxins such as sodium fluoroacetate. Project Kaka is a useful case study to quantify conservation outcomes of landscape-scale integrated pest management.

BEHAVIOUR AND ECOLOGY OF BRUSHTAIL POSSUMS IN NEW ZEALAND DRYLANDS: IMPROVING KNOWLEDGE TO ENHANCE CONTROL

Rouco C, Glen A, Norbury G, Smith J, Pech R, Byrom A
Landcare Research, PO Box 282, Alexandra 9340, New Zealand
rouco@landcareresearch.co.nz

The Australian brushtail possum (*Trichosurus vulpecula*) is a major environmental and agricultural pest in New Zealand (Cowan 2005). Little is known about the ecology of this marsupial in New Zealand's dryland ecosystems, despite them being common here and subject to population control over vast areas for mitigating their spread of bovine TB. Dryland ecosystems cover about 19% of New Zealand and are the subject of increasing conservation attention and research. Here we describe studies in two dryland regions of the South Island. In Molesworth Station in the north-east, we examined the summer diet, feeding preferences, denning behaviour and survival rates of possums. In Central Otago in the south, we studied possum densities, denning behaviour, and home ranges.

The summer diet at Molesworth was dominated by forbs and sweet briar shrubs (*Rosa rubiginosa*), both of which were consumed preferentially. Possums also strongly preferred crack willow (*Salix fragilis*), which was uncommon in the study area and consumed only occasionally, but in large amounts. Daytime refuges (i.e., dens) of radio-collared possums were mostly found in sweet briar shrubs, followed by rocky outcrops. Estimated activity areas of 29 radio-collared possums based on den locations varied from 0.2 – 19.5 (mean 5.1) ha. Estimated annual survival of radio-collared individ

In Central Otago, population densities derived from capture-mark-recapture methods were 0.50 (95% c.l. 0.42-0.59) ha^{-1} at one site, and 0.72 (95% c.l. 0.6-0.84) ha^{-} at another. Shrubs (mainly sweet briar) were more abundant at the latter site (50% cover) than the former (20% cover), which might explain the differences in possum density. Fourteen adult possums were radio-tracked at one of these sites. Shifts in den sites were very frequent – the maximum number of dens used by a single possum was 26 (from 31 fixes) and the minimum number of dens was 9 (from 9 fixes). Rocky outcrops were more common in this region compared with Molesworth. Most dens (61%) were therefore in rock cracks, 34% in shrubs, and 4% in rabbit burrows. Home ranges based on den site locations were similar to those at Molesworth but were larger for possums living in open areas compared with those in gullies (6.8 and 0.9 ha, respectively). Home ranges based on night-time activity were 3 times the size of daytime ranges in open areas, and 5 times that in gullies.

The ecology of possums in this study differed from other studies in forest or farmland (Cowan 2005), which we believe is a reflection of generally lower availability and more patchy distribution of resources. Our results suggest that invasive willow and sweet briar may facilitate possum abundance by providing abundant food and shelter. This information will be useful in modelling and managing the impacts of possums, and will increase the efficiency and effectiveness of ground control of possums in dryland habitats.

References

Cowan PE 2005. Brushtail possum. *In:* King, C.M. (Editor), The Handbook of New Zealand Mammals, pp 56-80. Melbourne, Oxford University Press.

THE EFFECTIVENESS OF BAITING IN THE MIDST OF A MOUSE PLAGUE: THE INFLUENCE OF POPULATION DYNAMICS ON CURRENT PRACTICES

Marion Atyeo[1], Tarnya Cox[2], Michelle Smith[1], Linton Staples[1].
[1]Animal Control Technologies (Australia), P.O. Box 379, Somerton, Victoria, 3062
[2]Industry & Investment NSW, Vertebrate Pest Research Unit, Forest Road, Orange NSW

Zinc Phosphide has been used successfully to control mice in broad-acre crops since the registration of MOUSEOFF® Zinc Phosphide bait in 2000. The theoretical limit of control for MOUSEOFF® ZP applied at 1kg/Ha is about 10,000 mice/ha assuming 2 poison grains per mouse. Testing during the registration process was conducted with low to moderate mouse numbers (maximum reported 190 mice/ha). The actual field limits of the product at extreme mouse densities have not been rigorously tested however, the reported density of mice during plague are rarely reported over 2500/ha, so the theoretical limit would seem sufficient. The limit of control is based upon several assumptions, these being:

1. MOUSEOFF® is applied evenly over the treated area at 1kg/ha,
2. Mice only eat a minimum required dose to achieve death (1-2 grains/mouse),
3. Mice are spread evenly across the landscape; and
4. The movement of mice across the landscape is minimal.

Trials conducted during mouse plagues in both Victoria and South Australia during 2010, confirmed that current baiting strategies (single application at 1kg/ha with follow up baiting in 'hot spots') are very effective at low to moderate mouse densities (299-1249 mice/ha) with →90% control measured within 3 days of treatment at most sites. However, capture-recapture trapping revealed evidence for potential reinfiltration of treated areas, particularly when mouse densities are likely to be high in un-treated areas adjacent to treated crops. Individual mice were recorded moving distances →300 meters in one night and up to 880m in two nights, with populations within baited plots increasing once infiltration occurred. Furthermore, preliminary bait consumption trials revealed that the average consumption was 5 grains, with one individual consuming 15 grains when mice had ready access to excess bait. These findings have important implications for baiting strategies during times of high mouse infestations.

COULD BAIT CACHING BEHAVIOUR OF SHIP RATS AFFECT THE EFFICACY OF 1080 BAITING FOR KILLING POSSUMS?

Grant Morriss and Bruce Warburton
Landcare Research, PO Box 40, Lincoln 7640, New Zealand
morrissg@landcareresearch.co.nz

Large-scale control of possums and rats in New Zealand forests relies on the aerial application of 1080 baits. Recent research (unpubl.) aimed at reducing the number of baits applied per hectare raises the concern that bait removal by rats may be a risk to possum control efficacy.

In pen trials in mid-2010 we investigated the behaviour of ship rats (*Rattus rattus*) presented with the types of cereal bait commonly used for broad-scale pest control in New Zealand. The hypotheses tested were:

- Ship rats cache both prefeed and toxic baits away from where possums can access them.
- The size and matrix of both prefeed and toxic bait will affect the quantity of baits that ship rats will cache.
- Ship rats leave behind bait fragments that could lead to sub-lethal poisoning of possums.

Forty wild-caught ship rats (21 F, 19 M) were acclimatised to captivity then presented with non-toxic and toxic cereal bait of two types (RS5 and Wanganui No. 7), and of three sizes (2g and 6-g prefeed and 6-g and 12-g 0.15% 1080 baits). Thirty-one (78%) rats cached prefeed bait whereas only 15 (42%) cached toxic bait. The average weight of toxic bait cached was 6.7 g per rat (range 0–6 whole baits; 0–36.8 g). Bait size and bait type had no effect on the quantity of bait cached. There was no difference in the amount of bait cached by male or female rats. Female rats dropped significantly more bait than males, but did not eat significantly less toxic bait compared with males.

Analysis of the size of the partially eaten baits dropped by rats (and therefore likely to be available for possums) suggests that rats may reduce the size of 6-g Wanganui No. 7 baits sufficiently to increase the risk of sub-lethal dosing of possums. Larger bait size eliminated the risk of this happening. Given typical rat densities recorded in New Zealand indigenous forest (c. 5 rats/ha), the degree of caching recorded in this study suggests the likely risk of possum kill being compromised is low.

SEASONAL VARIATION IN HOME RANGE AND PREFERRED HABITAT OF THE EUROPEAN RED FOX, *VULPES VULPES*, IN COASTAL SOUTH EAST QUEENSLAND

Julie O'Connor[1] and Richard Mylan[2]
[1] University of the Sunshine Coast, Locked Bag 72, SC Mail Centre, Maroochydore, 4557
[2] Sunshine Coast Regional Council, Locked Bag 72, SC Mail Centre, Maroochydore, 4557

The European red fox is one of the world's most studied carnivores and yet relatively little is known about its foraging ecology in coastal ecosystems in Australia. On the Sunshine Coast foxes appear to be well established in the dunal system but the extent to which they rely on the marine environment, native bushland and/or anthropogenic food sources is unknown. It is, however, well documented that foxes are significant predators of Loggerhead turtles at the egg and hatchling stages on nesting beaches on the Sunshine Coast and some other nesting beaches in Australia. As part of a broader three year study into the foraging eccology of coastal foxes in South East Queensland, the first six of twelve foxes have been fitted with GPS collars. To investigate whether foraging range and habitat preferences changes in response to seasonal resource availabilty, GPS duty cycles in the collars were programmed to record the foxes' locations every ten minutes for 20 days during summer (Loggerhead nesting season) and 20 days during winter. The data and preliminary findings from the first five foxes in the study are discussed.

Posters

(In Poster Number Order)

WILD DOGS AND BARRIER FENCES IN NE NSW

Guy Ballard[1], Sam Doak[2] and Peter J. S Fleming[1]
[1]Vertebrate Pest Research Unit, I & I NSW, UNE, Armidale, NSW, 2351
[2] Department of Environment, Climate Change and Water, Walcha, NSW 2354
guy.ballard@industry.nsw.gov.au

In the tablelands region of north-east NSW, barrier fences have long been used to minimise predation of livestock by wild dogs. Although some historic dog fences have fallen into disrepair, many remain and still others are being built in order to promote and maintain the viability of livestock enterprises.

In this poster, we report on the movements of wild dogs living adjacent to livestock enterprises 'protected' by barrier fences. Using data from GPS-collars, we report the frequency and duration of recorded wild dog incursions into livestock production areas, as well as the known impacts on livestock. Additionally, we make recommendations for enhancing the use of barrier fences as a means of mitigating livestock loss in the future.

WOLFING THEM DOWN. HOW MANY 1080 MEAT BAITS DO INDIVIDUAL WILD CANIDS CONSUME DURING BAITING PROGRAMS?

Guy Ballard[1], Sam Doak[2] and Peter J. S Fleming[1]
[1]Vertebrate Pest Research Unit, I & I NSW, UNE, Armidale, NSW, 2351
[2] Department of Environment, Climate Change and Water, Walcha, NSW 2354
guy.ballard@industry.nsw.gov.au

In association with an ongoing trial into the efficacy of various aerial baiting rates for wild canid control, individual wild dogs and foxes fitted with telemetry collars were monitored before and after baiting programs. In response to alerts from mortality sensors on study animals, the authors sought to retrieve carcases as soon as possible following baiting for examination and tissue sampling purposes. In this poster we present preliminary findings on the gut contents of dead canids in the context of known movements and bait locations.

A SCAT IN A HAYSTACK: THE PROBABILITY OF DETECTING FOX SCATS IN TASMANIA

Dave Ramsey[1], Candida Barclay[2], Alison Foster[3], Stephen Sarre[4]
[1] Arthur Rylah Institute for Environmental Research, Brown St, Heidelberg, VIC 3084
[2] TAS Department of Primary Industries, Parks, Water & Environment, Prospect, TAS 7250
[3] NSW Department of Environment, Climate Change & Water, Hurstville, NSW 2220
[4] Institute for Applied Ecology, University of Canberra, ACT 2601

The Tasmanian Fox Eradication Program (FEP) routinely undertakes carnivore scat collection surveys, by either people or trained scat detector dogs, as a primary means of finding evidence of foxes. Over a three year period the FEP has strategically monitored over 21,000km of Tasmania and collected more than 6,800 perceived carnivore scats, 57 of which have been found to contain fox DNA. In order to accurately interpret the results in terms of potential fox distribution, the likelihood of a search team finding a scat, given one is present, had to be quantified for a given amount of effort. To do this we undertook formal trials where participants were aware of the presence of trial scats and knew they were being tested, and blind trials undertaken during normal scat survey activities where participants were unaware of the presence of trial scats. Scats were randomly placed on features within the trial areas, and after the survey was completed the distance travelled to reach each scat was calculated. It was also noted whether or not the scat was 'encountered' (passed close to the scat) and/or 'detected' (found). Survival analysis was then used as the basis for estimating the detection rates, whereby scats were considered to have 'died' once found. Results showed that while people are more likely to encounter scats than dogs, they are less likely to detect them. The probability of finding a scat within a 9km area, if one is present, was found to be 20.5% for dog searches and 13.5% for people searches. This is despite dogs covering on average only 8 linear kilometres compared to people's 20km. The results also showed that people were less likely to detect scats when they were unaware of being tested, reflecting a possible observer fatigue under normal survey conditions. As a result of this study the Fox Eradication Program now aims to preferentially use scat detection dogs for monitoring over the use of people, and if people do undertake survey, survey effort is increased.

POPULATION GENETICS OF THE TOP-LEVEL AUSTRALIAN CARNIVORE: IS THERE GENETIC SUBDIVISION BETWEEN DINGO POPULATIONS

Kylie M. Cairns[1], Alan N. Wilton[1] and J. William O. Ballard[1,2]
[1]School of Biotechnology and Biomolecular Sciences, University of New South Wales, Australia
w.ballard@unsw.edu.au

North American and European top-level carnivores are observed to have distinct patterns of population subdivision, theorised to be the result of differences in climate conditions, prey choice and/or geographic barriers. Population geneticists consider these patterns to be examples of adaptive evolution and the beginnings of speciation. There is currently a lack of empirical data concerning genetic subdivision and regional variation in the dingo. The dingo is an ancient dog that has been isolated on the Australian continent for approximately 5,000 years. Today, dingoes are relatively common across most of central, northern and western Australia and are also present on some Australian islands. Understanding the population genetics of a carnivore such as the dingo is important for three main reasons: (1) as a model of adaptive evolution and speciation (2) to inform management and conservation plans and (3) to inform human perceptions. We assayed three dingoes from regionally dispersed regions to identify variable markers as a preliminary of a broader study. We assayed genetic variation for a large number of mitochondrial and nuclear genes. Mitochondrial genes investigated include CO1, Cytochrome b and ATP 6 and nuclear genes include coat colour genes (Agouti, MC1R and CBD103), olfactory receptor genes (cfOR0011, cfOR0123, cfOR0184, cfOR0034, cfOR0007, cfOR14A11, cfOR0821 and D6PRH07), DLA class II MHC genes (DLA-DRB1, DLA-DQA1 and DLA-DQB1) and the dopamine receptor 4 gene (DRD4).

THE AUSTRALIAN PEST ANIMAL STRATEGY

David Dall
National Coordinator, Australian Pest Animal Strategy
LPO Box 5055, University of Canberra Bruce ACT 2617
coordinator@apas.net.au

The Australian Pest Animal Strategy ('APAS') is a national framework plan developed by the Vertebrate Pests Committee (VPC) and endorsed by the Natural Resource Management and the Primary Industries Ministerial Councils in 2007. The vision of the APAS is that "Australia's biodiversity, agricultural assets and social values are secure from the impacts of vertebrate pest animals".

Consistent with the vision, the APAS sets out how those governments will work with each other, and with business, industry and the community to manage the issues and problems associated with vertebrate pests across the biosecurity continuum in Australia.

A key function of the APAS is to provide a mechanism for coordinating the adoption of consistent national approaches to management of pest animals and their impacts.

In cooperation with the Australian Weeds Committee, the VPC has finalised development of a 'National Categorisation System for Invasive Species', which will be forwarded to the National Biosecurity Committee for endorsement.

One of the categories established under this system is anticipated to be 'Established Invasive Species of National Significance'. This category is intended to identify pest species that actually or potentially occur across one or more states or territories with actual or potential 'nationally significant impacts', which cannot feasibly be eradicated, and for which national coordination of effort is needed to reduce/minimise impacts.

Species including rabbits, wild dogs and feral cats, goats and camels appear to satisfy the criteria required for Ministerial endorsement of a pest species as a member of this category.

Identification of a pest species as an Established Pest Animal of National Significance (EPANS) will assist to maintain a focus on investment of resources required for development and delivery of strategies and technologies to reduce their impact on the national environment.

ADVANCING PRACTICAL CANE TOAD MANAGEMENT WITH 'HOPSTOP'®

David Dall, Joan Dawes & Sally Campbell
Pestat Pty Ltd, LPO Box 5055, University of Canberra
Bruce ACT 2617

In 2010, HopStop® was registered by the Australian Pesticides & Veterinary Medicines Authority (APVMA) as the first commercial product for household control of the cane toad, *Rhinella (Bufo) marinus*. The product was developed and commercialised by Pestat Pty Ltd, a private SME based in Canberra that specialises in science management and research.

HopStop was developed to provide a safe, effective, humane and convenient method for householders to kill cane toads. The technology is based on a chemical that is poisonous for toads (chloroxylenol), formulated with others that act as anaesthetics. All the ingredients in the product are safe for humans and pets and are found in other household products, though not in the combination that delivers the results achieved by HopStop.

Because cane toads produce potent poisons in their skin and body, any animals that eat – or even pick up – a toad are frequently killed by the encounter. As well as the major impact on wildlife, many domestic pets – particularly dogs – are poisoned by cane toads each year. Cane toad poisons are also severely irritating to eyes, and cases have been recorded in Australia of human eye damage and even blindness from toad poison contacting eyes.

Using HopStop simply requires spraying the toad once or twice for 2-3 seconds. Toads then commonly hop at an ever-decreasing pace for a period of 25-40 seconds, before becoming immobilised as the anaesthetic takes effect. For a test population of large toads (mean = 210 gm; range 140-320 gm; n=13) the mean time ($\pm$ SE) to immobilisation was 55$\pm$13 seconds (median: 42 sec). Toads show no identifiable signs of distress subsequent to treatment. While the toad is 'knocked out' the product's toxicant takes effect, and the toad dies some 30-45 minutes later without regaining consciousness. The user is advised to subsequently dispose of the toad cadaver (so that other animals are not exposed to residually active toad poisons).

HopStop® thus delivers a practical advance in pest management that provides:

- the first officially-approved pesticide for cane toads;
- the first safe, humane and convenient method for householders to kill toads;
- the first example in the world (to our knowledge) of an aerosol spray that is approved to kill a vertebrate pest animal (as compared to insect and other invertebrate pests);
- a step towards effective management of the 'cane toad menace' in the Australian domestic environment, and
- a potential export product to the many other places in the world where cane toads are also a hazard to people, pets and the environment.

RAINFALL AFFECTS FERAL GOAT (*CAPRA-HIRCUS*) HOME RANGE IN AUSTRALASIA

Peter J.S. Fleming[1], John P. Tracey[1], Grant Eccles[2], Matthew N. Gentle[1,3], Robert P. Henzell[4], Mike Letnic[5]
Greg R. Jones[1], and Benjamin G. Russell[6]
[1]Vertebrate Pest Research Unit, I&I NSW, Orange, NSW 2800
[2] Tablelands Livestock Health and Pest Animal Authority, Goulburn, NSW 2580
[3] Biosecurity Queensland, Robert Wicks Pest Animal Research Centre, 203 Tor Street, Toowoomba, Qld 4350
[4] Animal and Plant Control Commission, GPO Box 2834, Adelaide, SA 5001
[5]University of Western Sydney, Locked Bag 1797, Penrith South DC, NSW 1797
[6]Pest Management Unit, DECCW, Hurstville, NSW 2220
peter.fleming@industry.nsw.gov.au

McNab (1963) and others postulated that energetic constraints associated with body size set home range size of vertebrates, that is, it is allometric. We propose that for vertebrate pests, which are usually generalist species with wide geographic ranges, home range size will vary according to primary productivity of the landscape and that this provides variation that exceeds allometric predictions. We use the female feral goat to demonstrate.

In the absence of measured primary productivity across many Australasian ecosystems, we use mean annual rainfall (mar) as a proxy. We reviewed all available estimates of goat home range size across their geographic range in Australasia, and these provided estimates for dry and wet climatic extremes, corresponding with where the studies were done. To fill in the gaps at middling rainfalls, we undertook field studies to estimate home ranges sizes at 4 sites with intermediate mar. We also used published allometric equations to predict the home range size of feral goats from recorded and published weights.

Home range sizes of adult female feral goats ranged from 0.72–81.35 km2. Allometric functions provided variable estimates of home range size that did not correspond well with empirical estimates. We found a strong negative power relationship between female home range size and rainfall, with home range size increasing rapidly as mar falls below 550mm mar. We predict that below this, feral goats are dependent on permanent water for constant residency and below about 250mm mar, feral goats are likely ephemeral in home range use and possibly nomadic in response to seasonal water and forage shortages. Our home range/ rainfall power function is a useful tool for predicting the size of feral goat management units.

McNab, B K (1963) Bioenergetics and the determination of home range size. Am. Nat. 97, 133–140.

BAIT HEAD DEVELOPMENT FOR MECHANICAL EJECTORS

Karen Harland[1] and Ricky-John Spencer[2]
[1] Water and Wildlife Ecology Group (WWE), Native and Pest Animal Unit,
[2] School of Natural Sciences, University of Western Sydney, Richmond, NSW 2753
k.harland@uws.edu.au

This poster experimentally evaluates a range of plastic composite and freeze dried bait head lures for the M44 Ejector. Nine field trials in various locations within New South Wales, Victoria and the ACT were used and ejectors were deployed for up to 12 months continuously at some sites. The most successful bait head, in terms of longevity and attractability, was a long-life polymer based bait head comprised of a plastic matrix incorporating dried meat flakes and liquid lures. The lures also provided an unexpected outcome of both mould and ant resistance.

REDUCTION IN FOX ACTIVITY IN THE SAND DUNES OF STURT NATIONAL PARK: EFFECTS ON SMALL TERRESTRIAL VERTEBRATES, CATS AND RABBITS

Ulrike Kloecker[1, 2 *], David B. Croft[1] and Ingrid Witte[2]
[1]School of Biological, Earth and Environmental Sciences, University of NSW, UNSW Sydney NSW 2052
[2]DECCW Parks and Wildlife Group, Tibooburra NSW 2880
uli.kloecker@environment.nsw.gov.au

Fox control is commonly used in Australia as a conservation tool. However, the benefit (or otherwise) of this action has rarely been assessed. This study investigated the responses of native small terrestrial vertebrates, House Mice, Cats and Rabbits to reduced Fox activity. The sand dunes in the western part of Sturt National Park presented a suitable study area as 1) populations of Foxes, Cats and Rabbits were abundant and largely uncontrolled due to the remoteness of the area and 2) the small vertebrate community of the Park included several threatened species for which Fox predation poses a likely threat.

The study design was conducted in the form of a BACI design. Fox activity was suppressed by 1080 baiting on the 'Impact' sites (n = 4). 'Control' sites (n=2) were left unbaited. There was also a likely drought-induced reduction in Fox activity across the course of the study. Thus a breakpoint analysis was used to assess the impact of any reduced Fox activity.

The results indicated that reduced Fox activity had no effect on most reptile and native small mammal species or Rabbits. However, House Mice and Cats may have benefitted as abundance increased. Thus competitive and predatory effects of the latter may have potentially counter-acted the reduced predation pressure from Foxes on small terrestrial vertebrates.

PREY-PREDATOR DYNAMICS BETWEEN CATS AND MICE ON GUADALUPE ISLAND, MĒXICO

Luciana Luna-Mendoza[1], Mick Clout[1], David Choquenot[2], James Russell[1] and Alfonso Aguirre-Muñoz[3]
[1]SBS, University of Auckland, Private Bag 92019, Auckland, New Zealand, 1142
[2]Landcare Research, Private Bag 92170, Auckland, New Zealand, 1142
[3]Conservacion de Islas, Moctezuma 836, Centro, Ensenada, Mexico, 22800
llun008@aucklanduni.ac.nz

Feral cats (*Felis silvestris catus*) and house mice (*Mus musculus*) have been introduced to islands all over the world. They represent a major threat to native flora and fauna and alter natural ecological processes. Eradication of cats and mice has been achieved on many islands but their simultaneous eradication is uncommon and challenging.

Ecological models have been built to study prey-predator dynamics in different environments. Several studies have been conducted on relationships between native predators and their prey (e.g. Gilg et al. 2006, Krebs et al. 2001). Fewer studies have focused on dynamics of introduced animals, measuring simultaneously functional and numerical responses of introduced predators and fluctuations in their prey (Harper 2005, Ruscoe et al. 2005).

On Guadalupe Island (24,171 ha) in Mexico, feral cats and house mice are both present. The aim of this study is to measure and model interactions between the three trophic levels: cats, mice and mouse food resources (seeds and invertebrates). Density and relative abundance of the four groups are being measured using different techniques as well as the response of the mouse population to cat exclusion. An important part of the research is to determine the dietary response of cats to changes in mouse population levels. Ecological models based on this information will be developed and used to explore management actions, in particular the eradication of cats and mice, on Guadalupe Island.

References:

Gilg, O., Sittler, B., Sabard, B., Hurstel, A., Sanē, R., Delattre, P. and Hanski, I. (2006). Functional and numerical responses of four lemming predators in high arctic Greenland. *Oikos* 113: 193-216.

Harper, G. A. (2005). Numerical and functional response of feral cats (Felis catus) to variations in abundance of primary prey on Stewart Island (Rakiura), New Zealand. *Wildlife Research* 32: 597-604.

Krebs, C. J., Boutin, S. and Boonstra, R. (2001). Ecosystem Dynamics of the Boreal Forest: The Kluane Project Oxford University Press. New York, USA.

Ruscoe, W. A., Elkinton, J. S., Choquenot, D. and Allen, R. B. (2005). Predation of beech seed by mice: Effects of numerical and functional responses. *Journal of Animal Ecology* 74: 1005-1019.

CANE TOAD (*BUFO MARINUS*) PATHWAY ANALYSIS FOR WESTERN AUSTRALIA

Marion Massam[1], Garry Gray[1] and Corrin Everitt[2]
[1] Department of Agriculture and Food, Locked Bag 4, Bentley Delivery Centre, Western Australia, 6983
[2] Program Leader, State Cane Toad Initiative, Department of Environment and Conservation, Kununurra, Western Australia, 6743

Cane toads have been detected in Western Australia on many occasions via accidental introductions and occasionally intentionally. While these occurrences have not yet resulted in the establishment of wild populations, a formal pathway analysis of cane toad introductions in WA was undertaken to assist prioritisation of inspection and extension efforts.

Thirty eight cane toad detections have been recorded in WA since 1974, to seven WA regions, and at the quarantine checkpoint east of Kununurra. The majority of detections for which origin of the toad was determined (or reliably assumed), were from Queensland, with slightly less from the Northern Territory. One animal recently located in the south-west of WA may have originated from the Kimberley region where the toad front is advancing west into the state.

The most frequent detections have occurred in road-transported items (including camping gear and general freight) that have probably come in contact with the ground, including pallets, shipping containers and other containers. Toads associated with campers have been detected at caravan parks, while general freight detections have been mostly made at freight yards and industrial areas. Other slightly less frequent detections have been made in agricultural piping in freight yards and industrial areas, in pot plants at the checkpoint and a nursery, and in banana shipments at food distribution centres.

This study also showed the benefits of collecting accurate and detailed data on pest detections. Western Australia's data was of a standard that could be analysed in detail to maximise investigation of invasion pathways. In the future it may also be important to address the reasons preventing the general community reporting toads. Data useful to pathway analyses as well as the reasons for non-reporting will be suggested, and may be applicable to other invasive species.

Risk matrices of prioritised actual and potential invasion pathways based on this study will be included on the poster, along with recommended and actual on-ground actions.

TOWARDS A CELL CULTURE SYSTEM FOR RABBIT CALICIVIRUSES

Markus Matthaei, Peter Kerr and Tanja Strive
CSIRO Ecosystem Sciences, Clunies Ross St, Black Mountain, ACT 2601
Invasive Animals CRC, Bldg 3, University of Canberra, Brice, ACT 2617
markus.matthaei@csiro.au

Rabbit Haemorrhagic Disease Virus (RHDV) is widely used in Australia and New Zealand to control populations of the European Rabbit (*O. cuniculus*), one of the worst invasive vertebrate pest species in these regions.

To date, no robust cell culture system exists for RHDV. Hence, RHDV has to be propagated in live rabbits and purified from liver homogenate to be deployed as a biocontrol agent and to prepare the commercial vaccine that is used to protect domestic rabbits from RHDV infection. Similarly, virus titrations need to be carried out in rabbits, which is time consuming, expensive and has animal welfare implications. Importantly, the lack of a suitable cell culture system has severely hampered molecular studies and thereby the understanding of the biology of RHDV.

Recent advances in the calicivirus research field could explain why former attempts to establish cell culture systems for caliciviruses failed. In particular, a strong activation of innate immune responses is likely to hinder the growth of RHDV and other caliciviruses *in vitro*[1] and represents a logical starting point to re-investigate the feasibility to establish an RHDV cell culture system.

Currently, different European and Asian RHDV strains are being examined in Australia to assess their ability to complement the Australian biocontrol strain of RHDV to improve rabbit management. The availability of a cell culture system for RHDV would represent an invaluable additional tool to propagate, titrate and characterise these strains.

We will present preliminary results of infection studies of established rabbit cell lines as well as primary hepatocytes and the activation of innate immune responses by RHDV in these cells.

[1]. Murine Norovirus: a model system to study norovirus biology and pathogenesis. Wobus, C., Thackray LB, Virgin HW. J Virol. 2006 Jun;80(11):5104-12. Review.

WHEN TO DECLARE FOX ERADICATION ON PHILLIP ISLAND

Rout, Tracy M.[1,2], Sutherland, Duncan R.[3], Kirkwood, Roger[3], Murphy, Stuart[4], McCarthy, Michael A.[1]
[1]School of Botany, University of Melbourne, VIC 3010
[2]School of Biological Sciences, University of Queensland, QLD 4072
[3]Research Department, Phillip Island Nature Parks, PO Box 97, Cowes, VIC 3922
[4]Environment Department, Phillip Island Nature Parks, PO Box 97, Cowes, VIC 3922
tmrout@unimelb.edu.au

Eradication of introduced predators from 'predator-naïve' ecosystems can have profound benefits. Accomplishing eradications is difficult, as is confidently identifying when they are achieved. False or delayed declarations carry significant risks. Declaring too early allows predators to re-establish, and declaring too late can be unnecessarily costly. Here we apply a decision framework that minimises the risk of both errors to the eradication of the red fox *Vulpes vulpes* on Phillip Island, Victoria. Red foxes were introduced to Phillip Island (100 km, permanently inhabited), in the early 1900s and threaten many of the island's wildlife, notably economically significant colonies of Little Penguins *Eudyptula minor*. A fox eradication program was established in 2006 and has achieved a substantial knockdown. It involves dedicated staff, island-wide baiting, spot-lighting, snaring etc., and a communications program. We model fox sign and catch-effort data to estimate the probability of detecting and removing a fox by each technique. The model also provides an estimate of the number of foxes remaining on the island at given points in time. In addition, the model can be used to determine how much search effort is needed after the last fox sign is recorded to provide a level of confidence that eradication has been successful. We can then estimate the optimum amount of search effort required to minimise expected cost, including the cost of continued searching as well as the cost of declaring eradication when foxes are still present.

SIGNS OF SUCCESS: 'KNOCK-DOWN' OF FOXES IN A LOCAL ERADICATION PROGRAM

Murphy, Stuart[1]; Fahnle, Beau[1]; Kirkwood, Roger[2]; Sutherland, Duncan R.[2]
[1] Environment Dept., Phillip Island Nature Parks, PO Box 97, Cowes, VIC 3922
[2] Research Dept., Phillip Island Nature Parks, PO Box 97, Cowes, VIC 3922
smurphy@penguins.org.au

Eradication of introduced pests typically involves three phases: 'knock-down', 'clean up' and 'post-eradication'. Monitoring is essential to recognising the achievement of each step, which leads on to a change in tactics for the next step. On Phillip Island, Victoria, a strategy to eradicate foxes commenced in 2006. This followed more than 20 years of a control program that potentially held foxes below the island's carrying capacity. The 'knock-down' procedure involved island-wide baiting supported by a suite of other techniques, including spot-lighting and trapping. To record the 'knock-down', we monitored catch rates, effort, fox sign (tracks and scats) and changes to other wildlife populations. After 5 years, results suggest a 'knock-down' has been achieved. Signs for this include reductions in fox sign and catch per unit effort, reduction to zero in little penguin deaths due to foxes and increases in numbers of ground nesting birds. Evidence suggests that the fox population has been reduced from 150-200 to ← 20 individuals (cubs included). Having achieved 'knock-down' we now enter a 'clean-up' phase, which is likely to require more resources than the 'knock-down'. Effort is also required to minimise the chance of re-invasion; DNA data suggests foxes migrate to the island at a rate of one every 5 years (Berry and Kirkwood 2010). The Phillip Island fox Eradication Program now seeks collaborators to increase effort in this important eradication attempt.

References:

Berry, O. & Kirkwood, R. (2010) Measuring recruitment in an invasive species to determine eradication potential. *Journal of Wildlife Management* 74, 1661–1670.

INITIAL FIELD TRIALS OF AN AUTOMATED CAT POISONING DEVICE

John Read[1], Clint Taylor[2], Andrew Bengsen[3] and Pip Masters[3]
[1]Ecological Horizons, PO Box 207, Kimba, SA 5641
ecological@activ8.net.au
[2]Arid Recovery, Charlton Rd, Olympic Dam, SA 5725
clint.taylor@aridrecovery.org.au
[3]Kangaroo Island, NRM Board, 35 Dauncey Street, Kingscote SA 5223
andrew.bengsen@uqconnect.edu.au, pip.masters@kinrm.com.au

Predation by feral cats continues to be one of the key threats to the conservation of many threatened species in Australia. Development of novel and targeted poison delivery mechanisms are priorities of the national feral cat management plan. One of the key challenges of feral cat control is their reluctance to consume baits or enter baited traps, particularly when live prey are abundant. A key breakthrough would be to develop a means for poisoning cats without relying on them deciding to consume baits. An automated feral cat poisoning device that lures cats into a pipe and then delivers poison directly to their fur for ingestion through impulsive grooming can potentially eliminate toxin exposure to key non-target species (Read 2010). Should this device be registered for use, it could drastically reduce non-target impacts, logistical costs and ethical concerns of controlling feral cats, whilst increasing efficacy of feral cat control, which will greatly assist with conservation initiatives.

This presentation shows investigations undertaken by Arid Recovery in parallel with complimentary trials conducted by the Kangaroo Island NRM Board including:

1. the inclination of feral cats to enter different pipe types
2. the durability and continued ability of the device to deliver poison medium under field conditions
3. the relative attractiveness of different lures and lure placements in attracting cats into the pipes
4. the response and potential of key non-target species to the automated poisoning devices

Key areas for further development planned by an Invasive Animal CRC project are also presented.

References:

Read, J.L (2010). Can fastidiousness kill the cat? The potential for target-specific poisoning of feral cats through oral grooming. *Ecological Management &Restoration* 11: 230-233.

HOW ACCURATE ARE FIELD-BASED ESTIMATES OF THE AGE OF WILD DOGS?

Lauren O'Bryan[1], Dr Lee Allen[2], Assoc. Prof. Peter Murray[2] and Dr Luke Leung[2]
[1] Biosecurity Queensland
[2] University of Queensland School of Animal Studies

Knowing the age of wild dogs at capture is an important attribute to consider when evaluating control programs or reporting ecological studies. Often the age of free-ranging wild dogs (*Canis lupus dingo* and *C.l. domesticus* hybrids) reported in scientific literature is determined by professional trappers at capture, and subjectively based on external physical characteristics such as weight, gender and physical condition. Such estimates may not be reliable. The pulp cavity: tooth width ratios of upper canines have been demonstrated to be an accurate method to determine the age of dingoes and other carnivores. In this paper we compare the age of 81 wild dogs as determined in the field by four professional trappers based in Western Australia, New South Wales and Queensland to ages calculated from pulp cavity: tooth width ratios measured from x-rays of upper canines taken from the same animals.

94% of field estimates of age were overestimated ($p \rightarrow 0.07$) with the mean discrepancies ranging from 4 to 35 months. There was a significant correlation between post-capture weight and discrepancy in age estimates ($r62 = 0.381$, $p = 0.002$) with heavier individuals judged older than slightly-built individuals of the same age. Similarly, there was a significant correlation between post-capture weight and discrepancy in age estimates based on gender ($r62 = 0.299$, $p = 0.015$) with less discrepancy in the age estimates made of a female dingo compared to that of a male. Adult dingoes (≥24 months) were correctly classed as adult by trappers in every case, 95% of sub adult dingoes (11-23 months) were overestimated as adult by trappers and 43% of the juveniles (t10 months) were overestimated and placed in the adult age class. These findings indicate that the four physical characteristics (weight, tooth wear, gender and physical condition) used together to estimate age are unreliable. We present a field guide, based on visual assessments of dentition and tooth wear, to assist field estimations of age where the extraction and x-raying of teeth is impractical or unwarranted but recommend the use of pulp cavity: tooth width ratios when reporting the ages of wild dogs for scientific studies.

NATIONAL PREDATOR DETECTION DOG PROGRAMME, CONSERVATION DOGS NEW ZEALAND

Karen Vincent[1] and Scott Theobald[2]
[1]Department of Conservation, Research and Development, PO Box 10-420, Wellington 6143
[2]Department of Conservation, Research and Development, PO Box 842, Whangarei 0112
kvincent@doc.govt.nz

Dogs have assisted with mammal eradications in New Zealand for the last 30 years. Since 2002 the Department of Conservation has run a dedicated predator detection dog programme providing dog and handler training and certification, systems development and improvement, a breeding programme and operational support. The dogs are trained to detect the presence of mammalian predators and browsers including rodents, mustelids, cats and rabbits for the purposes of audit, incursion contingency response, surveillance, biosecurity quarantine and optimising trap placement. Dogs have proven to be an extremely effective tool for confirming presence when predator numbers are low and other predator detection methods (tracking tunnels, traps, waxtags) are less efficient. Once detected by dogs the predators are killed using pesticides, traps or shooting. Since the programme started, these dogs have been involved in many successful pest eradication programmes on islands.

The Conservation NZ dog programme has also provided international advice, training and dogs (practical support) for eradication programmes e.g., Macquarie I., Australia (rabbits) and Amami I., Japan (mongoose).

This poster presents the dog programme and illustrates case studies where use of the dog programme has assisted eradications including: Raoul Island (cats), Campbell I. (cats and Norway rats), Secretary I. (stoats), Te Kakahu/Chalky I. (stoats), Tuhua/Mayor I. (cats), and many contingencies including Motuihe I. where the rodent dog detected the rat within 48 hours of tracks being discovered on tracking cards.

NEW WAYS IN AN OLD SYSTEM – HOW TO CHANGE AN ASPECT OF A STATE'S APPROACH TO RISK MANAGEMENT

Gina Paroz, Bronwen Williams, John Burley, Melinda Corry, and Susan Wisniewski
Victorian Department of Primary Industries, GPO Box 4440 Melbourne 3001

Significant changes to States' approaches to risk management can occur within existing legislative systems. In 2009 a comprehensive review was undertaken to identify new pest animal species that threaten, or potentially threaten Victoria. The decision was made to move away from a 'black' or 'prohibited' list approach, where a relatively limited number of species were regulated, towards a more proactive approach to the management and regulation of pest animals. Victoria now has a new list of declared pest animals, with supporting policy, providing a clearer and better way to manage the risks associated with the import, keeping, sale and release of pest animals.

Like most Australian states and territories, Victoria has a complex regulatory system in which it manages the risk of non-indigenous animals. With the exception of fish, invertebrates and domestic animals, non-indigenous animals can be regulated under the *Catchment and Land Protection Act 1994* (CaLP Act), and declared under this Act within four categories on the basis of their threat to primary production, Crown land, the environment and community health. The rationale for the declaration into the categories of Prohibited, Controlled or Regulated pest animals is based on the need for the regulation or banning of their import, keeping and sale. Animals are declared Established pest animals on the basis of their current establishment in the wild in Victoria and the need for their control. Under this Act declared pest animals were first published in the Victorian Government Gazette in 1997, and these declarations remained unchanged until last year.

While there had been little change in the regulation of pest animals in Victoria during the intervening years the general approaches, public perception, and the understanding of the assessment and management of risks have changed significantly.

An opportunity arose in 2009 to take a more proactive approach to the declaration of pest animals, using new policy approaches to lead legislative and operational change. The process Victoria went through was based on a risk management and was in line with national guidelines. The ways in which Victoria has made significant positive changes to policy within an existing regulatory framework, without negatively affecting commercial or other interests, and while providing significant benefits to the operations of invasive plants and animals program, is discussed.

ERADICATION OF INVASIVE RODENTS ON ISLANDS OF THE UNITED STATES

Gary W. Witmer[1], Judy Pierce[2], William C. Pitt[3]
[1]USDA/APHIS/WS National Wildlife Research Center, 4101 Laporte Avenue, Fort Collins CO 80521-2154 USA
[2]USVI Division of Wildlife, 6291 Estate Nazareth, St. Thomas VI 00802 USVI
[3]USDA/APHIS/WS National Wildlife Research Center, PO Box 10880, Hilo HI 96721 USA
gary.w.witmer@aphis.usda.gov

Many invasive rodents have become established in the United States and its territories. The species include several species of *Rattus*, house mice, Gambian giant pouched rats, ground squirrels, nutria and marmots. These rodents have caused serious impacts to native flora and fauna, agriculture, and other resources. Since the early 1990s, agencies have been eradicating rodents from various islands, primarily for conservation purposes. Of about 40 eradication attempts, 22 (55%) appear to have succeeded. For several islands, however, it is too early to determine if the attempted eradication has been successful or not. In the case of failed eradications, rapid re-invasion by rodents from nearby islands may be the reason. Numerous additional eradications are planned. We review the eradications, both successful and unsuccessful, that have occurred in the United States. Most eradications involved the use of the anticoagulant rodenticides diphacinone and brodifacoum. Rodenticides have been applied by hand-broadcast, bait station deployment, and aerial broadcast. We briefly review the strategies and methods used in eradication projects and the efforts to mitigate potential non-target and environmental impacts. Finally, we consider some of the remaining challenges in invasive rodent management and eradication in the United States. Some of the challenges faced include the use of toxicants, land access, public attitudes, resource availability and monitoring difficulties.

OPTIONS FOR IMPROVING PEST MANAGEMENT ACROSS THE LANDSCAPE: DATA CAPTURE AND REPORTING OF POISON BAIT PLACEMENT

Alison L. Towerton[A], Rhett Robinson[B], Cameron Chaffey[C], Trent D. Penman[D], Rodney P. Kavanagh[D] and Christopher R. Dickman[A]

[A]Institute of Wildlife Research, School of Biological Sciences A08, University of Sydney, NSW 2006, Australia

[B]Central West Livestock Health and Pest Authority, Dubbo, NSW 2830

[C]NPWS, NSW Department of Environment, Climate Change and Water, Dubbo, NSW 2830

[D]Forest and Rangeland Ecosystems, NSW Industry and Investment, Beecroft, NSW 2119, Australia.

alison.towerton@gmail.com

Predation by the European red fox continues to be a significant problem across NSW and most parts of Australia. Fox control over large areas using poison baits is used to protect both agricultural and ecological assets. Coordinated approaches to fox control are most effective and efficient, and necessarily involve placement of baits across the landscape by private and public land managers who participate in locally organised control programs. The timing and frequency of baiting is important and is determined by local coordination committees. However, participation varies seasonally, and the spatial coverage of baiting is difficult to determine and often remains unknown. For each control program, minimisation of gaps in bait coverage is likely to be an important factor in maximising bait encounters by foxes during the small temporal window of a baiting program.

With technological advances, opportunities arise to examine methods that enable and assist land managers to collect and use spatial information. The Land Management Database (LMDB) is managed by the NSW Department of Environment, Climate Change and Water (DECCW) and used primarily by Catchment Management Authorities to capture on-ground works related to Natural Resource Management, including pest control programs. Spatial data are captured using ArcGIS and linked to project management information stored in a database (eg. Catchment Information Management System (CIMS)). Automated reporting is developed for data quality checks, state and federal reporting and specific tasks as required. This platform can be further developed to capture and report on bait placement, by landholders and public land managers, across the landscape in a timely manner to provide feedback to control program committees on gaps in the landscape and/or where resources can be better utilised. Collection of such data also allows operational activities to be documented and reported, as well as providing important covariates for monitoring program analysis.

Increasing the chance of bait encounters by foxes and other pest species during control programs is likely to improve the success of control efforts. We believe the next step in strengthening the coordinated approach is to increase the spatial coverage of baits during programs. We believe this can be best achieved by organising the placement of baits across the landscape using GIS and other technologies to provide the necessary spatial information in a timely manner for responsive action.

A COORDINATED APPROACH TO INTEGRATED FOX CONTROL: A CASE STUDY OF THE SOUTHERN NEW ENGLAND REGION

Rebecca Ballard[1], Peter Frizell[2], Brian Ferris[2] and Ken Pines[3]
[1] Southern New England Landcare, PO Box 85, Armidale, NSW 2350
[2] New England Livestock Health and Pest Authority, 123-130 Taylor St, Armidale, NSW 2350
[3]National Parks and Wildlife Service, PO Box 402, Armidale, NSW 2350
bec@snelcc.org.au

In 2004, the European Red Fox *(Vulpes vulpes)* cost the Australian environment and agricultural industries more that $227 million annually (McLeod, 2004). Fox densities in the Northern Tablelands area of New South Wales range from 4.6 – 7.2 foxes per km (Thompson and Fleming 1994). Fine wool and lamb production is a major industry in the Northern Tablelands. Foxes have a considerable impact on profits from sheep production through predation of new born lambs.

Pioneering Landcare groups had found that greater gains in fox control could be made by ensuring neighbouring groups conducted '1080' fox baiting within a close time frame. In an effort to build on this success Southern New England Landcare in partnership with the New England Livestock Health and Pest Authority and National Parks and Wildlife Service formed The Southern New England Coordinated Fox Control Program in 1997. This program promotes an integrated approach to fox control including coordinated baiting, shooting and trapping. Over the past 14 years this community lead program has evolved to include 30 community groups, with 36 volunteer group coordinators baiting over a 6 week period. The regional program consistently involves over 300 properties and distributes more than 18,000 fox baits.

A major component of the program is community awareness and education, focussing on the impact of predation on livestock and native wildlife, how foxes contribute to the spreading of weeds such as blackberries and disease, and the impact foxes have on Dung Beetles. Responsible baiting techniques such as mound baiting are also promoted.

In recent years the program has enlisted the support of local businesses to provide incentive prizes to individuals who collect shooting data and take part in the Coordinated Baiting Program. Shooting data includes the locality of the shooting event, the number of foxes spotted, the number of foxes shot and if those foxes were adults or juveniles. This data, along with annual mapping of the distribution of baits, provides a valuable resource to assess the success of fox control in the region.

Over the past 14 years the Southern New England Coordinated Fox Control Program has demonstrated the value of an integrated approach to fox control with a coordinated effort by a range of partners.

References:

McLeod, R. (2004). Counting the cost: impact of invasive animals in Australia, 2004. *Cooperative Research Centre for Pest Animal Control. Canberra.*

Thompson, J., and Flemming, P. (1994). Evaluation of the efficacy of 1080 poisoning of red foxes using visitation to non-toxic baits as an index of fox abundance. *Wildlife Research* 21: 27-39.

DEVELOPMENT OF SPECIFIC ELISA TESTS FOR THE NON-PATHOGENIC AUSTRALIAN RABBIT CALICIVIRUS RCV-A1

June Liu, Peter Kerr and Tanja Strive
CSIRO Ecosystem Sciences, GPO Box 1700, Canberra, ACT, 2601
Invasive Animals CRC, Bldg 3, University of Canberra, Brice, ACT 2617
june.liu@csiro.au

A non-pathogenic calicivirus (RCV-A1) has recently been discovered in Australia wild rabbit populations in the cooler and wetter areas of the south east[1]. Previous experimental infections with RCV-A1 have shown that this virus can partially protect rabbits from lethal RHDV-challenge, making it one of the factors impeding effective rabbit biocontrol in these areas[2]. RCV-A1 cross reacts to a degree in serological tests for RHDV and this cross-reactivity has been used in the past for epidemiological studies[3]. However, a specific serological test is essential to determine the exact distribution of RCV-A1 across the Australian continent and to understand the epidemiological interplay between the two viruses.

For this purpose both antigens and antibodies specific for RCV-A1 needed to be generated: Virus-like-particles (VLP) of RCV-A1 were produced in insect cells, purified by ultracentrifugation, and their integrity confirmed by electron microscopy. A polyclonal antibody against RCV-VLPs was produced in a chicken and purified from egg yolk. Monoclonal antibodies (mAb) were produced in mice and screened by enzyme-linked immunosorbent assays (ELISA) and Western blot. Two mAbs showed highly specific reactivity with intact RCV-A1 but not with RHDV. Using these reagents, we developed four different tests including ELISAs specific for IgG, IgM and IgA isotype antibodies to RCV-A1 as well as a specific competition ELISA.

These serological diagnostic tools will considerably facilitate the study of RCV-A1 epidemiology in rabbit populations in Australia and in turn, will help to explore better strategies to improve RHDV effectiveness in areas where RCV-A1 is endemic.

[1] Identification and partial characterisation of a new Lagovirus in Australian wild rabbits. Strive T, Wright JD, Robinson AJ. Virology. 2009 Feb 5;384(1):97-105

[2] The non-pathogenic Australian lagovirus RCV-A1 causes a prolonged infection and elicits partial cross-protection to rabbit haemorrhagic disease virus.Strive T, Wright J, Kovaliski J, Botti G, Capucci L. Virology. 2010 Mar 1;398(1):125-34.

[3] Use of ELISAs in field studies of rabbit haemorrhagic disease (RHD) in Australia. Cooke BD, Robinson AJ, Merchant JC, Nardin A, Capucci L. Epidemiol Infect. 2000 Jun;124(3):563-76.

PREDATOR FAECAL ODOURS AS REPELLENTS TO MANAGE FERAL GOATS AND KANGAROOS

Tarnya Cox, Peter Murray, Graham Hall, Xiuhua Li, Andrew Tribe
School of Animal Studies, The University of Queensland, Gatton

It has been previously reported that tiger (*Panthera tigris*) fecal odour was an effective repellent for eastern grey kangaroos (*Macropus giganteus*) and goats (Cox *et al*. 2010). To further evaluate these findings, faecal odours from two other predatory species (African lion, *P. leo* and dingo, *Canis lupus familiaris*) were tested along with tiger faecal odour.

In field trails with kangaroos, more supplementary feed was consumed by kangaroos at the control odour feed station than at any other feed station ($P < 0.001$). There was no difference in supplementary feed intake by kangaroos at feed troughs, with all predator faecal odours deterring kangaroos from supplementary feed. Lion faecal odour caused a shift in resting location for eastern grey kangaroos and another macropod species present, the red-necked wallaby (*M. rufrogriseus*).

Under simulated field conditions, only tiger faecal odour was successful at modifying goat grazing patterns with goats moving away from where the test odour was placed for each day of the testing period ($P = 0.01$). Both tiger ($P = 0.03$) and lion ($P = 0.03$) faecal odour resulted in goats moving their resting locations away from the test odour.

Habituation to dingo faecal odours by goats was observed. In contrast, no habituation by kangaroos and goats to tiger, lion (and for kangaroos, dingo) faecal odours was observed.

References:

Cox, T.E., Murray, P.J., Hall, G.P. and Li, X. (2010) Pest Responses to Odors from Predators Fed a Diet of Target Species Conspecifics and Heterospecifics *Journal of Wildlife Management* 74: 1737–1744

CSI: NEW ZEALAND — IDENTIFICATION OF SPECIES AND INDIVIDUAL POSSUMS FROM BITE MARKS

Keisuke Sakata[1], Shaun Ogilvie[1], Adrian Paterson[1], James Ross[1], Charles Eason[1, 2]
[1] Centre for Wildlife Management and Conservation, Faculty of Agriculture and Life Sciences, Department of Ecology, Lincoln University, PO Box 84, Canterbury 7647, New Zealand.
[2] Connovation Research, PO Box 58613 Auckland, New Zealand.
sakatak@lincoln.ac.nz

New Zealand's brushtail possum (*Trichosurus vulpecula*) abundance is monitored by the trap-catch method where the proportion of traps catching possums is used to index its abundance. The comparatively new waxtag® method where the proportion of interfered tags is similarly used as an abundance index has advantageous properties, including its minimal risk to non-target fauna, low operational cost, and ease of use. However, unlike the trap-catch method, the bait can be interfered with by many individual animals of multiple species, and likewise a single individual can interfere with multiple baits, which is an intrinsic drawback to the method, confounding the results due to an unknown probability of multiple interference of bait. We addressed the issues by identifying the responsible species and individual animals from the bite marks left on the waxtags. Possum and rodent bite marks were defined by measuring single tooth-mark widths. A novel method to identify individual animals was developed by applying the forensic toolmark examination principle to microscopic features observed on the bitemarks. This demonstrated that bitemarks can be used to reliably identify individual animals.

NEW PRESENTATION FOR SESSION 8

RHDV BOOST: THE NEXT STEP IN RABBIT BIOCONTROL

Andrew Read[1], Paul Hick[1], Peter Kirkland[1], Tarnya Cox[2], Chris Lane[2], Glen Saunders[2], Peter Kerr[3], Markus Matthaei[3], Tanja Strive[3] and Brian Cooke[4]

[1]Elizabeth Macarthur Agricultural Institute, DPI NSW, PMB 4008, Narellan, NSW 2567, Australia
[2]Vertebrate Pest Research Unit, DPI NSW, Locked Bag 6006, Orange, NSW 2800, Australia
[3]CSIRO Ecosystem Sciences, GPO Box 1700, Canberra, ACT 2601, Australia
4Institute for Applied Ecology, University of Canberra, ACT 2601 Australia

When initially released in 1995, Rabbit Haemorrhagic Disease Virus (RHDV) (formerly known as rabbit calicivirus) had a profound impact on rabbit populations in Australia. Unfortunately, evidence suggests that there has been a gradual increase in rabbit populations over the last 5-7 years. This may be due to reduced effectiveness of RHDV in the field and there is evidence that genetic resistance amongst rabbits and prior infection with related benign viruses may be involved.

In contrast to the Australian situation, new variant strains of RHDV have emerged in Europe in the past decade and have continued to suppress rabbit populations.

The objective of the RHDV BOOST project is to import and assess a number of variant RHDV strains based on antigenic and genetic characteristics. The ability of selected strains to overcome genetic resistance and prior infection with the benign virus RCV-A1 will be determined. Experiments will be conducted to assess the potential for variant strains to out-compete the current Australian strain of RHDV. Models for effective release and monitoring of novel RHDV strains will also be developed.

It is hoped that a new strain of RHDV will be able to boost the usefulness of this virus and thereby re-establish it as an effective biological control agent of rabbits.

NEW POSTER 25

MULTIPLE GENETIC LINEAGES IN RATTUS RATTUS: MULTILOCUS PHYLOGENY AND DISTRIBUTION MAPPING

Andrew S. Wiewel[1], Stephen C. Donnellan1,[2], Terry Bertozzi[2], Ken P. Aplin[3], and Alan Cooper1,[4]
[1]School of Earth and Environmental Sciences, University of Adelaide, Adelaide SA 5005
[2]Evolutionary Biology Unit, South Australian Museum, Adelaide SA 5000
[3]Ken Aplin Fauna Studies Pty Ltd, 2751 Pappinbarra Rd, Pappinbarra NSW 2446
[4]Australian Centre for Ancient DNA (ACAD), University of Adelaide, Adelaide SA 5005
Andrew.Wiewel@adelaide.edu.au

Rattus rattus is one of the most widespread and destructive species on Earth, with significant negative impacts on agriculture, conservation, and human health and welfare. Despite extensive and ongoing research and management efforts aimed at minimizing these impacts, our understanding of the evolutionary and taxonomic history of R. rattus is far from complete and may even be impeding progress. Traditional taxonomic approaches based on geography and morphology generally have been ineffective for deciphering the relationships between R. rattus and allies, largely because these species display high levels of phenotypic variation and also because many have been widely dispersed by humans. DNA-based approaches provide hope for clarifying this confusion. Several recent studies have revealed high levels of genetic diversity within R. rattus, suggesting that this putative species is actually a complex of closely related and recently diverged lineages, some or all of which may warrant full species status. In this study, we use a multilocus molecular genetic dataset to further resolve the phylogeny of R. rattus lineages and to map their distributions, with a focus on mainland and island Southeast Asia. Ultimately, these data will contribute to the delineation of species boundaries within the R. rattus complex, with long-term implications for improving the effectiveness of research and management aimed at mitigating negative impacts on agriculture, conservation, and human health and welfare.

AUTHORS' INDEX

AUTHORS' INDEX

AUTHORS' INDEX

For more information contact;

Invasive Animals CRC
Level D, Building 3
University of Canberra
Bruce, ACT 2617