

AUSTRALIAN MAMMAL SOCIETY



Conference Handbook



AUSTRALIAN MAMMAL SOCIETY
56th meeting
CANBERRA 2010

The 56th Scientific Meeting and Rock-wallaby Symposium

4-9 July 2010

Australian Academy of Science
Gordon St
Canberra ACT 2600



Acknowledgements

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Conference Timetable

Scientific Meeting			Rock-wallaby Symposium	
Monday (5 July)	Tuesday (6 July)	Wednesday (7 July)	Thursday (8 July)	Friday (9 July)
0830 Welcome	0830 Predators (1); Keynote address: Chris Johnson	0830 Genetics; Keynote address: Rob Lanfear	0830 Welcome	0845 Management
0845 Conservation (1); Keynote address: Tony Friend			0900 Ecology	
1015 Morning tea and poster session	1015 Morning tea and poster session	1000 Morning tea and poster session	1000 Morning tea and poster session	1015 Morning tea and poster session
1045 Conservation (2)	Predators (2)	1030 Reproduction; Keynote address: Lyn Hinds	1030 Genetics	1045 Reintroduction
1215 Lunch	1215 Lunch	1215 Lunch	1200 Lunch and poster session	1215 Lunch
1315 Conservation (2) cont	1315 Excursion: Australian National Wildlife Collection, CSIRO, Gungahlin	1315 Feeding Ecology	1330 Field trip to Tidbinbilla	1315 Discussion of issues relating to rock-wallabies
1345 Parasites and Disease; Keynote address: David Spratt		1445 Afternoon tea and poster session		1415 Closing remarks
1500 Afternoon tea and poster session				
1530 Physiology		1515 General Ecology		
1715 AGM	1730 Public Lecture, Shine Dome	1645 Closing remarks and presentation of awards		
	Informal dinners	1900 Conference dinner		

PROGRAMME

MONDAY 5 JULY 2010

AUSTRALIAN MAMMAL SOCIETY SCIENTIFIC MEETING

TIME	ACTIVITY
8.00am	Registration
8.30	Welcome to the Australian Academy of Science, Hugh Tyndale-Biscoe
8.35	Conference Opening AMS President (Tony Friend)
8.45	SESSION 1: Conservation Chair: Graeme Coulson
8.45	Keynote address: Dr Tony Friend "Conservation of Australian mammals: successes, failures and future challenges"
9.15	Restoration of koala habitat in Gunnedah, NSW: I. building on a 1990 success <u>Dan Lunney</u> , Mathew Crowther, John Lemon, Robert Wheeler and George Madani
9.30	Restoration of koala habitat in Gunnedah, NSW II. movement of koalas across a patchy rural landscape <u>Mathew Crowther</u> , Dan Lunney, John Lemon, Robert Wheeler and George Madani
9.45	Listen to the plants... the pre-European biogeography of NSW mammals <u>Fred Ford</u> and Ken Aplin
10.00	Predictors of extinction risk in Australian terrestrial mammals <u>Emily Hanna</u> and Marcel Cardillo
10.15 – 10.45	Morning Tea and Poster Session
10.45	SESSION 1: Conservation continued Chair: Dan Lunney
10.45	Evaluating functional extinction in Tasmanian devils – what, how and when? <u>Samantha Fox</u> , Drew Lee, David Sinn, Sam Thalmann and Phil Wise
11.00	Climate change may re-invigorate endangered Hastings River mouse (<i>Pseudomys oralis</i>): ancient DNA informs conservation decisions. <u>Vicki Thomson</u> , Fred Ford and Ken Aplin
11.15	An accurate assessment of habitat loss and current threats to the mahogany glider (<i>Petaurus gracilis</i>). <u>Stephen Jackson</u> , Gethin Morgan, Jeanette Kemp, Mirjam Maughan and Cherie Stafford
11.30	Patterns of site occupancy by southern brown bandicoots following sustained fox control Terry Coates
11.45	Fauna translocations to the mainland and offshore islands of Western Australia: Barrow Island and beyond <u>Andrew Smith</u> and Keith Morris
12.00	Conservation and cultural significance of the red panda <i>Ailurus fulgens</i> in Jigme Dorji National Park and Thrumshingla National Park, Bhutan. <u>Sangay Dorji</u> , Rajanathan Rajaratnam and Karl Vernes
12.15 – 1.15	Lunch

MONDAY 5 JULY 2010 (continued)

1.15pm	SESSION 1: Conservation continued Chair: Dan Lunney
1.15	Four generations of a koala family at Campbelltown, NSW <u>Robert Close</u> , Tristan Lee and Steven Ward
1.30	The status of two smoky mouse populations in Victoria, and an assessment of non-invasive survey techniques <u>J Nelson</u> , M Main, R Chick, M Scroggie and Peter Menkhorst
1.45	SESSION 2: Parasites and Disease Chair: Pat Woolley
1.45	Keynote address: Dr David Spratt "Origins of the helminths of Australian Marsupials"
2.15	Do general rules explain the ecology of arthropod ectoparasites of small mammals? <u>Boris Krasnov</u> and Irina Khokhlova
2.30	Eucalypts as a possible source of oxalate for koalas suffering from oxalate nephrosis <u>Natasha Speight</u> , Julie Haynes, William Breed, David Taggart, Wayne Boardman and Brian Rich
2.45	Efficacy of the EG95 hydatid vaccine in the tammar wallaby (<i>Macropus eugenii</i>) <u>Tamsin Barnes</u> , Lyn Hinds, David Jenkins and Marshall Lightowlers
3.00 – 3.30	Afternoon Tea and Poster Session
3.30	SESSION 3: Physiology Chair: Don Bradshaw
3.30	Predicting the climatic niche of kangaroos and their response in a changing climate <u>Jessica Roberts</u> , Graeme Coulson, Adam Munn and Michael Kearney
3.45	Mass mortality of western grey kangaroos (<i>Macropus fuliginosus</i>) in a heat wave <u>Graeme Coulson</u> and Jemma Cripps
4.00	Torpor ecology of the western pygmy-possum <u>James Turner</u> , L Warnecke, G Körtner and Fritz Geiser
4.15	Hygric physiology of a living fossil, the Monito del monte (<i>Dromiciops gliroides</i>) <u>Philip Withers</u> , Christine Cooper and Roberto Nespolo
4.30	Mammals used for physiological studies can be successfully returned to the wild Christine Cooper
4.45	How sensitive are male germ cells of the hopping mouse to high environmental temperatures? <u>Harsha Wechalekar</u> , B Setchell, E Peirce, M Ricci, Chris Leigh and William Breed
5.00	Close Day 1
5.15 – 10.45	AGM

TUESDAY 6 JULY 2010

AUSTRALIAN MAMMAL SOCIETY CONFERENCE

TIME	ACTIVITY
8.30am	SESSION 4: The roles of predators in Australia's ecosystems Chair: Chris Dickman
8.30	Keynote address: Professor Chris Johnson,
9.00	Putting the bite back into biodiversity conservation and rangeland management: what role(s) for dingoes? <u>Euan Ritchie</u> and Chris Johnson
9.15	Dingoes prevent red fox re-establishment in a landscape-scale enclosure: implications for threatened species management in arid Australia <u>Katherine Moseby</u> , Heather Neilly, John Read and Helen Crisp
9.30	Six important considerations when evaluating dingoes (<i>Canis lupus dingo</i>) as potential biodiversity conservation tools in Australia Benjamin Allen, <u>Peter Fleming</u> and Guy Ballard
9.45	Keystone effects of dingoes benefit native mammals in arid Australia Mike Letnic
10.00	Constructing a reliable dingo purity test 1– distinguishing between pure and hybrid dingoes Justyna Zofia Paplinska
10.15 –10.45	Morning Tea and Poster Session
10.45	SESSION 4: The roles of predators in Australia's ecosystems (continued) Chair: Chris Johnson
10.45	A novel observation of dingoes <i>Canis lupus dingo</i> attacking a swimming eastern grey kangaroo <i>Macropus giganteus</i> Brad Purcell
11.00	Predator-driven regional extinctions of small desert mammals <u>Chris Dickman</u> , Aaron Greenville, Bobby Tamayo and Glenda Wardle
11.15	Guardian dogs for livestock and biodiversity protection in Australia <u>Linda Van Bommel</u> , Chris Johnson, Brendan Mackey and David J Jenkins
11.30	A novel disease threatens Tasmania's top predator: an integrated approach to research for managing the entire ecosystem Menna E Jones
11.45	Using mesopredator suppression by dingoes as a conservation strategy in Australia: the need for appropriate conservation benchmarks Matt Hayward
12.00	Direct and indirect effects of cougar predation lead to strong Allee effects in bighorn sheep <u>Marco Festa-Bianchet</u> , Aurélie Bourbeau-Lemieux and Fanie Pelletier
12.15 – 1.15	Lunch
1.15	Field trip: CSIRO Gungahlin Australian National Wildlife Collection
5.30	Australian Academy of Science Public Lecture: "The Water Dance" Leith Bouilly, University of Queensland Drinks and refreshments 5.30pm; Public lecture 6.00-7.00pm
	2 x Informal Dinners

WEDNESDAY 7 JULY 2010

AUSTRALIAN MAMMAL SOCIETY CONFERENCE

TIME	ACTIVITY
8.30am	SESSION 5: Genetics and Evolution of Australian Mammals Chair: Rob Close
8.30	Keynote address: Dr Rob Lanfear "Natural History of Mammalian Genomes: mutation, selection and rates of evolution"
9.00	Development of sexual dimorphism in eastern grey kangaroos <u>Wendy King</u> , Jessica Caissy-Martineau, Michelle Wilson and Graeme Coulson
9.15	Brain size reduction in captive breeding programs: a marsupial perspective <u>Patrick-Jean Guay</u> , Marissa Parrot and Lynne Selwood
9.30	From insectivores to hypercarnivores: Functional analysis and evolutionary patterns for skull morphology in carnivorous marsupials (Marsupialia: Dasyuridae) <u>Natalie Warburton</u> , Philip Withers, Ken Aplin, J O'Shea and N Milne
9.45	Quaternary rodent fossils from Mt Etna, central Queensland. <u>Jonathan Cramb</u> and Scott Hocknull
10.00 – 10.30	Morning Tea and Poster Session
10.30	SESSION 6: Reproduction Chair: Felicity Bradshaw
10.30	Keynote address: Dr Lyn Hinds "Fertility control – an option for managing overabundant native species?"
11.00	Effects of gnRH Reproduction-targeted immunocontraception on male behaviour in a model macropodid species, the tammar wallaby, <i>Macropus eugenii</i> . <u>Melissa Snape</u> , Lyn Hinds and Lowell Miller
11.15	The influence of reproduction on the foraging behaviour of female eastern grey kangaroos: an experimental study <u>Jemma Cripps</u> , Mark Elgar and Graeme Coulson
11.30	Why eating ants leads to promiscuity: diet, spatial ecology and the echidna mating system Stewart Nicol
11.45	Reproductive and adrenal hormones and their relationship to successful breeding in captive Tasmanian devils <u>Tamara Keeley</u> , Paul McGreevy and Justine O'Brien
12.00	Estimating age and sexual maturity in female indo-pacific bottlenose dolphins from South Australia <u>Mauro Talamonti</u> and Catherine Kemper
12.15 – 1.15	Lunch

WEDNESDAY 7 JULY 2010 (continued)

1.15	SESSION 7: Feeding Ecology Chair: Ross Goldingay
1.15	Available and not total nutrients explain ecological traits <u>Ian Wallis</u> , Jane DeGabriel, Ben Moore and William Foley
1.30	Facts from faeces: A new faecal index for measuring diet quality in mammalian folivores <u>Hannah Windley</u> , Ian Wallis, Jane DeGabriel, Ben Moore, Chris Johnson and William Foley
1.45	Eucalypt foliar chemistry influences diet choice and niche partitioning in marsupial folivores. <u>Lora Jensen</u> , Ian Wallis and William Foley
2.00	Spatial variation in habitat quality effects fine-scale resource use by a low-density koala population <u>Eleanor Stalenberg</u> , Ross Cunningham, William Foley and Ian Wallis
2.15	First evidence of truffle consumption by New Guinea forest wallabies (<i>Dorcopsis</i> , <i>Dorcopsulus</i> and <i>Thylogale</i>) <u>Karl Vernes</u> and Teresa Lebel
2.30	Kangaroo foraging and movements in urban Canberra <u>Claire Wimpenny</u> and Don Fletcher
2.45 – 3.15	Afternoon Tea and Poster Session
3.15pm	SESSION 8: General Ecology Chair: Steve Jackson
3.15	Do nest box design and temperature impair the use of artificial hollows by arboreal marsupials? <u>Ross Goldingay</u>
3.30	Hit me with your best shot: maximising capture rates through camera trap set up Justine Smith
3.45	Effect of pitfall depth and diameter on mammal and reptile capture rates in cracking clay habitats in arid South Australia <u>Helen Waudby</u> and Sophie Petit
4.00	Home range and movements of common wombats in the Snowy Mountains <u>Alison Matthews</u> and Ken Green
4.15	The responses of small mammals in the Simpson Desert to a broadscale wildfire <u>Louise Pastro</u> , Chris Dickman and Mike Letnic
4.30	Observations of individual hand preference in wild groups of white-faced sakis (<i>Pithecia pithecia</i>) in Suriname Helen Smith
4.45	Closing Remarks and presentation of awards
5.00	Conference Close
Evening	Conference Dinner

PROGRAMME

THURSDAY 8 JULY 2010

AUSTRALIAN MAMMAL SOCIETY ROCK-WALLABY SYMPOSIUM

TIME	ACTIVITY
8.30 am	Welcome and Introduction: Mark Eldridge, The Australian Museum
9.00 am	SESSION 1: Ecology Chair: Mark Eldridge
9.00	Multiple scales of diet selection by brush-tailed rock-wallabies <u>Katherine Tuft</u> , Mathew Crowther and Clare McArthur
9.15	Do rock-wallabies just like rocks? Modelling the distribution of warru in the Anangu Pitjantjatjara Yankunytjatjara (APY) lands, SA <u>Laura Ruykys</u> , Matthew Ward and David Taggart
9.30	Social organisation of the allied rock-wallaby at Black Rock 1973-1976 Wal Davies
9.45	Diet selection by Victorian brush-tailed rock-wallabies <u>Lily Van Eeden</u> , Graeme Coulson and Julian Di Stefano
10.00 – 10.30	Morning Tea and Poster Session
10.30	SESSION 2: Genetics Chair: Tony Corrigan
10.30	Phylogenetic analysis reveals multiple divergent lineages within <i>Petrogale</i> Sally Potter, Steve Cooper, David Taggart and <u>Mark Eldridge</u>
10.45	Fine-scale genetic structure in the black-flanked rock-wallaby informs fertility control management <u>Nicole Willers</u> , Oliver Berry and Dale Roberts
11.00	Assessing the fitness of black-footed rock-wallaby populations, utilizing a major histocompatibility complex (antigen recognition) gene <u>Robert Mason</u> , Teena Browning and Mark Eldridge
11.15	Genetic research in the brush-tailed rock-wallaby and its application to conservation and management of the species. Justyna Zofia Paplinska
11.30	Phylogeography of the <i>brachyotis</i> group with recognition of two species within the short-eared rock-wallaby <u>Sally Potter</u> , Mark Eldridge, Steve Cooper and David Taggart
11.45	Phylogeography of the brush-tailed rock-wallaby and implications for conservation Stephanie Hazlitt, Teena L Browning, Anne Goldizen, James Nicholls and <u>Mark Eldridge</u>
12.00 – 1.30	Lunch and Poster Session
1.30	SESSION 3: Tidbinbilla trip

FRIDAY 9 JULY 2010

AUSTRALIAN MAMMAL SOCIETY ROCK-WALLABY SYMPOSIUM

8.45 am	SESSION 4: Management Chair: David Taggart
8.45	Towards an adaptive integrated management approach for brush-tailed rock-wallabies: lessons from recent research on healthy populations in the northern evolutionary significant unit. <u>Justine Murray</u> , Clive McAlpine, Samantha Low Choy, Hugh Possingham and Anne Goldizen
9.00	Distribution, status and community involvement in the conservation of warru in the Anangu Pitjantjatjara Yankunytjatjara lands, South Australia <u>Matthew Ward</u> , Amber Clarke, Anika Dent, Thalie Partridge, Jason van Weenen, John Read, David Taggart, P Copley and Roman Urban
9.15	Insights and lessons learnt from the long-term monitoring of the yellow-footed rock-wallaby <u>Mark Lethbridge</u> , Nicki de Preu and Megan Harper
9.30	Fox predation of the black-flanked rock-wallaby, on the Anangu Pitjantjatjara Yankunytjatjara Lands in South Australia Anika Dent
9.45	A decade of monitoring and management of remnant brush-tailed rock-wallabies in Victoria <u>Lucas Bluff</u> , Lucy Clausen, Amie Hill and Michael Bramwell
10.00	The warru recovery plan – novel initiatives to support the endangered South Australian black-flanked rock-wallaby <u>John Read</u> and Matthew Ward
10.15 – 10.45	Morning Tea and Poster Session
10.45	SESSION 5: Reintroduction Chair: Justyna Zofia Paplinska
10.45	Determining resource availability and habitat suitability prior to a translocation of brush-tailed Rock-wallabies. <u>Tony Corrigan</u> , David Taggart, Glenn Rudolph, Emily Beddgood, Sean Frey, Lucy Clausen, Mike Stevens and Mick Bramwell
11.00	Supporting brush-tailed rock-wallaby reintroduction with landscape-scale fox control: Grampians Ark case study Mike Stevens
11.15	Reintroduction of the brush-tailed rock-wallaby into the Grampians National Park, Victoria. <u>David Taggart</u> , Tony Corrigan, David Schultz, Mike Stevens, David Dobroszczyk, Emily Beddgood, Justyna Paplinska and Glenn Rudolph
11.30	What we don't know and haven't learned about pulling rock-wallabies from an extinction vortex Deborah Ashworth and <u>Todd Soderquist</u>
11.45	Health monitoring of brush-tailed rock-wallabies prior to and after reintroduction <u>David Schultz</u> , Brian Rich, Tony Corrigan, David Taggart and Tim Schultz
12.00	Home ranges of a reintroduced population of brush-tailed rock-wallabies in Grampians National Park, Victoria <u>Jenny Procter</u> , David A Taggart and Tony Corrigan
12.15 – 1.15	Lunch

FRIDAY 9 JULY 2010 (continued)**AUSTRALIAN MAMMAL SOCIETY ROCK-WALLABY SYMPOSIUM**

1.15	SESSION 6: Discussion of issues relating to rock-wallaby biology and management Chair: Todd Soderquist
2.15	Conclusion
2.30	Conference close; Afternoon tea

Abstracts for the Scientific Meeting of the Australian Mammal Society

Spoken papers

SESSION 1: Conservation

KEYNOTE ADDRESS

CONSERVATION OF AUSTRALIAN MAMMALS: SUCCESSES, FAILURES AND FUTURE CHALLENGES

Tony Friend

Australian Mammal Society, 86 Brunswick Road, Port Albany, WA 6330

Early European explorers and settlers found an abundance of strange and wonderful life-forms in Australia, especially amongst its unique mammal fauna. During a brief period this diversity of mammalian forms was available for early scientific description but within a matter of decades, the decline in abundance and species richness, especially in the southern semi-arid areas, was being documented. In hindsight we can catalogue the causes of these declines and extinctions, but are we in a position to reverse or even halt these processes? While Australia's record for extinctions of mammals since European settlement is by far the worst on any continent in the last 500 years, the fruits of Australia's conservation efforts over the past 40 years have given some hope that we can reverse the trend. Due to targeted recovery programs for particular threatened mammal species, giving priority to the most threatened taxa, no Australian mammal became extinct between the 1960s and 2009.

Recent moves in conservation policy away from targeted recovery have been to the disadvantage of Australia's mammal fauna. The concept of landscape-scale conservation action has been adopted, but it is clear that unless it is applied in conjunction with species-specific action, the rate of extinction will rise again. Current predictions from climate change modelling, without management intervention, are dire for many mammals in southern Australia. Assisted migration of species at risk, creation of extensive habitat linkages and broadscale control of exotic predators must all be applied or we face an even more drastic phase of mammal extinction in Australia.

RESTORATION OF KOALA HABITAT IN GUNNEDAH, NSW: I BUILDING ON A 1990 SUCCESS

Dan Lunney¹, Mathew S Crowther^{1,2}, John Lemon³, Robert Wheeler¹ and George Madani⁴

¹ Department of Environment, Climate Change and Water, Hurstville, NSW 2220

² School of Biological Sciences, University of Sydney, NSW 2006

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From the early 1990s, a Landcare project saw thousands of trees planted to address salinity problems around Gunnedah in north-western NSW. A by-product of this land rehabilitation was an increase in koala habitat. This appears to have translated to an increase in koala abundance as Gunnedah was one of the few locations to record an increase in koala distribution in a state-wide wildlife survey in 2006. The current project aims to capitalise on the success of the tree planting programs to determine exactly how the koalas are moving across the landscape, which trees are being selected, and what issues have arisen that could help guide further plantings or koala management strategies. There is widespread interest in koalas across Gunnedah Shire, the Liverpool Plains, and within the Namoi CMA region. The flags flying in the main street of Gunnedah proclaim it to be the koala capital of the world. It also shows that there is high local interest in the outcome of this study and any advantage that we can bring to landholders and land managers will be welcomed. We are currently working with three farms in the area, as well as on Crown land on the Gunnedah Research Centre. This project also implements and addresses actions and recommendations of the *NSW 2008 Koala Recovery Plan* and the *2009-2014 National Koala Conservation and Management Strategy*.

RESTORATION OF KOALA HABITAT IN GUNNEDAH, NSW II: MOVEMENT OF KOALAS ACROSS A PATCHY RURAL LANDSCAPE

Mathew S Crowther^{1,2}, Dan Lunney², John Lemon³, Robert Wheeler² and George Madani⁴

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We studied the movements of 33 koalas in Gunnedah and surrounding regions in north-western NSW, using GPS collars. Our aims were to test: 1) if the apparently increasing population was a result of tree-plantings on farmland, and 2) what type of trees and tree configuration koalas use and how this differs between night and day during the year. We projected the GPS coordinates onto vegetation layers and geo-referenced aerial photographs. After overcoming some initial technical limitations of the GPS collars, we now have high-quality data of koala movements across the rural landscape. Koalas used the tree-plantings and existing remnant paddock trees, moved frequently and often used a different tree each night. The koalas were mostly restricted to relatively small patches of trees during each three-month data collection period. This pattern of movement may present a problem as many tree-plantings are concentrated along roads and railway tracks, areas of koala mortality. The study also found that koala mortality appears high when there is a sequence of abnormally hot dry days, such as the 8 day heat wave in November 2009. The concentration of movement within these small patches may not allow for adequate nutrition and water for koalas at all times of the year. Hence land managers need to carefully consider tree planting configuration, as well as species, in order to maintain sustainable koala populations in the future.

LISTEN TO THE PLANTS... THE PRE-EUROPEAN BIOGEOGRAPHY OF NSW MAMMALS

Fred Ford and Ken Aplin

Australian National Wildlife Collection, CSIRO, GPO Box 284, Canberra, ACT 2601

It's galling for a mammalogist to admit that plants might be more useful in unravelling mammal related questions, but such is probably the case when trying to reconstruct the distributions of mammals 250 years ago. Our work on recent small mammal bone deposits across NSW has revealed significant range extensions and reinforced previously suspected or recognised historical declines for many species. These mask our knowledge of their true biogeography. The pattern that emerges is similar to that in Qld, with "coastal" species occurring far inland, overlapping or interdigitating with their "arid" counterparts. There were few small mammals distributed primarily in the semi-arid zone. The occurrences of vine thickets at inland sites containing *Melomys*, and the occurrence of spinifex at eastern sites with arid zone species are typical of the annoying ability of contemporary plant communities to indicate what the mammal fauna of a region may once have been. This is potentially useful, as topographies suitable for producing subfossil material are limited across inland NSW, but with enough reference sites, a detailed modelling of past community distributions may be possible.

PREDICTORS OF EXTINCTION RISK IN AUSTRALIAN TERRESTRIAL MAMMALS

Emily Hanna and Marcel Cardillo

Centre for Macroevolution and Macroecology, Division of Evolution, Ecology and Genetics, Research School of Biology, Australian National University, Canberra, 0200

In the last two centuries, over one quarter of terrestrial mammal extinctions have been in Australia, and many other Australian mammal species have suffered serious declines. Large-scale comparative studies can uncover the general patterns of extinction risk that help to answer the question of why some species seem to be more extinction-prone than others. This study identified correlates of Australian mammal decline and extinction using multivariate comparative models, with robust parameter estimates obtained through model-averaging. We used these models to predict species' latent extinction risk (the difference between current and predicted extinction risk), and the ecoregions in Australia with the highest average latent risk. This study contributes to an understanding of the underlying drivers of species declines, and provides a way of identifying the species and regions with the greatest potential for future declines.

EVALUATING FUNCTIONAL EXTINCTION IN TASMANIAN DEVILS – WHAT, HOW AND WHEN?

Samantha Fox, Drew Lee, David Sinn, Sam Thalmann and Phil Wise

Save the Tasmanian Devil Program, Department of Primary Industries, Parks, Water and the Environment (DPIPWE), Hobart, Tasmania 7001

The Tasmanian devil has been in decline since the early 1990's when a transmissible facial cancer (Devil Facial Tumour Disease (DFTD)) began spreading through east coast devil populations. Native to Tasmania and the largest remaining carnivorous marsupial, the plight of the Tasmanian Devil has been followed across the world. Although modeling has suggested that this species would be extinct in 20-25 years, 14 years after first being exposed in the north-east of Tasmania, local extinction has not been observed. The population at Mt. William National Park in the north-east of the State has declined by 94% according to annual spotlighting surveys. However, it continues to persist, albeit at extremely reduced numbers, with a lack of older animals.

There are few top order predators in Tasmania. The extinct Thylacine no longer fills this important ecological role and both the Tasmanian Devil and the Wedge-tailed eagle are in decline. With the threat of foxes and feral cats decimating important small mammal assemblages, one of the most important questions being asked by management agencies in Tasmania is “what effect will the loss of the Tasmanian Devil have on the ecosystem”? Hand-in-hand with this question is that of functional extinction, how to define it in the case of the Tasmanian Devil, how to measure it and when do you decide that it has occurred? This presentation will give a very brief overview of management activities focused on conserving the Tasmanian Devil and then examine the questions stated above on the important aspect of Functional Extinction.

CLIMATE CHANGE MAY RE-INVIGORATE ENDANGERED HASTINGS RIVER MOUSE (*PSEUDOMYS ORALIS*): ANCIENT DNA INFORMS CONSERVATION DECISIONS.

Vicki Thomson¹, Fred Ford², Ken Aplin².

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² CSIRO Sustainable Ecosystems, Bellenden St, Crace, ACT 2911

Ancient DNA (aDNA) studies have shown that current distributions of species often produce misleading views of their evolutionary history. Therefore, management plans for endangered species based solely on genetics of remnant populations may lead to bad decisions, especially in view of future climate change. We undertook an aDNA study of subfossil bone remains and museum specimens (n>20) of the Hastings River mouse (*Pseudomys oralis*), to add a temporal dimension to known modern spatial genetic data and test whether current management plans reflect historical gene flow. *P. oralis* is currently restricted to upland forests in southern Qld and northern NSW, with these modern populations falling into genetically distinct northern and southern haplogroups, conserved at a population level. However, subfossil material indicates the species had an historical distribution that extended as far south as central Victoria. We demonstrate that extinct populations contained purely southern haplotypes and persisted into the 19th century. Past genetic diversity of the southern lineage is higher than previously thought. The translocation of animals from the southern lineage into more southerly localities where the species is now extinct, may allow the species to persist and survive through the warmer and more variable climates predicted under future climate change models.

**AN ACCURATE ASSESSMENT OF HABITAT LOSS AND CURRENT THREATS TO THE
MAHOGANY GLIDER (*PETAURUS GRACILIS*)**

**Stephen M Jackson¹, Gethin Morgan², Jeanette E Kemp³, Mirjam Maughan² and
Cherie M Stafford⁴**

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Despite legislation to protect the remaining habitat of the endangered mahogany glider *Petaurus gracilis* there is an urgent need to understand where habitat remains and how it should be managed. Regional ecosystem mapping was used to identify the true extent of habitat loss due to clearing, and of habitat degradation due to rainforest expansion and sclerophyll thickening. The total area of habitat available to mahogany gliders before large scale clearing began had decreased by 49%, from 276,880 to 141,122 hectares. Of the habitat remaining only 51,870 hectares consisted of the most structurally complex and floristically diverse habitat type "Mixed Open Forest" (OF); 55,760 hectares was the more open and less diverse "Mixed Woodland" (WL); 29,988 consisted of mainly single canopy species vegetation "Monotypic Stands" (MT) and 3,504 was classed as having only Emergent (EM) trees suitable for the mahogany glider. The land tenure that contributed the largest loss of habitat through clearing was freehold land, decreasing from 129,435 to 26,852 hectares. Within the remaining OF habitat, 45% was considered to have decreasing habitat suitability for the mahogany glider as a result of sclerophyll thickening or rainforest expansion, compared with 26% of WL habitat, 33% of MT and 8% of EM. The large reduction in habitat area and suitability has been magnified by extensive habitat fragmentation. The remaining habitat must be managed with an appropriate fire regime to ensure that it does not further decrease in its usefulness to the mahogany glider.

PATTERNS OF SITE OCCUPANCY BY SOUTHERN BROWN BANDICOOTS FOLLOWING SUSTAINED FOX CONTROL

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The southern brown bandicoot (*Isodon obesulus obesulus*) was once common and widespread in south eastern Australia. The species is now largely confined to patches of vegetation with a dense ground layer. Dense low vegetation is thought to provide refuge from exotic predators such as foxes. Several earlier small scale studies at the Royal Botanic Gardens Cranbourne (RBGC) indicated that bandicoots had a strong affinity for dense heathy woodland vegetation recovering from disturbance. The studies have promoted a view that bandicoot populations were adapted to periodic habitat disturbance and amenable to deliberate anthropogenic management of habitat. However, the link between habitat management and population persistence remains equivocal.

Since 2003 the RBGC has reduced fox abundance primarily by exclusion fencing, poison baiting and ongoing monitoring. Ecologically based burning of vegetation has been implemented to manage biodiversity. Here I examine patterns of distribution and site use by bandicoots at the RBGC after seven years of population recovery. “Reconyx” remote game cameras were used to record bandicoots at 53 randomly selected sites in woodland vegetation communities. Bandicoots were more likely to be detected at younger sites than older sites both before and after fox control. However there was also evidence to indicate that bandicoots colonized older, more open sites supporting the view that they will occupy these habitats when the risk of encountering a fox is low.

FAUNA TRANSLOCATIONS TO THE MAINLAND AND OFFSHORE ISLANDS OF WESTERN AUSTRALIA: BARROW ISLAND AND BEYOND

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Barrow Island, off the northwest coast of Western Australia, is an A-class nature reserve and also the site of a long established oil field. Recently, permission was granted for the Gorgon gas development to proceed on the island. Under ministerial environmental conditions imposed on the development, a financial offset program was established to fund the translocation of selected Barrow Island fauna to new locations on the mainland and other offshore islands. The first phase of the translocation was implemented in February 2010 and saw the reintroduction of 160 golden bandicoots (*Isodon auratus*) and 111 spectacled hare wallabies (*Lagorchestes conspicillatus*) to Hermite island in the Montebello Islands, 104 brushtail possums (*Trichosurus vulpecula*) to Cape Range in Exmouth, and 165 golden bandicoots and 65 boodies (*Bettongia lesueur*) to a 1100ha fenced enclosure in Lorna Glen nature reserve in the goldfields. Here we outline the research plan associated with the translocation project and report on the methodology used and present initial results relating to the establishment of translocated populations at each destination.

CONSERVATION AND CULTURAL SIGNIFICANCE OF THE RED PANDA *AILURUS FULGENS* IN JIGME DORJI NATIONAL PARK AND THRUMSHINGLA NATIONAL PARK, BHUTAN.

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The Himalayan kingdom of Bhutan is a global biodiversity “hot spot” because of its location at the juncture of two bio-geographic realms (Palearctic and Indo-Malayan). Bhutan is committed to maintaining 60% of its land under forest cover and conserving more than 51% of the country in a network of protected areas. Although the globally threatened red panda (*Ailurus fulgens*) shares the mid-elevation (2000-4000m asl) temperate forests of Bhutan with the country’s human population, information on the red panda in Bhutan is poor. Our study is the first to determine the distribution, habitat preferences and conservation status of this species in Bhutan. Questionnaire surveys (N= 664 participants) from various occupational groups in two national parks revealed that red pandas had high cultural and conservation significance. The animal is believed to be the reincarnation of a Buddhist monk, and visual sighting of a red panda is considered to be a good omen. Our work also revealed a distinct lack of knowledge of red pandas among many residents. Increasing human population growth induced activities within these parks such as road construction, livestock grazing, subsistence agriculture, timber, firewood and bamboo collection threaten the red panda. Predation by domestic dogs and accidental kills by wildlife poachers represent additional threats. Conserving pristine red panda habitat is paramount for ensuring the quality of life for Bhutanese people living sympatrically with the red panda. Therefore, the conservation of the red panda has positive implications for socio-economic development and adherence to the tenet of Gross National Happiness in Bhutan.

FOUR GENERATIONS OF A KOALA FAMILY AT CAMPBELLTOWN, NSW

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As part of a wider study, the lives of a long-lived female koala and three generations of her offspring living on the edge of suburbia were followed by either radio-tracking or by sightings reported by members of the public. Starting from 1993, when the matriarch was captured and radio-collared, one female in each of the second and third generations was also radio-collared. Wherever possible all other offspring were fitted with a unique combination of coloured ear-tags. We then depended on members of the public reporting these individuals’ movements to us via a pager number that we publicised via a weekly column in a local newspaper, and on street signs. Over 2,700 calls have been made to the pager, indicating the power of using the public to help study low density populations (1 koala/ 20ha). The work has revealed the remarkable longevity (15 years), despite the hazards of cars and dogs, and productivity of established females (at least 7 of the matriarch’s young completed pouch life). It has also shown how closely to their mother’s home-ranges daughters will establish their own home-ranges, and how far male offspring will move away (19km). The family tree built from the data illustrates the remarkable ability of a koala family to multiply when conditions are suitable. Similar results were seen in other koala families in Campbelltown and we suggest that they are typical of a population regenerating after a crash in numbers. Such extensive family trees may not be so common in populations with higher densities.

THE STATUS OF TWO SMOKY MOUSE POPULATIONS IN VICTORIA, AND AN ASSESSMENT OF NON-INVASIVE SURVEY TECHNIQUES

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The Smoky Mouse is a rare native rodent, endemic to south-eastern mainland Australia. In Victoria it is classified as Critically Endangered. Populations are generally small, scattered and ephemeral, making this species difficult to detect during surveys. Trapping has been the main method of locating Smoky Mouse populations. However, non-invasive techniques, that do not involve the capture of animals, may provide a less labour-intensive alternative to trapping. We surveyed 31 sites in North East Victoria and coastal East Gippsland using hair-tubes and remote cameras; half corresponded to historic Smoky Mouse records. We used occupancy modelling to estimate the probability of detecting Smoky Mice on occupied sites and the likely rates of site occupancy within the two survey areas. The Smoky Mouse was detected at eight of 10 sites surveyed in the North East. It was not detected in East Gippsland. The probability of detecting Smoky Mice with remote cameras after a week's deployment, or with a grid of 20 hair-tubes, was high (> 90% and 80% respectively) suggesting both are effective tools for surveying Smoky Mice. However, remote camera surveys are less expensive to implement, particularly when multiple site visits are required for occupancy modelling purposes. Inferred occupancy rates for East Gippsland were extremely low, and it is possible the species is locally extinct there. In contrast, inferred occupancy rates for the North East were high. Our results indicate remote cameras are an efficient tool for determining the distribution and status of Smoky Mouse populations.

SESSION 2: Parasites and disease

KEYNOTE ADDRESS

ORIGINS OF THE HELMINTHS OF AUSTRALIAN MARSUPIALS

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The diversity of helminth parasites - trematodes, cestodes, nematodes and acanthocephalans - encountered across almost all groups of Australian marsupials is striking, given that the hosts may represent a monophyletic assemblage. This possibility permits insight into the origins of helminth parasites and the evolution of parasite communities in the Australian marsupials. We are able to observe successional evolutionary changes in the hosts and the parasite communities they harbour. One such evolutionary shift has been from the carnivorous (Dasyuroidea) through the insectivorous (Perameloidea) to the herbivorous (Diprotodonta), although the transfer to herbivores has not always followed the course of host evolution. This evolutionary change was often associated with anatomical changes in the gastrointestinal tract of the hosts and changes in niches available for parasites. A shift from one mode of feeding to another clearly provided limited opportunities for some groups of parasites while opening new niches for others. Similarly, the necessity for an intermediate host in the life cycle may have influenced the transition between host groups. Three origins have been identified for the different helminth groups: 1) those present in the original marsupials which dispersed from South America, 2) those acquired from sympatric but unrelated vertebrate hosts on the Australian continent from the time of its separation from Antarctica about 40 mya to the time of its collision with the Southeast Asian plate about 15 mya, and 3) those acquired from eutherian mammals, principally chiropterans and murids, which commenced arriving in Australia about 20 mya from the Asian region.

DO GENERAL RULES EXPLAIN THE ECOLOGY OF ARTHROPOD ECTOPARASITES OF SMALL MAMMALS?

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Any scientific study that reveals some patterns or processes should still answer the question: how general are these patterns and processes? Studies in other locations or on other taxa should invariably validate the findings of a particular study to establish general rules. Here, we compare several studies that examined patterns of the relationships between small mammals and different taxa of their arthropod ectoparasites (fleas, gamasid mites and ixodid ticks) in different geographic regions (Middle East, Central Europe, South Africa, Western Siberia). We consider patterns revealed at two hierarchical ecological scales, namely ectoparasite populations and ectoparasite communities. In particular, for populations of parasites, we ask:

1. How are ectoparasites distributed among their hosts?
2. Is abundance a true attribute of a parasite species?
3. Can we predict the prevalence of a parasite from abundance data?

For parasite communities, we ask:

1. Is the diversity of parasites a true attribute of a host species?
2. What are the host characters that affect the diversity of their parasite communities?
3. Do parasite species co-occur on the same host individual more or less often than expected by chance?

We conclude that although general ecological laws apply for populations of parasites, most patterns observed for communities of parasites are highly contingent and far from universal.

EUCALYPTS AS A POSSIBLE SOURCE OF OXALATE FOR KOALAS SUFFERING FROM OXALATE NEPHROSIS

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Kidney disease is a significant cause of morbidity in the koala population of the Adelaide Hills, SA. It is attributed to the condition oxalate nephrosis, where calcium oxalate is deposited in the kidney tissue and causes decreased kidney function. The most common cause of oxalate nephrosis in other species of herbivorous mammals is ingestion of foodstuffs high in oxalate content, particularly in the soluble form. In addition, ingestion of foodstuffs high in oxalate can increase the severity of the disease Primary Hyperoxaluria, which also results in the condition oxalate nephrosis and is due to a liver enzyme deficiency.

In order to determine whether koalas in the Adelaide Hills are consuming eucalypts with high oxalate content, the oxalate concentration of stomach contents was determined using high performance liquid chromatography and findings compared with samples from Moggill, Queensland. The preliminary results showed that Adelaide Hills koalas do indeed have higher average levels of soluble oxalate in their stomachs compared to individuals from Queensland. In addition there is also a higher proportion of soluble oxalate to total oxalate in the Adelaide Hills samples. These findings therefore support the hypothesis that ingestion of high levels of oxalate could be contributing to oxalate nephrosis in the koala population of the Adelaide Hills.

EFFICACY OF THE EG95 HYDATID VACCINE IN THE TAMMAR WALLABY (*MACROPUS EUGENII*)

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Hydatid disease, caused by the tapeworm, *Echinococcus granulosus*, was introduced to Australia at the time of European settlement. A sylvatic life cycle exists: native macropods (wallabies and kangaroos) act as intermediate hosts, developing hydatid cysts primarily in the lungs, and dingoes/wild dogs are the most significant definitive hosts, harbouring the adult tapeworms. We determined the pathophysiology of the disease in experimentally infected captive wallabies, demonstrating significant pulmonary impairment and other complications. We subsequently assessed the efficacy of the EG95 hydatid vaccine.

Tammar wallabies were vaccinated subcutaneously with the EG95 vaccine at time 0 and one month later. At one or 9 months post final vaccination, wallabies were challenged with an oral dose of 8000 *E. granulosus* eggs. Responses to the challenge were assessed at necropsy 8-12 months later.

Tammars experimentally infected with hydatid eggs showed more rapid development of cysts compared to sheep: the minimum time to cyst maturation in the tammar was 8 months compared to several years in sheep. After vaccination with EG95, vaccinated tammars were less likely to become infected and developed fewer cysts compared to control animals.

These studies demonstrate a more rapid progression of hydatid infection in this wallaby than is observed in the sheep, the natural intermediate host, and suggest macropods may respond as naïve hosts to this parasite. Vaccination with EG95 may be beneficial if administered pre-release in captive breeding programmes for endangered species such as the brush-tailed rock-wallaby. Further work is being undertaken to develop oral delivery of this vaccine.

SESSION 3: Physiology

PREDICTING THE CLIMATIC NICHE OF KANGAROOS AND THEIR RESPONSE IN A CHANGING CLIMATE

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Why species “are where they are” is a fundamental question in ecology that must be understood before we can predict where species might be under future scenarios, especially under climate change. Occurrence-based correlative analyses are the most frequently used approach for predicting species distributions, but such “top-down” approaches provide little understanding of the underlying causes. We are instead taking a “bottom-up” approach based on known mechanisms through which climate affects individual organisms, based on functional traits relating to physiology, morphology and behaviour.

We parameterized a mechanistic model of heat transfer to investigate how and why climate constrains large kangaroo species. This model uses physical principles to calculate the energy and water costs of maintaining a constant body temperature in a given environment. We use it to examine how these costs change with different thermoregulatory behaviours and compare the results with empirical data that we have collected on western grey and red kangaroos monitored in a semi-natural enclosure in Fowlers Gap, NSW, and with patterns of microclimate selected by eastern grey kangaroos at a site in Victoria. We outline how we can use this model, based on individuals, to infer potential distributions and how they may be affected under climate warming.

MASS MORTALITY OF WESTERN GREY KANGAROOS (*MACROPUS FULIGINOSUS*) IN A HEAT WAVE

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The Mallee Region of Victoria experienced an unprecedented heat wave in 2009. Over a 12-day period from 27th January to 7th February, daily maximum temperatures ranged from 39.1°C to 48.1°C, with only one day below 40°C. Two weeks after the heat wave we tracked a radio-collared sample of western grey kangaroos (*Macropus fuliginosus*) on Birthday Plains, Murray-Sunset National Park. No rain had fallen in the park in January or February, and there was no surface water at the study site. We located eight of ten resident kangaroos, six adult females and two adult males, and found the radio-collar of another female. All eight kangaroos were dead. We located them in deep shade within their normal home ranges, and the stage of decomposition of the carcasses indicated that they had died recently. Their age at time of death, based on molar index scores from the cleaned skulls, ranged from 5 to 15 years. The presence of many other fresh carcasses suggested high mortality, although we saw some living kangaroos including one tagged male (without a radio-collar), which was emaciated and moving in an uncoordinated manner. We conclude that extreme heat in the absence of free water, as experienced in this event, would have a substantial impact on populations of western grey kangaroos.

TORPOR ECOLOGY OF THE WESTERN PYGMY-POSSUM

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Little is known about the thermal biology of marsupials in the wild. We quantified torpor patterns and habitat use in free-ranging western pygmy-possums (*Cercartetus concinnus*), a small marsupial known to employ torpor in captivity. In an area of coastal mallee heath, individuals usually nested beneath bark and leaf litter at the base of dead *Banksia ornata*; nest sites were often reused. Home ranges were 0.07 ± 0.05 ha for females and 0.78 ± 0.70 ha for males and decreased with increasing torpor use. Possums displayed both short (< 24 h) and prolonged (> 24 h) torpor bouts (6.4 ± 5.4 h and 89.7 ± 45.9 h, respectively), with the longest bout lasting 186.0 h. The optimal ambient temperature (T_a) for prolonged torpor was $\sim 6.5^\circ\text{C}$. Short torpor bouts began in the early morning, whereas prolonged bouts began in the early evening. Rewarming from torpor always occurred shortly after midday. Nights when animals entered torpor were colder ($T_a = 8.4 \pm 2.4^\circ\text{C}$) than those when they stayed normothermic ($T_a = 10.1 \pm 2.7^\circ\text{C}$); T_a s were warmer ($13.1 \pm 2.2^\circ\text{C}$) on days they rewarmed than on days they remained torpid ($12.0 \pm 2.1^\circ\text{C}$). Torpid body temperature decreased with T_a to a minimum of 4.1°C (mean = $8.8 \pm 2.7^\circ\text{C}$). Rewarming rate decreased with increasing torpor bout length. Our study shows that, similar to other small opportunistic hibernators, T_a strongly affects torpor patterns in free-ranging *C. concinnus*.

HYGRIC PHYSIOLOGY OF A LIVING FOSSIL, THE MONITO DEL MONTE (*DROMICIOPS GLIROIDES*)

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The monito del monte (*Dromiciops gliroides*) is the only living representative of the marsupial order Microbiotheria. We present here the first measurements of evaporative water loss and relative water economy for this microbiotherian, during normothermia and torpor. Standard EWL (2.6 ± 0.21 mg g⁻¹ h⁻¹ at 30°C) was 103% of that predicted for a marsupial, and conformed statistically to the all-marsupial allometric relationship. Evaporative water loss remained constant below thermoneutrality, but there was a significant increase at higher ambient temperatures. Torpor at low ambient temperatures significantly reduced EWL to 21% (15°C) to 47% (20°C) of normothermic values. The point of relative water economy for the monito of 15.8°C is consistent with that of other Neotropical and Australian marsupials of a similar body mass. Despite their absolute water savings, torpid monitos had a less favourable relative water economy than normothermic individuals.

MAMMALS USED FOR PHYSIOLOGICAL STUDIES CAN BE SUCCESSFULLY RETURNED TO THE WILD

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Animals may be released into the wild for introduction, translocation or rehabilitation purposes, but they often do not survive or reproduce as well as wild conspecifics. Another circumstance whereby animals may be released is the return of research animals to where they were captured. I examine here the fate of southern brown bandicoots and yellow-footed antechinus returned to the wild after being held in captivity for measurement of metabolic rate and evaporative water loss. Six adult male bandicoots were held in captivity for three weeks for physiological measurements, before being released at the site of capture. Five of the six bandicoots were re-trapped seven weeks later. Post-release monitoring of four female antechinus held in the laboratory for approximately a week for physiological studies resulted in the re-capture of three, all with pouch young. Three other females caught but not held in captivity were not re-captured. Even for more invasive laboratory interventions, such as abdominal surgery to implant temperature loggers, animals can be successfully returned to their original habitat. For example, 11 of 14 operated/implanted common brushtail possums were recaptured 3 months post-surgery. Clearly, temporary captivity to conduct these physiological experiments does not prevent animals from being successfully returned to the wild. This knowledge of successful release of animals used for scientific research is important for researchers, wildlife managers and animal ethics committees to make informed judgements concerning the fate of these research animals.

HOW SENSITIVE ARE MALE GERM CELLS OF THE HOPPING MOUSE TO HIGH ENVIRONMENTAL TEMPERATURES?

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In most mammals, testes lie in the scrotum where the temperature is several degrees lower than that of core body temperature due to a counter-current heat exchange between descending blood in the testicular artery and the surrounding pampiniform plexus. The spinifex hopping mouse has extremely small testes that are either scrotal, inguinal or lower abdominal; and a highly coiled testicular artery and well developed pampiniform plexus are absent. Here we investigate whether male germ cells are resistant to high temperatures. Adult male hopping mice were used to determine (1) lower abdominal and scrotal temperatures, (2) testis weights and spermatogenesis 7 to 21 days after attaching one testis to the lower abdominal wall, and (3) germ cell apoptosis, by TUNEL, after exposing animals to either 37-38°C or 23-24°C (controls) for 8 hours per day for 3 days. Results showed that lower abdominal temperature was ca. 38°C and scrotal temperature ca. 36°C. Testes retained in the abdominal region did not lose weight even after 21 days although some impairment of spermatogenesis was evident; however animals subjected to heat had ~40-50% increase in apoptotic germ cells. We conclude that, even though adult male hopping mouse testes reside in an environment that does not markedly lower temperature, developing germ cells in animals exposed to high temperatures frequently degenerate. Thus adaptation of this species to arid Australia has not resulted in decreased sensitivity of male germ cells to high temperatures in spite of an absence of a well developed cooling mechanism of blood supply to the testis.

SESSION 4: The roles of predators in Australian ecosystems

KEYNOTE ADDRESS

LARGE PREDATORS AND THE CONSERVATION OF AUSTRALIAN MAMMALS

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Australia is unusual among the continents in its lack of large native mammalian predators. This is a recent phenomenon, produced by the extinction of large marsupial predators over the last 50 000 years. Within the last 200 years, new mesopredators have been added to the Australian fauna, and are responsible for dramatic declines in native mammals. These declines have not ended: mammals are currently being lost across northern Australia, and Tasmania's mammal fauna is under threat. In this paper, I argue that restoring the structure of predator communities can help stem current declines and restore declined species. This is the basis for controversial proposals to reinstate the ecological function of dingoes on mainland Australia. I discuss the evidence that is relevant to this debate, and the new research that will be needed to guide management.

PUTTING THE BITE BACK INTO BIODIVERSITY CONSERVATION AND RANGELAND MANAGEMENT: WHAT ROLE(S) FOR DINGOES?

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There is growing recognition worldwide of the important roles played by predators in regulating ecosystems and sustaining biodiversity. In Australia, we have suffered substantial biodiversity and economic losses through the effects of exotic predators, most notably cats (*Felis catus*) and red foxes (*Vulpes vulpes*), as well as overabundant herbivore populations. We show that the impacts of these species could be reduced significantly by a new management philosophy with respect to the dingo. Recent studies show clear and consistent evidence that the ongoing persecution of the dingo, Australia's sole remaining large mammalian terrestrial top-predator, is linked with outbreaks of cat and fox populations ('mesopredator release'), as well as herbivores (kangaroos). With reference to these studies, and a study we are currently undertaking across Australian landscapes, we outline the functional roles of the dingo and how it could be better managed to simultaneously maximise biodiversity and economic benefits. With the recent introduction of the red fox and concurrent decline of the devil in Tasmania, and evidence for increasing rabbit and cat populations and declining native mammals in northern Australia, there is clearly an urgent need to reassess predator management in Australia.

DINGOES PREVENT RED FOX RE-ESTABLISHMENT IN A LANDSCAPE-SCALE ENCLOSURE: IMPLICATIONS FOR THREATENED SPECIES MANAGEMENT IN ARID AUSTRALIA

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Anecdotal evidence suggests that dingoes may suppress feral cats and foxes, although this relationship has not been proven experimentally. Our study aimed to test this Mesopredator Release Hypothesis by re-introducing a male and female dingo, seven foxes and five feral cats into a 37 square km enclosure in arid South Australia. Radio-collars with GPS dataloggers recorded locations every two hours and interactions between species, mortality rates and post-mortems were used to determine the mechanisms of any direct or indirect suppression.

Autopsy results and GPS fixes suggest that dingoes killed all seven foxes within 17 days of introduction to the enclosure. No pre-death interactions were recorded between the dingoes and foxes suggesting that they were killed during their first encounter. Dingoes typically stayed with fox carcasses for several hours after death and/or returned to the carcass up to several days after death. Carcasses were not eaten. The dingoes were travelling together during six of the seven deaths, the remaining fox was killed by the female dingo near her breeding den.

All five feral cats died between 27 and 123 days after release into the pen. Autopsy results and GPS fixes implicated the dingoes in the deaths of at least two of these feral cats.

Results from this study support anecdotal evidence that dingoes may play an important role in suppressing exotic medium-sized predators, particularly foxes, but further proposed research is required to determine if this translates into a net benefit for threatened prey species.

SIX IMPORTANT CONSIDERATIONS WHEN EVALUATING DINGOES (*CANIS LUPUS DINGO*) AS POTENTIAL BIODIVERSITY CONSERVATION TOOLS IN AUSTRALIA

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Dingoes have recently been considered as a biodiversity conservation tool in Australian ecosystems. However, several important factors must be considered thoroughly before dingoes are used to manage biodiversity. Dingoes are not typical apex predators. They are exotic, eutherian mesopredators that supplanted the thylacine (*Thylacinus cynocephalus*) on mainland Australia. Dingoes were selected by man from wolves and those domestication processes resulted in behavioural changes, generalist diets and flexible foraging tactics that expose a broad range of Australian animals to their predation. Australian landscapes have been grossly altered since 1788. Because of the European anthropogenic changes to vegetation structure and provision of resource subsidies including increased permanent water and food availability (livestock– Bovidae, rabbits – *Oryctolagus cuniculus*, rubbish tips and macropods– Macropodoidea), the positive management of dingoes will not automatically restore threatened species. The functional role of dingoes is likely variable with spatial scale. Patterns evident at nation-wide scale disappear at the local scales where dingoes themselves may threaten faunal populations.

The assertion that dingo control will facilitate exotic mesopredator release ignores the practicalities of canid control. Control programs simultaneously reduce both dingo and fox abundance, and foxes are unlikely to respond positively to effective dingo control programs.

Ultimately, the threatening processes affecting critical weight range species are likely a combination of top-down and bottom-up effects. Outside of an adaptive management framework, undertaking management actions that ignore either suite of effects is risky and unlikely to succeed in preserving faunal biodiversity.

KEYSTONE EFFECTS OF DINGOES BENEFIT NATIVE MAMMALS IN ARID AUSTRALIA

Mike Letnic

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Alien predators can have catastrophic effects on ecosystems and are thought to be much more harmful to biodiversity than their native counterparts. However, trophic cascade theory and the mesopredator release hypothesis predict that the removal of top predators will result in the reorganization of trophic webs and loss of biodiversity. Using field data collected at arid locations located on either side of the dingo fence, I provide evidence that removal of dingoes, has cascading effects through lower trophic levels and is linked to the loss of native small mammal species. There were stark differences in mammal assemblages on either side of the dingo fence and the effect of dingo exclusion on mammal species scaled with body size. Kangaroos and red foxes were more abundant in the absence of dingoes while small mammals were less abundant where dingoes were absent suggesting that they may benefit from lower red fox numbers in the presence of dingoes. Feral cats and rabbits did not respond consistently to dingo exclusion. Using species distribution data I predict that reintroducing or maintaining dingo populations would produce a net benefit for the conservation of threatened native mammals across $> 2.4 \times 10^6$ km² of Australia. This study provides evidence that dingoes have a keystone role in arid Australia and may be beneficial for biodiversity conservation.

CONSTRUCTING A RELIABLE DINGO PURITY TEST 1– DISTINGUISHING BETWEEN PURE AND HYBRID DINGOES.

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Hybridisation with the domestic dog is listed as a key threatening process for the Australian dingo in the Threatened Species Act. It is thought that hybridisation rates between domestic feral dogs and dingoes are extremely high but quantification has been hampered by the absence of a reliable dingo purity test. We present a method which uses the genotypes of 3,419 known purebred domestic dogs from 57 of the most common breeds in Australia to generate and compare the distributions of the posterior probability of belonging to a breed (Q) for purebred dogs and hybrids. A randomly chosen subset of 12 of the 57 breeds was used to generate cross bred genotypes and *STRUCTURE* was used to calculate Q for purebred dogs and hybrids. Average Q values were compared using a randomization test. Preliminary results indicate that the average Q for purebred dogs ($\bar{X}=0.991$) is higher than that of 50% hybrids ($\bar{X}=0.013$, $p=0$), 75% hybrids ($\bar{X}=0.711$, $p=0.0$), and 87.5% hybrids ($\bar{X}=0.909$, $p=0.0$). Additionally, there are significantly more purebred dogs than 87.5% hybrids with $Q=1.000$ than $Q<1.000$ ($\chi^2_1=68.45$, $p=0.000000$); and $Q=0.999$ than $Q<0.999$ ($\chi^2_1=19.15$, $p=0.000012$); but there is no significant difference between the number of purebred dogs and 87.5% hybrids with $Q=0.998$ and $Q<0.998$ ($\chi^2_1=0.66$, $p=0.417$). We have shown that *STRUCTURE* can distinguish between purebred dogs and hybrids and we have a criterion ($Q\geq 0.999$) on which to base the inclusion of dingoes in a purebred dingo reference population to which dingoes of unknown purity can be compared.

PREDATOR-DRIVEN REGIONAL EXTINCTIONS OF SMALL DESERT MAMMALS

Chris R Dickman, Aaron C Greenville, Bobby Tamayo and Glenda M Wardle

School of Biological Sciences, University of Sydney, NSW 2006

Rodents and some dasyurid marsupials in arid Australia show eruptive population cycles, with ‘boom’ periods of high numbers taking place after large rainfall events and ‘busts’ occurring as conditions once again become dry. These extreme cycles have been interpreted as being driven largely by the effects of climate on primary productivity, but recent evidence suggests that predators also may play a key role in hastening and prolonging population declines. Here, we describe the population dynamics of several species of small mammals in the Simpson Desert over a period of 20 years, and attempt to disentangle the effects of rainfall and predation on the observed patterns. The native rodents *Notomys alexis* and *Pseudomys hermannsburgensis* usually erupt six months after heavy summer rain, while the carnivorous *Dasyercus blythi* increases up to three months later. Peak numbers are sustained very briefly, and then fall rapidly as indices of the activity of foxes *Vulpes vulpes* and feral cats *Felis catus* are rising. Analysis of predator scats from different phases of the population cycle shows that predation on small mammals is most intense when their numbers are declining, and suggests that predation is a significant additive source of mortality at this time. Since 1990, three species of native rodents – *Rattus villosissimus*, *Leggadina forresti* and *Pseudomys desertor* – have been lost from the regional trapping record, most likely due to these transitory but intense predation effects. We discuss the likelihood that further extinctions may occur, and how management could prevent this.

GUARDIAN DOGS FOR LIVESTOCK AND BIODIVERSITY PROTECTION IN AUSTRALIA

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Conventional predator control methods have numerous disadvantages. Guardian dogs can provide an alternative way to protect livestock from predation, and in Europe and the USA they have proven highly effective. In addition, in Australia guardian dogs might have a net benefit to biodiversity by reducing the numbers of foxes and feral cats. This research aims to 1) investigate how well guardian dogs protect livestock in Australia, 2) determine the behavioural mechanisms by which guardian dogs deter predators, and 3) measure the influence of guardian dogs on feral cats and foxes.

We have interviewed 150 Australian producers currently using guardian dogs and conducted several detailed case studies to measure the effectiveness of guardian dogs in protecting various species of livestock. In addition, we have monitored the movements of resident guardian dogs on several properties using GPS collars, and intend to do behavioural experiments to measure how they respond to incursions by dingoes and wild dogs. Wildlife surveys will also be done on these properties and on neighbouring properties in conjunction with conventional predator control methods.

The results of the survey and the detailed case studies indicate that guardian dogs can be highly effective in predator control in Australia. For some producers, they mean the difference between going out of business because of financial losses due to predation, and making a profit farming livestock.

A NOVEL DISEASE THREATENS TASMANIA'S TOP PREDATOR: AN INTEGRATED APPROACH TO RESEARCH FOR MANAGING THE ENTIRE ECOSYSTEM

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Tasmania has been an important refuge for marsupial conservation. Free of dingoes and foxes, it has supported the most intact remaining guild of marsupial carnivores and a number of marsupial species that have become extinct or endangered on mainland Australia.

In 1996, a new unusual contagious cancer, Devil Facial Tumour Disease (DFTD), was detected in Tasmanian devils, the top predator in Tasmania's ecosystems. In 15 years, DFTD has spread across most of the devil's range causing overall population decline of 70% with local declines up to 94%. Predictions of extinction in the wild in ~ 35 years has led to "Endangered" listing internationally and locally. Intriguing patterns of lower infection rate and population impact in northwest Tasmania where the disease is encountering different devil genotypes for the first time offer hope of resilience to the disease.

A decision theoretic approach is used to establish management and research priorities. Disease management is based on breaking transmission. Management options are limited, to *ex-situ* insurance metapopulation and disease suppression in wild populations. Longer term options potentially include genetic restoration through translocation including detection and spread of resilient genotypes. The program aim is to maintain an enduring and ecologically functional population of devils in the wild in Tasmania. Measuring ecosystem impacts of the loss of the top predator, with particular attention to the presence of foxes in Tasmania and the potential increase in feral cat populations, is crucial to a holistic and integrated approach to conservation management and restoration of the entire ecosystem.

A NOVEL OBSERVATION OF DINGOES *CANIS LUPUS DINGO* ATTACKING A SWIMMING EASTERN GREY KANGAROO *MACROPUS GIGANTEUS*

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The dingo, *Canis lupus dingo*, is a keystone species in Australian ecosystems. The current study reports four dingoes observed attacking a swimming eastern grey kangaroo *Macropus giganteus* in the Wollondilly River, a tributary to Lake Burragorang in the Greater Blue Mountains World Heritage Area, approximately 65km west of Sydney. It is proposed that the depth of water may hinder any efforts by kangaroos to escape predation, if dingoes can continue attacking from opposing directions. Predatory behaviours underlie the functional role of dingoes and it is recommended that adaptive livestock management strategies are developed to minimise disruption to dingo packs and maintain the function of dingoes in Australian ecosystems.

USING MESOPREDATOR SUPPRESSION BY DINGOES AS A CONSERVATION STRATEGY IN AUSTRALIA: THE NEED FOR APPROPRIATE CONSERVATION BENCHMARKS

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The dingo *Canis lupus dingo* has recently been promoted as a method of controlling feral cats *Felis catus* and introduced red foxes *Vulpes vulpes* via mesopredator suppression. We test this using track surveys from arid zone Australian Wildlife Conservancy sanctuaries. Dingoes were the most abundant predator on both study sites, and the presence of mesopredators was positively related to dingo presence suggesting resource availability was the major factor driving their presence. Dingoes increasingly avoided areas further from water, whereas foxes and cats appeared less affected. Fire appeared to have little influence on the presence or absence of placental predators at our sites. Our results provide little evidence for dingoes affecting the presence of foxes and cats, and water appears to be a bigger driver of dingo presence but its presence has less influence on mesopredators. Despite this, recent research has provided exciting evidence of a faunal response to dingo presence. We agree that there are likely to be some ecological benefits to retaining pure-bred dingoes in the landscape, however believe that this accepts an inappropriately recent conservation benchmark of allowing foxes and cats to remain in the environment. We recommend a 1770 conservation benchmark be formally adopted by Australian conservation agencies which would prioritise the eradication of foxes and cats from, at least core conservation areas, of the country. We also argue that biodiversity conservation is an issue of such national importance that it should be managed by the Commonwealth rather than individual states.

DIRECT AND INDIRECT EFFECTS OF COUGAR PREDATION LEAD TO STRONG ALLEE EFFECTS IN BIGHORN SHEEP

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Although classical density-dependence is thought to dominate population dynamics of large herbivores and is the foundation of wildlife management, Allee effects (inverse density-dependence) can also affect the dynamics of small populations, with important implications for conservation. The bighorn sheep (*Ovis canadensis*) population at Sheep River, Alberta, Canada, monitored for 27 years, dramatically declined over 15 years, following several episodes of high cougar (*Puma concolor*) predation that depressed both adult survival and recruitment. Predation appeared associated with individual specialist cougars that switched to bighorn sheep from preying on cervids. In years of high cougar predation, lamb survival was lowered on average by 21% and ewe survival by about 10%. We did not find any negative density-dependence, even though the population ranged from 39 to 152 sheep. Population growth rate was negative in 5 of 8 years with fewer than 100 sheep. Allee effects due to predation now drive the dynamics of this population, with a high risk of extinction. In addition to direct negative effects of predation on survival, during years of high predation ewes appear to reduce maternal care and lambs suffer indirect mortality through reduced growth. For an average-sized lamb in a year of high predation, the indirect effect on survival through reduced growth accounted for about a third of the total decrease of survival, while two thirds appeared directly due to predation. Allee effects and indirect effects of predation can greatly influence the dynamics of small populations of herbivores.

SESSION 5: Genetics, evolution and development of Australian mammals

KEYNOTE ADDRESS

NATURAL HISTORY OF MAMMALIAN GENOMES: MUTATION, SELECTION AND RATES OF EVOLUTION

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The features of mammalian genomes vary considerably between taxa. For instance, rates of molecular evolution vary by at least an order of magnitude across mammals, but it has been extremely difficult to understand why this variation occurs. It is only in the last few years that the wealth of available DNA sequence data has allowed us to begin to untangle the myriad of possible causes and consequences of the variation, and the results have not always been quite what we expected. In this talk, I will discuss the results of a number of recent attempts to understand some of the variation in the natural history of mammalian genomes, and provide some pointers of where we might look next.

DEVELOPMENT OF SEXUAL DIMORPHISM IN EASTERN GREY KANGAROOS

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In many polygynous vertebrates, inter-male competition has led to the evolution of male-specific morphological features and increased male size. Adult male eastern grey kangaroos (*Macropus giganteus*) appear substantially larger than adult females and also seem to have proportionally longer limbs. The developmental timing of these differences, however, has not been examined in detail and here we describe the development of sexual dimorphism for this species. Morphological data from 264 males and 471 females were collected between 1994 and 2007 on individuals culled from three locations across southeastern Australia. Body mass, body measurements (arm, foot and leg length) and the ratios of those measurements were compared with age from 1.0 to 16.3 years, as determined by a molar index. Males soon became larger than females according to every measurement and ratio studied, except for the ratio of leg length:foot length. Dimorphism arose at approximately 2 years, with mass and most measurements reaching a plateau in development at about age 6 in both sexes. In contrast, males showed continuous growth of the arms throughout life, so that ratios involving the arms also did not reach an asymptote in males. Both body size and the degree of sexual dimorphism increased with decreasing population density, indicating the effect of resource competition.

BRAIN SIZE REDUCTION IN CAPTIVE BREEDING PROGRAMS: A MARSUPIAL PERSPECTIVE

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Domestication and captive breeding have been shown to cause a reduction in brain size in a variety of taxa. All domesticated mammals examined, with the exception of the house mouse (*Mus musculus*), have shown a decrease in brain volume compared to their wild counterparts. Captive breeding has caused a similar brain volume reduction in wild horses and waterfowl, often after only a few generations. Many species of marsupials are currently bred in captivity for conservation and re-introduction programs throughout Australia, yet no study has investigated the potential negative effects of captive breeding on brain size in marsupials.

We investigated the impacts of captive breeding on brain volume in a small dasyurid marsupial, the stripe-faced dunnart (*Sminthopsis macroura*), that has been successfully bred in captivity for multiple generations. We examined the intact skulls of museum specimens from 54 dunnarts that were either bred in captivity or collected from the wild, and measured their endocranial volume, while taking into account sex and body size. Unlike results from wild horses and waterfowl species, we found that there were no significant differences in absolute brain volume or brain volume relative to body weight between captive bred and wild dunnarts. Although we could not detect any impact of captive breeding on brain volume in this marsupial, we advocate that great care be taken to provide suitable husbandry conditions and environmental enrichment to captive-bred marsupials if re-introduction programs are to be successful.

FROM INSECTIVORES TO HYPERCARNIVORES: FUNCTIONAL ANALYSIS AND EVOLUTIONARY PATTERNS FOR SKULL MORPHOLOGY IN CARNIVOROUS MARSUPIALS (MARSUPIALIA: DASYURIDAE)

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Carnivory, the consumption of vertebrate flesh and/or bone, has evolved in numerous mammalian groups, among both placentals (eg, 'Insectivora', Chiroptera, Carnivora, Creodonta) and marsupials (eg, Borhyaenoidea, Didelphoidea, Dasyuromorphia, Diprotodontia). In all but the last of these, carnivory probably had its roots in insectivory, and presumably passed through a stage of generalized animalivory before culminating in a few groups of obligate vertebrate flesh-eaters ('hypercarnivores') or specialised bone-cracking carnivores. We describe masticatory musculature and size/shape of the skull for adaptations correlated with the evolution of carnivory and hypercarnivory, for a monophyletic group of 16 dasyurine marsupials (Marsupialia: Dasyuridae).

Dissections of jaw closing muscles indicated that the anatomy of the masticatory musculature was conservative. Linear distance measurements and three-dimensional landmark measurements of the skull indicate an overall increase in size, an increase in size-independent robustness, and an increase in the mechanical advantage of the jaw-closing muscles, with the transition from insectivory to carnivory. These analyses identify two groups of dasyurines based on skull robustness that strongly reflect phylogenetic affiliation, and for each group there is a similar progression of size and shape changes of the skull, associated with the progression from insectivory to carnivory and hypercarnivory. We conclude that feeding strategy has been a major selective force for skull shape, but not masticatory musculature, in dasyurine marsupials.

QUATERNARY RODENT FOSSILS FROM MT ETNA, CENTRAL QUEENSLAND.

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Cave sites at Mt Etna, eastern central Queensland, contain fossils representing a diverse rainforest community. These sites date to the middle Pleistocene (>500ka-280ka BP), and record the regional extinction of rainforest-adapted mammal assemblages after 280 thousand years before present. Murid rodents comprise a large proportion of specimens recovered from the sites, but have not received adequate taxonomic attention. Here we describe initial results of a taxonomic study of the Mt Etna murid faunas. More than twenty species were identified, including representatives of all major extant Australian murid clades. Additionally, a minimum of five new species were also identified. Some new species can be assigned to known genera, but it appears that at least two new genera are also present. In the time span represented by the Mt Etna sites (>500 ka BP to recent) species richness appears to change very little, while assemblage composition changes dramatically. Most species interpreted as rainforest-adapted (e.g. *Uromys* and *Pogonomys spp.*) were extinct by 205-170 ka BP, when they were replaced by an assemblage predominantly adapted to dry conditions (e.g. *Notomys* and *Leggadina spp.*). By the late Pleistocene this dry-adapted fauna had been partially replaced to create an essentially modern assemblage.

SESSION 6: Reproduction

KEYNOTE ADDRESS

FERTILITY CONTROL – AN OPTION FOR MANAGING OVERABUNDANT NATIVE SPECIES?

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Species are defined as pests if they cause serious environmental, social or economic damage to a valued resource. Many introduced vertebrates (eg. foxes, rabbits, camels, carp, cane toads) have become pest species within Australia. However, native species (kangaroos, koalas, corellas) have also become overabundant in some habitats due to modification of their environment leading to population imbalances that are incompatible with land management objectives.

For pest vertebrates, generally, lethal control methods are widely used but require regular re-application and may or may not be species specific. Fertility control approaches, first proposed more than 3 decades ago, have gained wide public acceptance as potential alternatives to lethal control methods in some circumstances. Approaches to fertility control include the use of immunocontraceptive vaccines, steroid hormone implants, hormone agonists, and chemicals which disrupt key reproductive processes, particularly in females. Some approaches are permanent, others are reversible and not all are species specific. While several fertility control agents (gonadotrophin releasing hormone (GnRH) agonists to steroid implants to vaccination against GnRH) have proven effective when delivered to individual animals, including kangaroos and wallabies, the greatest challenge has been to develop cost effective systems for their delivery to populations. This paper will review recent progress in the development of fertility control agents and their delivery systems. Achieving species specific, broad scale, oral delivery of fertility control agents is still some years away.....and is even more problematic when considering the management of overabundant, iconic native species.

EFFECTS OF GNRH-TARGETED IMMUNOCONTRACEPTION ON MALE BEHAVIOUR IN A MODEL MACROPODID SPECIES, THE TAMMAR WALLABY, *MACROPUS EUGENII*.

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Fertility control has been proposed as a means to manage overabundant macropodid populations where conventional methods of management, such as culling, are considered unacceptable. Our recent studies have demonstrated that reproduction can be effectively inhibited in both male and female tammar wallabies (*Macropus eugenii*) using a GnRH-targeted immunocontraceptive vaccine known as GonaCon. GonaCon is currently formulated as an injectable vaccine, which induces an immune response against the hypothalamic hormone gonadotrophin releasing hormone (GnRH). Anti-GnRH antibodies then bind to native GnRH, disrupting the reproductive endocrine cycle in both sexes leading to infertility. In males, disruption of this endocrine axis results in an inhibition of the production and release of testosterone from the testes, which further impacts a number of behaviours previously demonstrated to be testosterone-dependent. Accordingly, behavioural studies of vaccinated males have demonstrated disruption of both sexual and agonistic behavioural interactions between individuals. The behavioural modifications observed, and their potential impacts in terms of social organisation, animal welfare and potential effects on contraceptive efficacy will be discussed.

THE INFLUENCE OF REPRODUCTION ON THE FORAGING BEHAVIOUR OF FEMALE EASTERN GREY KANGAROOS: AN EXPERIMENTAL STUDY

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Lactation is one of the most energetically expensive components of reproduction in mammals. Thus, reproducing females may adjust their behaviour to compensate for increased energy demands during this period. Previous investigations into the differences in the behaviour of reproducing and non-reproducing female mammals are largely correlative and the results are typically confounded by individual differences and seasonal variables. We aimed to avoid these confounding factors by experimentally controlling reproduction using a fertility control agent, and then compared the activity patterns and fine-scale foraging behaviour of reproducing and non-reproducing adult female eastern grey kangaroos (*Macropus giganteus*).

Reproducing females increased their bite rates, and thus their food intake, when the energetic demands of lactation were high. Late in lactation, reproducing females spent more time foraging during the day and less time resting than non-reproducing females. This novel field study eliminates most of the confounding factors of previous studies, and the results suggest that female kangaroos alter their behaviour in response to the energetic demands of reproduction.

WHY EATING ANTS LEADS TO PROMISCUITY: DIET, SPATIAL ECOLOGY AND THE ECHIDNA MATING SYSTEM

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Echidnas are solitary animals, and although this has been seen as an indication of their primitive status, it is more likely to be a function of their diet. All ant-eaters appear to be solitary, and in fact, most carnivores that eat prey significantly smaller than themselves are solitary. In solitary eutherian mammals females distribute themselves according to resource availability and males benefit from searching widely for females, but published data for echidnas shows no difference between home range size of males and females. We calculated home ranges for echidnas at our Tasmanian study site using the kernel method (90% kernel for home range, and 50% kernel for core area), and by the minimum convex polygon (MCP) method. Male home ranges were twice as large on average as those of females. This is one of the many manifestations of intense sperm competition in this species. Home ranges were smaller than those predicted for eutherian carnivores or omnivores of the same body mass, and an examination of the available home range data for ant-eaters in general shows that they do not conform to the normal scaling relationship between home range and body mass.

REPRODUCTIVE AND ADRENAL HORMONES AND THEIR RELATIONSHIP TO SUCCESSFUL BREEDING IN CAPTIVE TASMANIAN DEVILS

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The Tasmanian devil (*Sarcophilus harrisi*) is the largest extant species of the family Dasyuridae and has recently been classified as endangered by the IUCN. Few studies have investigated the reproductive endocrinology of dasyurids. The objective of this study was to examine the temporal relationship between reproductive and adrenal hormone concentrations and their correlation to signs of oestrus and successful pairing in captive devils. Faecal samples were collected 3-7 times per week in 35 captive adult female devils across 7 different institutions. Samples were analysed for progesterone and corticosterone metabolite concentrations and correlated with behavioural indices of oestrus. Specifically, we examined timing of inappetance and affiliative or aggressive behaviour that triggered pairing and separation, in relation to reproductive success. Between 1 and 3 cycles were detected in each female during a single breeding season; 54% successfully producing viable young. Devils exhibit a bi-phasic production of progesterone with elevated concentrations associated with both oestrus and the luteal phase, with low concentrations in between, a feature unique to dasyurids. There were no differences in either progesterone or corticosterone metabolite concentrations regardless of whether females had breeding opportunities or produced young. This is contrary to previous endocrinology studies, but is supported by early morphological analysis of the corpus luteum in pregnant and non-pregnant dasyurids. Further, females in this study were more likely to produce young if pairing extended into the latter half of oestrus (defined by elevated progesterone concentration). Endocrinology is potentially useful in optimising management strategies and may elucidate the influence of biological phenomena such as reproductive suppression.

ESTIMATING AGE AND SEXUAL MATURITY IN FEMALE INDO-PACIFIC BOTTLENOSE DOLPHINS FROM SOUTH AUSTRALIA

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There is limited information on the life history of Australian bottlenose dolphins yet such data are required for their conservation and management. Age and sexual maturity were determined in 62 female *Tursiops aduncus* obtained opportunistically from South Australian coasts. Age was estimated by tooth structure (Growth Layer Groups) using decalcified, stained thin-sections. Ovaries of 60 females were assessed: presence of at least one corpus (luteum or albicans) indicated sexual maturity. Ovaries were unavailable for two females and maturity was determined by enlarged uteri and/or presence of mammary gland milk.

Dolphin age ranged from 0 to 31 years: 26% were 0–3 years and 59% were 11–23 years. Females ≤ 8 years were sexually immature. With the exception of one female (13 years), all dolphins ≥ 11 years were mature. There was a lack of females in the critical age of 9–10 years, when maturity is likely to be attained in most dolphins. Maximum length for *T. aduncus* is 250 cm; the smallest mature and the largest immature female were 191 and 209 cm, respectively.

Total counts of corpora were related to age but not body length. Maximum number of corpora per dolphin was 11 (females 16, 18, 23 years). With an inter-birth interval of 2–3 years in bottlenose dolphins, these data show it is not possible to assume each corpus represents a conception. Mean corpora counts were greater in the left (4.42) compared with right (1.88) ovaries.

The results obtained in this study are similar to those described for *T. aduncus* in South Africa.

SESSION 7: Feeding ecology

AVAILABLE AND NOT TOTAL NUTRIENTS EXPLAIN ECOLOGICAL TRAITS

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Many ecologists recognise that animals, especially herbivores, do not obtain all of the nutrients from their food. Instead, a proportion of each nutrient remains unavailable mainly because it is indigestible and excreted in the faeces. Thus, measuring the total concentration of a dietary nutrient may not explain the nutritional state of the animal. Why then are measures of available nutrients so rare in the ecological literature? The likely answer is that measuring total nutrients is infinitely easier than are the tedious animal studies that measure available nutrients.

A favourable compromise is an *in vitro* digestion that ranks foods depending on the availability of particular nutrients. We used this process to measure available nitrogen (AvailN) concentrations in eucalypt leaves because many ecologists view N as a limiting nutrient in Australian ecosystems. There was a gross disparity between the concentrations of total N and AvailN in 138 eucalypt species. Two factors reduce the availability of N: 1) fibre binds some N; and 2) tannins, found in most dicotyledenous plants, bind proteins. By incubating samples during our *in vitro* digestion with polyethylene glycol (PEG), a tannin-binding agent, we showed that tannins explain most of the variance in the AvailN concentration of eucalypt leaves.

Furthermore, we showed that *in vitro* AvailN and not total N explains life-history traits of wild brushtail possums eating a predominantly eucalypt diet in north Queensland. Finally, assuming that tannin-protein complexes pass to the faeces we should be able to measure this with PEG and assess their effect on diet quality.

FACTS FROM FAECES: A NEW FAECAL INDEX FOR MEASURING DIET QUALITY IN MAMMALIAN FOLIVORES

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Estimating the nutritional value of the diet of herbivores is a major challenge for ecologists, because it requires knowledge of the actual diet as well as some measure of the relative quality of each component. Current methods are cumbersome and rely on many assumptions that are hard to evaluate. We describe here a new method of estimating relative diet quality directly from faeces that avoids some of the problems inherent in other methods. In herbivores eating a tannin-free diet, there is a strong correlation between dietary nitrogen and faecal nitrogen (N). This relationship is not as reliable in browsers because they ingest significant amounts of tannins that form complexes with proteins, reducing the availability of nitrogen, thus increasing faecal N concentrations. We predicted that these faecal tannin-protein complexes could be measured to indicate relative diet quality in herbivores, including those ingesting large quantities of tannins. Using the tannin-binding compound, polyethylene glycol (PEG) we showed that tannin-bound N is a significant and variable part of total faecal N in common brushtail possums and could form the basis of an Integrative Faecal Index (IFI) of diet quality. We applied the IFI to a population of common brushtail possums from an intensively studied site near Townsville Qld and found that the index predicted the reproductive success of female possums. The IFI provides a useful way of estimating the relative nutritional value of the diets of browsing herbivores.

TOLERANCE TO EUCALYPT TOXINS INFLUENCES NICHE PARTITIONING IN MARSUPIAL FOLIVORES

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Marsupial folivores choose their diets by balancing the need to acquire nutrients against the need to avoid toxicosis. *Eucalyptus*, the predominant forest type in Australia and a key dietary component for marsupial folivores, produces foliage that is nutritionally poor due to low protein concentrations, poor digestibility and high concentrations of secondary metabolites. Earlier studies have found that the feeding decisions of the koala, the common ringtail possum and the common brushtail possum are influenced by different tolerances to two major groups of eucalypt secondary metabolites - tannins and formylated phloroglucinol compounds (FPCs). The fourth eucalypt folivore, the greater glider, has not been studied from this perspective.

We hypothesized that due to a close evolutionary relationship, the greater glider would have similar chemical tolerances to the common ringtail possum. We tested this hypothesis through a series of feeding experiments that used the natural chemical variation within and between eucalypt species. We found that the greater glider had a high tolerance to tannins, similar to the common ringtail possum, but in contrast to the common brushtail possum. However, greater gliders showed a high tolerance to FPCs, unlike the common ringtail possum which is highly sensitive to these compounds. It appears that differences in the tolerance of these folivores to secondary compounds may contribute to niche partitioning, but the diversity of chemical structures within broad groups such as tannins may provide opportunity for finer scale diet selection.

SPATIAL VARIATION IN HABITAT QUALITY EFFECTS FINE-SCALE RESOURCE USE BY A LOW-DENSITY KOALA POPULATION

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The ‘nutritional quality’ of leaves for folivores is determined by the types and concentrations of nutrients and toxins contained within them. Plants vary considerably in foliar chemistry, even between the leaves of nearby trees of the same species. At broader-scales, environmental influences and spatial genetic structure result in patches of varying nutritional quality across forested areas. Wild folivores must therefore make simultaneous decisions at multiple scales to obtain a balanced diet – first to decide which areas to feed in and second to choose to feed from particular trees. It is generally thought that what drives fine-scale foraging decisions will explain broader-scale preferences; however few studies have examined this hypothesis.

We examined the influence of foliar chemistry on the multi-scaled foraging decisions of a low-density population of koalas (*Phascolarctos cinereus*) at Bermagui, NSW. Using the presence of koala faecal pellets as a proxy for visitation, we examined how variations in foliar chemistry were related to koala visitation to trees at two scales: between neighbouring trees and between different areas. Variations in foliar chemistry influenced which trees koalas visited within a plot; however they did not explain koala choices at a broader-scale. Koalas preferred trees with higher concentrations of foliar *in vitro* available nitrogen and dry matter digestibility and lower concentrations of tannins and the FPC - sideroxylonal, when compared with the foliage of neighbouring conspecifics. Differences in foliar chemistry between trees at different surveyed plots were not related to koala preferences for areas or their distribution across the site.

FIRST EVIDENCE OF TRUFFLE CONSUMPTION BY NEW GUINEA FOREST WALLABIES (*DORCOPSIS*, *DORCOPSULUS* AND *THYLOGALE*)

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Although a reasonable amount of work has been done on mycophagy in Australian mammals, including macropods, no work has been done on the mycophagous diet of New Guinea mammals. We examined stomach samples from *Dorcopsis atrata* (1 sample), *D. hageni* (2 samples), *Thylogale brunii* (1 sample) and *Dorcopsulus vanheurni* (5 samples) for the presence of fungal spores of forest macrofungi. All wallaby species were found to have consumed fungi as part of their diet, including those fungal taxa that form symbiotic relationships with forest trees and produce hypogeous (‘truffle-like’) fruiting bodies. In total, at least 20 fungal taxa were identified in the combined diets, with *D. atrata* and *D. vanheurni* diets each containing more than ten fungal taxa. This is the first record of truffle consumption by New Guinea forest wallabies. The results are suggestive that macropods are important fungal dispersers in New Guinea forests, and support recent Australian research that demonstrates the importance of macropods as fungal dispersers in forested ecosystems.

KANGAROO FORAGING AND MOVEMENTS IN URBAN CANBERRA

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Thousands of kangaroos live in the Australian ‘bush capital’ Canberra, dwelling mostly in suburban nature reserves, with excursions mainly at night to feed in sporting fields, nature strips, and front yards. These movements result in more than 1,000 motor vehicle collisions per year with kangaroos in the suburban area. There are also vegetation impacts in the reserves which have led to kangaroo control programs. One of the first steps in improving the management of either the risk of collisions, or the vegetation impacts, is to quantify the movement behaviour of urban kangaroos, so that later studies to target more specific behavioural questions will be well based.

Excursions by kangaroos to feed in suburbs (rich in dogs, cars and people) are also an opportunity to test hypotheses about ‘landscape of fear’ or predation-sensitive foraging, if either domestic dogs, cars or people are perceived by kangaroos as equivalent to predators. The study can also evaluate folklore about kangaroos and motor vehicles. If kangaroos lack recognition of the risk of fast moving vehicles, as commonly believed, kangaroo movements should not indicate avoidance of high speed roads. A research design will be presented for a study using GPS collars, and results from a pilot survey.

SESSION 8: General ecology

DO NEST BOX DESIGN AND TEMPERATURE IMPAIR THE USE OF ARTIFICIAL HOLLOWES BY ARBOREAL MARSUPIALS?

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Many species of arboreal marsupial depend on tree hollows for their survival. However, the abundance of hollow-bearing trees has declined in many Australian landscapes, leading to concern that this may cause populations of arboreal marsupial to decline. Nest boxes are commonly advanced as a solution to this dilemma but recent studies have questioned their ability to support adequate numbers of animals and thermal instability within boxes has been suggested as an inhibiting factor. To address this I conducted a study of nest box design in north-east NSW where 5 different designs were installed across 32 plots. The designs included three front-entry boxes (entrances 6.5-10 cm), one rear-entry box (entrance 4.5 cm) and one side-entry box (entrance 2.5 cm). Sugar gliders (*Petaurus breviceps*) were observed in 18 of 32 rear-entry boxes compared to 4 of 128 boxes of other designs. I also investigated the temperature profiles of nest boxes occupied by squirrel gliders (*P. norfolcensis*) in south-east Queensland. Pairs of nest boxes with either a north-west (NW) or south-east (SE) aspect were installed across 36 plots to provide a contrast in thermal environments. A slight preference was shown for SE boxes. Over one 4-week period in summer, SE boxes experienced temperatures $>35^{\circ}\text{C}$ on an average of 3 days compared to 11 days in NE boxes. Further work is needed to understand the influence of temperature on box use. The species included here are suitable surrogates for improving the deployment of nest boxes to manage populations of endangered petaurid marsupials.

HIT ME WITH YOUR BEST SHOT: MAXIMISING CAPTURE RATES THROUGH CAMERA TRAP SET UP

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Camera traps are increasingly being used for ecological research, helping to monitor elusive and threatened species, which are otherwise difficult to study. Traditionally camera traps are set up pointing out towards a bait station, to capture images of animals as they move past. An alternative set-up, in which the camera faces down towards the ground, has recently been used for small mammals. This study aimed to determine which of these set-ups is most effective for monitoring two rare and cryptic mammal species, the southern brown bandicoot (*Isodon obesulus*) and the long-nosed potoroo (*Potorous tridactylus*).

Cameras were set in pairs, consisting of one camera facing out and one facing down, both pointed towards the same bait station. Of 48 photo events, only nine were captured by both cameras. Cameras facing downwards captured an additional 37 photo events compared with only two additional photo events captured through the traditional set-up. These two methods could lead to different conclusions about the populations in question. These findings highlight the need to test camera trap set-ups on target species so that we can make best use of this technology.

EFFECT OF PITFALL DEPTH AND DIAMETER ON MAMMAL AND REPTILE CAPTURE RATES IN CRACKING CLAY HABITATS IN ARID SOUTH AUSTRALIA

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Pitfall traps are often employed for ecological studies. A number of issues should be considered before purchasing and installing traps, including the effect of trap design on capture rates of certain taxa. As part of our research on cracking clay soils and biodiversity in the South Australian rangelands, we are investigating whether mammal and reptile capture success differ between two different pitfall trap types (70 cm deep PVC drainage pipes with a 15 cm diameter and 40 cm deep PVC buckets with a 29 cm diameter). Traps are arranged in two lines of eight traps at six sites (16 traps at each site). Trap types are alternated, spaced 10 m apart, and joined by drift-net fencing. Traps are opened for three to four days and nights. Our research questions include: (1) what are the differences in mammal and reptile capture rates between pitfall trap types and (2) what is the difference in capture success for naive and experienced individuals of the most common species between pitfall types? Trapping was initiated in April 2009; 2 818 pitfall trap day and nights have been completed. We will present preliminary results and comment on the importance of considering pitfall trap design in biological studies.

HOME RANGE AND MOVEMENTS OF COMMON WOMBATS IN THE SNOWY MOUNTAINS

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The aim of this study was to determine how snow influences the home range use and movements of common wombats in the Snowy Mountains. Very little is known about their movements above the winter snow line, and this basic ecological information is essential for predicting their dispersal ability with changing environmental conditions. GPS collars were deployed on wombats (6M, 5F) to monitor nightly movements continuously over the year, to cover both the winter and non-winter periods. Home ranges were far larger than previously reported (mean = 172 ha; 95% kernel method), but varied significantly with altitude. These larger home ranges may be due to poorer quality habitat at higher altitudes. Wombats remained active throughout the winter and were typically faithful to their non-winter home range area, but they contracted their range (from 7 – 43%) and shifted their centre of activity to north-facing aspects where the snow was shallower. Wombats also moved more slowly and did not travel as far per night (total path and net displacement) during winter. This study has shown that wombats at their upper range limit have a surprising capacity for dispersal and the alpine zone is easily within their dispersal range, but they are currently constrained by snow. If the snow-cover declines as predicted under climate change scenarios, then wombats will be limited only by the availability of suitable habitat in the alpine zone, such as for burrowing.

THE RESPONSES OF SMALL MAMMALS IN THE SIMPSON DESERT TO A BROADSCALE WILDFIRE

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The Australian arid and semi-arid zones have suffered huge species losses in the past fifty years, with more than one third of the mammal species having become extinct and the remainder comprising more than half of Australia's currently threatened mammal species. A primary factor driving these declines is thought to be the replacement of Aboriginal patch-mosaic burns with infrequent, broadscale, lightning-induced wildfires, although little is known about how mammals respond to these broadscale fires or the mechanisms driving their responses. This study aims to 1) describe the distribution, abundance and diversity of mammals following a broadscale wildfire; and 2) to experimentally identify the key factors that influence animal recovery in burnt areas. A broadscale wildfire scorched over three million hectares of the Simpson Desert in the summer of 2001-2002, creating the ideal study area. Live pitfall trapping and radio-telemetry were used to characterise animal responses to the fire, and habitat data, resource availability and rainfall data were collected. Preliminary trapping showed that species richness was similar across the burnt, ecotone and unburnt habitats, but animal abundance was highest in unburnt areas, followed by the ecotone and the burnt habitats. The responses of some species agreed with results from previous research, while the responses of others contrasted the results of previous work. We expect the radio-telemetry and experimental components of the study will further explain the mechanisms behind these observed responses, as will the habitat, rainfall and resource availability data.

OBSERVATIONS OF INDIVIDUAL HAND PREFERENCE IN WILD GROUPS OF WHITE-FACED SAKIS (*PITHECIA PITHECIA*) IN SURINAME

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Individual handedness is well observed in humans and some primates. Unlike other primates, however, humans show a consistent hand preference across a variety of tasks, and a distinct right-handed skew over populations. Although there are a moderate number of published studies, many studies done on a few species unbalance the primate handedness literature. No previous studies have addressed hand preference in wild White-faced sakis (*Pithecia pithecia*). We followed three habituated groups of White-faced sakis in Suriname, and recorded individual preferences for 6 different hand behaviours. There was no consistent hand preference for a range of uni-manual behaviours for any individual. Likewise, there were significantly more ambidextrous individuals in the population than expected (χ^2 ; $df = 2 = 11.2$; $P = 0.004$), and thus, no population level handedness. Our findings support the notion that lateralization of hand function is extremely unusual in primates and contributes good baseline data to the debate of primate hand lateralization.

Posters

SURVIVAL OF REINTRODUCED SOUTH AUSTRALIAN MAINLAND TAMMAR WALLABIES

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The SA mainland sub-species of the Tammar Wallaby was extinct by the 1930s, due to broad-scale land clearing for agriculture and predation by the red fox. During the 1990s, a feral population was discovered on New Zealand's Kawau Island and 85 adult wallabies (52F, 33M) and 7 female pouch young were repatriated to Australia in 2003. A captive breeding colony was established at Monarto Zoo, including a cross-fostering program to enhance reproductive output. We chose Innes NP as the reintroduction site and initiated an intensive predator control program. We released 125 wallabies in four stages between November 2004 and October 2008 (10, 36, 36 and 43 individuals, respectively). Only 40% of the 1st release animals survived to 12 months, with the majority falling prey to foxes. The survival of the 2nd release animals was significantly reduced due to starvation, believed to be due to low nutrient levels in winter feed. Following the onset of warmer weather and improved pastures, the survival rate increased significantly. However, by the end of 12 months, only five wallabies remained (14% survival). Following the 3rd release, ten wallabies died from an unknown viral infection, but the survival rate subsequently stabilised and at 12 months post-release, 61% remained alive. Current estimates indicate that 36 to 49 reintroduced wallabies remain alive in the park. The wallabies have bred, with 4th generation wild-born animals detected. Although the survival rate in early releases was low, the population is growing slowly and the program is tentatively considered a success.

SPATIAL AND TEMPORAL VARIATION IN DECLINING EASTERN QUOLL (*DASYURUS VIVERRINUS*) POPULATIONS IN TASMANIA

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The eastern quoll is considered extinct on the Australian mainland, with Tasmania being its last refuge. Whilst eastern quolls are listed as widespread and common in Tasmania, annual spotlighting suggest declines of >50% statewide over the past 10 years. The factors responsible for this apparent rapid rate of attrition are not known, so that no appropriate management plan exists to address the decline. Given the contribution of foxes to the eastern quoll's demise on the mainland and their recent establishment in Tasmania, the eastern quoll may be facing extinction.

This research will generate current abundance estimates of the eastern quoll at several sites across Tasmania and will also examine individual animals at each site for potential causal factors contributing to population declines. These estimates will be compared to historic abundance estimates to quantify any population changes at each site. Findings will facilitate spatial and temporal analysis of a range of factors possibly contributing to the decline, including health status, dietary analysis, population structure and reproductive output. This research is a critical step in assessing the current status of the eastern quoll across Tasmania and in identifying responsible agents of decline and associated stressors.

SARCOPTIC MANGE IN WOMBATS: THE SPATIAL DISTRIBUTION OF *SARCOPTES SCABIEI* IN SOUTH-EASTERN AUSTRALIA

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The aim of this project was to investigate the spatial distribution of sarcoptic mange (*Sarcoptes scabiei*) in mammals within south-eastern Australia and to further understand potential factors influencing the spread of the disease into wombat populations where the disease exists as a threatening process, especially to populations that are small and fragmented. Two specific hypotheses were tested 1) the increased density of other species infected with sarcoptic mange in the environment, the greater the number of infected wombats in close proximity and 2) the number of sarcoptic mange cases increase in zones of low temperature, high rainfall and relative humidity.

We obtained spatial data on the presence and absence of mange via a survey sent to groups or individuals associated with mammals in NSW, Victoria and south eastern SA. The distribution of mange was then compared to a series of environmental variables using ArcMap and statistics.

The presence mammals infected with mange was most strongly correlated with increasing mean rainfall. The number of infected wombats increased most significantly with relative humidity. Infected foxes were the species most often correlated with infected wombats suggesting that the canine may be a culprit for introducing the disease into wombat populations.

The spatial model constructed in this study can be further used to target disease 'hot spot' areas for finer research, to understand when and where culling permits should be alleviated, potential areas for disease migration and general long term management for all three species.

ACTIVITY AND THERMO-REGULATION IN WILD COMMON DUNNARTS *SMINTHOPSIS MURINA*

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In the Pilliga forests, five *Sminthopsis murina* were fitted with temperature-sensitive radio-transmitters to determine nesting sites, activity patterns and thermal biology. We detected 16 dunnart burrows sites in a range of situations. Burrows at a depth of 15-17 cm maintained fairly stable temperatures (10.3°C - 15.8°C) during wide fluctuations of ambient temperature. The mean duration of activity bouts was 14.7 hr with the onset of activity ranging from 2 to 61 min after sunset. Cessation of activity was more common after sunrise than before. Normothermic resting bouts were short (< 3 hr, n=10). An overall average T_{skin} during normothermic rest periods was $32.3 \pm 0.8^\circ\text{C}$, (n=17) with individual means ranging from 30.7 to 33.8°C. All five dunnarts entered torpor with two different patterns of torpor identified, “deep” ($T_{\text{skin}} < 23^\circ\text{C}$) and “shallow” ($T_{\text{skin}} > 23^\circ\text{C}$). Mean minimum T_{skin} during torpor bouts was 17.2°C (n=11). Animals in deep bouts showed a minimum T_{skin} range of 17.2 to 22.7°C (mean: $20.8 \pm 1.8^\circ\text{C}$, n=8), those in shallow bouts showed a minimum range of 25.4 to 26.7°C (mean: $25.9 \pm 0.7^\circ\text{C}$, n=4). Individuals in deep torpor exhibited arousal rates of between 0.11 and 0.30°C/min (mean: 0.20 ± 0.02 , n=8), while in shallow torpor, arousal rates of between 0.02 and 0.07°C/min (mean: 0.05 ± 0.0 , n=4) were recorded. The duration of torpor bouts differed considerably ranging between 58 min (deep bout) to 6 hrs, 21 min (shallow bout). The variation in patterns of torpor and activity suggest a facultative metabolic capability in *S. murina* to variable environmental conditions.

FORAGING PATTERNS AS A RESPONSE TO PLANT TOXINS: THE CASE OF SWAMP WALLABIES (*WALLABIA BICOLOR*) AND CINEOLE.

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Optimal foraging theory states that the decisions made by a forager are based on profitability. Herbivores encounter Plants Secondary Metabolites (PSMs) that can act as toxins or digestibility-reducers, diminishing food profitability. Foragers have been shown to be selective in where and what they eat, in part to reduce the costs of consuming PSMs. Swamp wallabies are mammalian browsers that frequently eat a range of plants (such as *Eucalyptus* seedlings, shrubs and bracken fern) that contain a variety of toxic PSMs. Our aim was to determine how PSM concentration influences foraging patterns of free-ranging animals. We used the Giving-Up Density (GUD) framework in two different experimental designs (small and large spatial scale; blocked Latin square design or repeated measures respectively), with the terpene cineole (at five starting concentrations: 0, 1%, 2%, 5% and 10%) as a surrogate for the set of PSMs that occur in plants. Results from both experiments were consistent, showing a positive relationship between cineole concentration and GUD. Interestingly, food with no cineole had a higher GUD than food with a low concentration of cineole. We hypothesise that cineole acts as an olfactory cue, decreasing search time among the inedible matrix, partly counteracting its physiological cost. Our results demonstrate the ecological importance of plant toxin concentration - not just presence/absence – as a modifier of the foraging of free-ranging herbivores. This, in turn, has important implications for the potential selective pressure that herbivores exert on plants and plant defences.

DIGESTIVE STRATEGIES TO COPE WITH LOW QUALITY DIETS IN FREE RANGING HOWLERS MONKEYS (*ALOUATTA PIGRA*) INHABITING DIFFERENT DISTURBED HABITATS

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Ecological physiology examines how animals cope with changing environmental demands. In disturbed habitats primates may be forced to consume low-quality, high fiber food, and flexible digestive strategies have been recognized to play a key role in this context. We examined four black howler monkeys *Alouatta pigra* (from two groups) which inhabit two different highly disturbed habitats in Balancán, Tabasco, México and measured their digestive efficiency (DE), transit time (TT), total transit time (TTT) and mean retention time (MRT) when they consumed the same natural diet as available in their respective habitats. We found an average MRT 36.9 ± 7.4 hr, TT 22.7 ± 0.8 hr and TTT 80 ± 21 hr with a low-fiber diet containing 49.9% neutral detergent fiber (NDF). For the higher-fiber diet containing 62.1% NDF we found an average MRT 68.8 ± 7 hr, TT 39 ± 9.8 hr and TTT 124 ± 1.4 hr. Although a long retention time influences and increases fermentation rates and overall digestibility, in this study dry matter DE was significantly lower ($P < 0.05$) with the higher-fiber diet (69.73 ± 17.7) than with the low fiber diet (84.72 ± 8.35). The results indicate that howlers can cope with low quality diets available in a perturbed habitats but with a high investment of digestion time and obtaining less assimilation of nutrients.

NUTRITION OF CAPTIVE KULTARRS (*ANTECHINOMYS LANIGER*)

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The kultarr (*Antechinomys laniger*) is a small (<30g) dasyurid, that inhabits inland areas of arid and semi-arid Australia. It is listed as least concern on the IUCN red list, even though it has undergone a reduction in range and there is little information on the species. There is a little research on the species but no published data on diet or nutrition of either wild or captive kultarrs. The aim of the study was to use captive animals to determine the apparent digestibility of food items that kultarrs eat with a view to developing diets for captive animals. Trials were conducted to collect food items and scats from the animals with chemical analyses to determine nutrient composition.

The food items eaten by kultarrs are relatively digestible with apparent digestibility of dry matter (DMD) above 85%. These digestibility results are similar to those for other small dasyurids such as 80 % DMD for dusky antechinus (*Antechinus swainsonii*) fed a diet of mice (*Mus musculus*). Larger species, such as the eastern quoll (*Dasyurus viverrinus*) and Tasmanian devil (*Sarcophilus harrisii*) have DMD values above 80% when maintained on a diet of rat (*Rattus* spp.).

SEX DETERMINATION IN THE EXTANT OTARIID SEAL *NEOPHOCA CINEREA* FROM PELVIS MORPHOLOGY

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To date, sex determination of otariid seals has been determined on cranial morphology. This method has limited application to post-cranial material. However, this study found that, like humans and several other animals, the pelvises of adult Australian fur seals (*Neophoca cinerea*) are sexually dimorphic. The ischiopubis of the female have a curved posterior border, tapered ventral margin, and a maximum width at mid obturator foramen. In contrast, the ischiopubis in males was squarer, and did not have the rounded posterior border or tapered ventral margin. The maximum width occurred distal to the obturator foramen in males. Quantitative measurements (length and width) were taken of the pelvis to analyse the difference between the sexes (14 male, eight female). Each measurement was divided by the standard length (i.e. distance from the tip of the snout to the tail) to control for size variation between individuals. A t-test was performed, and showed that the differences in width between males and females was significant ($P = 0.00004$ for maximum width). Differences in morphology are hypothesised to result from sexual dimorphism, and may be related to weight-bearing on land. Pelvis morphology can be used to sex adult *Neophoca* in the absence of cranial elements. If the same morphological difference occurs in other otariid genera, this technique may be suitable for sexing fossil otariid taxa.

THE EVOLUTION OF THE SPERMATOZOON IN THE OLD ENDEMIC RODENT GENUS, NOTOMYS.

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The spermatozoon is a highly polarised cell that is composed of a head, in which the male haploid genome occurs, and a motile tail that facilitates its migration along the female reproductive tract to the potential site of fertilisation. Comparative morphological studies have shown that most species of the old endemic rodents of Australia (tribe: Hydromyini) have a characteristic sperm that is more morphologically complex than that of any other group of eutherian mammals. Here we have determined the intra- and interspecific variation of spermatozoon morphology and placed it on an independently derived molecular phylogeny. For this we ascertained the morphology of the spermatozoon using a variety of microscopical techniques and determined the *Notomys* phylogeny from multiple mtDNA and nuclear sequences. Preliminary observations have shown that *Notomys cervinus*, separates at the base of the *Notomys* clade, and has retained an ancestral sperm morphology, whereas the other four extant species *N. alexis*, *N. fuscus*, *N. aquilo*, and *N. mitchelli* are derived from a common ancestor and have evolved a simpler, and more variable, sperm head and shorter sperm tail. We suggest that this derived sperm form evolved in a common ancestor of the latter four species early in the evolution of *Notomys* due to a change in breeding system from a multi-male to single-male mating system associated with which there was a relaxation of inter-male sperm competition.

DO FERAL CATS AVOID INTERACTIONS WITH AN APEX PREDATOR, THE DINGO, IN SPACE OR TIME?

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Apex predators suppress populations of smaller mesopredators through resource competition or aggressive interactions. Mesopredators may change the times and places they move to avoid these potentially lethal encounters. Removing apex predators may 'release' mesopredators, increasing their populations and altering their habitat use and/or activity patterns with possible adverse effects on prey. Feral cats (*Felis catus*), which are difficult to monitor and control, prey on native wildlife and may threaten declining populations. The dingo (*Canis lupus dingo*) is persecuted for attacking livestock, but may be a trophic regulator. It may suppress mesopredator populations by restricting their activity to complex habitats or to areas or times where dingoes are less common. The absence of foxes in northern Australia provides an opportunity to investigate dingo-feral cat interactions in isolation from other eutherian carnivores.

We conducted remote camera surveys at three paired sites in different regions of north Qld to determine whether dingo activity affects feral cat habitat use and activity patterns. Paired sites were either baited to remove dingoes, or unbaited. Dingoes and feral cats occurred in all habitats and were more common along roads. However, we observed trends towards temporal partitioning, with feral cats restricting their activity times in unbaited areas with more dingoes.

If dingoes can suppress feral cat behaviour over space and/or time, they may have a significant role in reducing the effects of feral cats on native species.

THE COSTS AND BENEFITS OF WILD DOGS IN CONTESTED LANDSCAPES OF THE WET TROPICS

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Wild dogs (dingoes - *Canis lupus dingo*; free-ranging domestic dogs - *Canis lupus familiaris*; and hybrids) in the Wet Tropics may regulate populations of their prey species, exclude introduced mesopredators from their range, and play an important role in controlling populations of pest animals such as wallabies, rodents and pigs. However, wild dogs in the Wet Tropics are also believed to pose a major threat to human livelihoods and biodiversity conservation. This threat is compounded by the rapid rate of urban expansion in the region and the subsequent increase in the rate at which domestic dogs enter the feral population. Dogs, dingoes and hybrids may have different movement patterns, social behaviour, and predation rates on native fauna and livestock, which may also vary according to land use types. This project will analyse data from grids of hair- and camera traps, analysis of wild-dog scats and stomach contents, and GPS tracking. We will also use questionnaires to investigate the attitudes of Wet Tropics residents towards wild dogs, and the demographic variables which influence these attitudes. The results of this research will identify the distribution, abundance, diet, and movement patterns of wild dogs in different land use types in the Wet Tropics, and facilitate management actions which are aligned with public attitudes towards wild dogs. Our results will also enable predictions to be made of future potential wild dog problems under different land use scenarios, and enable pest managers to devise strategic plans which can target areas where management is needed most.

FOSSIL *RATTUS*: THE ARRIVAL AND DIVERSIFICATION OF NEW ENDEMIC RODENTS.

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Australia has eight indigenous *Rattus* (muridae) species, with one or more species found in most terrestrial habitats. However, the close similarities between species and apparent lack of specialisation have long suggested to mammalogists that the Australian *Rattus* radiation is of relatively recent origin.

Estimates of the timing of arrival and diversification of *Rattus* within Australia have tended to rely on molecular clocks and the rather limited published record of fossils. Workers have suggested arrival dates ranging from two to less than one million years before present. *Rattus* is absent from Pliocene fossil sites, as well as an early Pleistocene site at Nelson Bay in Victoria.

Here we report *Rattus* fossils from Queensland that shed some light on the history of the genus in Australia. Fossils are from sites at Chillagoe (north-east Queensland), Floraville (north-west Queensland), Mt Etna (eastern-central Queensland) and Texas (south-east Queensland). Dated sites older than approximately 280ka BP seem to lack *Rattus*. A single *Rattus* species is present in each of two sites dating to approximately 200ka BP. Late Pleistocene-Holocene sites contain multiple *Rattus* species.

DATING THE ORIGIN OF PLACENTAL MAMMALS: RECONCILING MOLECULAR AND MORPHOLOGICAL ESTIMATES

Kate Loynes and Matthew Phillips

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Estimates for the timing of the initial diversification of modern placental mammals range from shortly after the Cretaceous/Palaeogene (K/Pg) impact 65 million years ago (Ma), based on comparative morphology of extant and extinct mammals, to over 100 Ma for nuclear and mitochondrial sequence analyses of extant species. This discrepancy is significant in its own right, but also further complicates inference of early placental biogeography. While fossils point to a Northern Hemisphere origin, some molecular results have been interpreted to suggest a Gondwanan origin. This study aimed to propose an origin date that does not significantly contradict either morphological or molecular data.

We re-evaluated morphological matrixes of extinct and extant mammals and molecular datasets of living mammals. The most comprehensive (408 characters for 69 taxa) morphological database (Wible, 2007) was analysed using both Maximum Likelihood and Maximum Parsimony models, with variable partitioning and taxon sets. In contrast to the original analysis, a number of extant Cretaceous taxa fall within the modern placental radiation, suggesting that the group arose prior to 65 Ma and that a handful of lineages crossed the K/Pg boundary. Molecular evolutionary rates infer more than 20 modern lineages originating in the Late Cretaceous, but as few as 4-7 lineages crossing the K/Pg boundary cannot be rejected and is more consistent with the fossil record. Our result will be further examined with the addition of well-sampled mitochondrial and nuclear sequence datasets, to model evolutionary rates for both a pre- and post-K/Pg placental origin.

HABITAT SELECTION OF THE PILLIGA MOUSE *PSEUDOMYS PILLIGAENSIS*

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The habitat selection of the Pilliga mouse was studied in the Pilliga East State Forest of northern New South Wales. A significant correlation was found with a range of floristic associations, post-fire environments and habitat structure, with mice preferring shrubby woodland and heathland habitats. There was a significant positive correlation between numbers of Pilliga mice and a well-developed low shrub cover 50 cm high and a high groundcover of litter and other vegetation. Habitats having this type of cover, in particular Broombush *Melaleuca uncinata* and Kurricabah *Acacia burrowii* dominated scrublands and early and late post-fire stages of vegetation, were favoured. The Pilliga mouse avoided recently burnt areas (<6 months old) with little or no vegetation and habitats with a high shrub cover at 2 m, typical of intermediate age post fire (5-15 years old) habitats. Its floristic and structural preferences are most similar to the New Holland mouse *Pseudomys novaehollandiae* and its post-fire preferences are similar to other temperate-zone *Pseudomys*.

MAMMALS IN ECOLOGICAL CONSULTING

Cassandra Thompson

SMEC Australia, Level 6, 76 Berry Street, North Sydney, NSW 2060

SMEC is a multi-disciplinary engineering and environmental consultancy with offices and projects throughout Australia and the world. The ecological consultants within SMEC provide specialist advice and expertise for a wide range of projects and clients. While projects often involve a variety of flora and fauna species, mammals often shape ecological and environmental project outcomes.

This poster will aim to show the application of mammal research and monitoring information gathered by the scientific community, consultants and government agencies into ecological consulting practices. Main areas of application include:

- survey, impact assessment and mitigation;
- monitoring and implementation of adaptive management;
- habitat fragmentation amelioration; and
- fauna sensitive road design.

Case studies of recent projects showcasing the role of research information in the application of ecological assessment and management will be examined. These projects will become the focus of the poster presentation which will look at the use of mammal information and data in ecological consulting.

Case studies will include:

- Hume Highway upgrades – fauna sensitive road design, fauna rescue and squirrel glider monitoring;
- Tugun Bypass Common Planigale Monitoring, Qld Department of Main Roads;
- Bat translocation and nest box installation at the Eastern Treatment Plant near Melbourne; and
- Cardwell Range Upgrade Project – fauna sensitive design for the mahogany glider.

Abstracts for the Rock-wallaby Symposium of the Australian Mammal Society

Spoken papers

SESSION 1: Ecology

MULTIPLE SCALES OF DIET SELECTION BY BRUSH-TAILED ROCK-WALLABIES

Katherine Tuft^{1,2}, Mathew S Crowther^{1,3} and Clare McArthur¹

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Rock-wallabies are constrained to eating the plants around their refuges and must therefore employ specialised foraging strategies at a variety of scales in order to obtain sufficient nutrients while avoiding predators. Recent changes in ecological dynamics have altered the foraging landscape of rock-wallabies and may necessitate specialised conservation management.

Understanding rock-wallaby diet patterns forms an essential base for this process. We measured the diet of brush-tailed rock-wallabies (*Petrogale penicillata*) using microscopic examination of plant cuticle fragments in faeces from three populations across New South Wales:

Warrumbungles, Curracabundi, and Kangaroo Valley, over two years. Diet was analysed at the level of plant functional groups for all three populations, then in more detail at the plant species level in the Warrumbungles. Diet selection was measured by comparing diets with vegetation biomass. Rock-wallaby diet composition varied considerably between populations and seasonally. Some particular food plants of note include leaves and fruit of *Ficus* species, leaves of *Acacia* species and a potential facilitative relationship with a grass that forms grazing lawns around rock-wallaby refuges. Rock-wallabies selected food resources on multiple scales by combining a generalist feeding strategy at the broad spatial scale (across populations) with a more specialist strategy for particular plant species at the fine spatial scale (within one population). These results demonstrate that brush-tailed rock-wallabies are highly adaptable feeders, capable of eating a broad range of plant species and of adjusting their diet composition as the availability of resources differ in space or vary over time.

DO ROCK-WALLABIES JUST LIKE ROCKS? MODELLING THE DISTRIBUTION OF WARRU IN THE ANANGU PITJANTJATJARA YANKUNYTJATJARA (APY) LANDS, SA

Laura Ruykys¹, Matthew Ward² and David A Taggart³

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Warru (*P. lateralis* MacDonnell Ranges race) is currently being managed as SA's most endangered mammal, with the Recovery Team aiming to reintroduce captive-bred progeny to the APY Lands in the next 2 years. Before this can be done, it is necessary to understand the dynamics of warru habitat utilisation. Continued predation of warru by feral species means that current colony sites are likely to represent refugia rather than preferred habitat; however, understanding the characteristics of such is still critical for management. The current study aimed to determine the environmental parameters that influence warru distribution at three spatial scales – 1. across the whole APY Lands (landscape scale); 2. on hills where warru are extinct or extant within the APY Lands (hill scale) and 3. at core and non-core areas within hills (site scale). A maximum entropy modelling algorithm (Maxent) was used to model distribution at the landscape scale, while at the hill and site scales, we did fieldwork and then regression modelling. Geology, precipitation and vegetation type were key determinants of warru presence across landscapes. This information will assist with identifying sites to aerially survey for warru. At the hill scale, aspect, habitat type and rock and vegetation characteristics were important. Within sites, slope, aspect, vegetation and rock complexity were good predictors of warru presence. This information will help with selecting reintroduction sites most likely to act as refugia, from which warru can then successfully expand.

SOCIAL ORGANISATION OF THE ALLIED ROCK-WALLABY AT BLACK ROCK 1973-76

Wal G Davies

Rose Rd Wildlife Refuge. 487 Rose Rd, Tuntabale Ck, NSW 2480.

The longitudinal data from this four year University of Queensland field study of allied rock-wallaby (*Petrogale assimilis*) are discontinuous with that of the 12 year Black Rock Project (1986-95) conducted by James Cook University by an unfortunate gap of 10 years. However, behavioural observations and trapping data, particularly during the period 1986-90, are comparable because of continuity in site locations, nomenclature and methods. This provides the opportunity for comparison of population demographics and behavioural ecology, during a period of above average rainfall (1973-76) when the population was estimated as > 150 and of below average rainfall (1986-90) when the population dropped from an estimated 50 to 33. During 10 field trips, a total of 212 days, 75 males and 88 females were trapped at least once. A total of 136 birth intervals based on sequences of up to eight births were documented for 52 females, allowing calculation of oestrus and age of young. Quantitative behavioural analysis is based on 650 hours observation documenting 2,758 agonistic and 1250 affiliative interactions. At high population density it was possible to document behavioural mechanisms associated with female philopatry and maintenance of genetic diversity that was not possible during a period of low density with a skew towards older adults, no observable subadult females and negligible recruitment.

DIET SELECTION BY VICTORIAN BRUSH-TAILED ROCK-WALLABIES

Lily Van Eeden, Graeme Coulson and Julian Di Stefano

Ecologists assume that resource selection by animals has fitness benefits so quantifying resource selection can help determine suitable conditions for species persistence and guide management plans. We studied diet selection by the critically endangered Victorian brush-tailed rock-wallaby (*Petrogale penicillata*) by comparing proportions of plant species eaten with their availability in the three remaining rock-wallaby colonies in East Gippsland, Victoria. We estimated availability of plant species using an adaptation of the point transect method. Using microhistological analysis of faecal pellets we determined diet composition at the resolution of five plant functional groups: monocots, forbs, ferns, shrubs and trees. At all sites, forbs, monocots and shrubs were the main dietary items. However, diet composition and selection differed among the sites, particularly with regards to the consumption and selection of monocots, which appeared to be favoured at two sites, and of shrubs which were favoured at the third site. Overall, the diet composition suggested that brush-tailed rock-wallabies consume a diverse range of food types. These results can be used to improve current management by increasing the availability of preferred food types, perhaps through targeted fire regimes, and to guide the selection of reintroduction sites.

SESSION 2: Genetics

PHYLOGENETIC ANALYSIS REVEALS MULTIPLE DIVERGENT LINEAGES WITHIN *PETROGALE*

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⁵ Molecular Biology (Terrestrial Vertebrates), Australian Museum, NSW 2010.

The endemic Australian rock-wallaby genus, *Petrogale*, currently includes 16 species and forms one of the largest groups of extant macropodoids. *Petrogale* appear to have undergone a recent and rapid diversification, with inter-relationships of many taxa remaining unclear. We have examined phylogenetic relationships among *Petrogale* taxa using DNA sequence data from three mitochondrial (CO1, Cytb, ND2) and two nuclear (BRCA1, omega-globin intron) genes. Four distinct clades were identified within *Petrogale* from both the nuclear and mitochondrial genes, and in a combined analysis. The first, comprised the brachyotis group (*P. brachyotis*, *P. concinna*, *P. burbidgei*) from northern Australia; the second, *P. persephone* from north-east coastal Queensland; the third, *P. xanthopus* from semi-arid south-eastern Australia; and the fourth lineage comprised 11 closely related species of the *lateralis/penicillata* group (plus *P. rothschildi*) distributed throughout southern and central Australia. Molecular dating suggested an initial diversification during the late Miocene and Pliocene, with continued speciation throughout the Pleistocene associated with the movement of rock-wallabies back and forth across the continent. These data confirm that *P. persephone* is distantly related to all other rock-wallabies, although the *brachyotis* group was identified as the most ancestral *Petrogale* lineage.

FINE-SCALE GENETIC STRUCTURE IN THE BLACK-FLANKED ROCK-WALLABY INFORMS FERTILITY CONTROL MANAGEMENT

Nicole Willers, Oliver Berry and J Dale Roberts

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Fertility control is an increasingly popular technique for managing overabundant wildlife where political or ethical considerations rule out culling or translocations. To minimise the loss of genetic variation, the effect of fertility control must be equal for all individuals and not biased towards some components of the population either accidentally or deliberately. It is therefore necessary to understand the spatial structure of a population, including rates of dispersal and gene flow within and between discontinuous habitat, yet this information can be difficult to obtain by observation or trapping. Fertility control is being investigated as a tool to manage overabundance in an isolated population of the black-flanked Rock-wallaby (*Petrogale lateralis lateralis*) a threatened marsupial in the central wheatbelt of Western Australia. At Mount Caroline Nature Reserve this species inhabits a patchy habitat, where some refuges are widely separated and there is strong potential for non-random interaction among individuals. This study employed fine-scale analysis of microsatellite DNA variation to establish the extent of population structuring and the relative mobilities of males and females in this population. We revealed that overall gene flow is extensive within the Mt Caroline reserve, but at least two areas of refuge were genetically distinct from distant neighbours (minimum distance 950m). We also showed that female-mediated gene flow was less extensive than male-mediated gene flow. Our results imply that in this example where females are targeted for fertility control it is desirable to deploy that control within each of the genetic isolates.

ASSESSING THE FITNESS OF BLACK-FOOTED ROCK-WALLABY POPULATIONS, UTILIZING A MAJOR HISTOCOMPATIBILITY COMPLEX (ANTIGEN RECOGNITION) GENE

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The black-footed rock-wallaby (*Petrogale lateralis lateralis*) population on Barrow Island contains one of the lowest levels of genetic diversity of any mammal. In contrast, mainland black-footed rock-wallaby populations in the wheat-belt and Exmouth regions of Western Australia contain relatively healthy levels of genetic diversity, despite having suffered recent population bottlenecks due to fox predation. These measures of diversity were performed with microsatellites, a non-functional and selectively neutral class of genetic markers. To find out whether these results may also apply to functional genes that have a direct bearing on the fitness of individuals and populations, we examined levels of diversity at an immune system antigen recognition gene (*DAB β1*) in island and mainland populations of the black-footed rock-wallaby. The mainland populations displayed greater levels of allelic diversity (4–7 alleles) than the island population, despite being small and isolated, and contained at least two *DAB* gene copies. The island population displayed low allelic diversity (2 alleles) and fewer alleles per individual in comparison to mainland populations, and probably possesses only one *DAB* gene copy. The patterns of *DAB* diversity suggested that the island population has a markedly lower level of genetic variation than the mainland populations, but preserves unique alleles not found in mainland populations. If this result reflects the patterns of other immune genes, the island population would be highly susceptible to infections. Where possible, conservation programs should pool individuals from multiple populations, not only island populations, for translocation events, and focus on preventing further declines in mainland populations.

GENETIC RESEARCH IN THE BRUSH-TAILED ROCK-WALLABY AND ITS APPLICATION TO CONSERVATION AND MANAGEMENT OF THE SPECIES.

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The brush-tailed Rock-wallaby (*Petrogale penicillata*) is a small macropodid marsupial once common along the east coast of Australia. Since European settlement in Australia the species has suffered extensive reductions in range and population size especially to the south of its distribution. It is one of the most intensively studied species of rock-wallaby and research includes numerous genetic studies. This paper reviews brush-tailed rock-wallaby genetic research including the resolution of the relationship between *P. penicillata* and *P. herberti*, the use of non-invasive DNA sampling for individual identification and population monitoring, quantifying mating dispersal rates and how they shape population substructure, and sub-specific taxonomy (ESUs). We show how the data from these studies have been used to inform management practices. We also suggest future research directions for brush-tailed rock-wallaby genetic research such as investigating whether maternal and paternal MHC haplotypes affect mate choice and reproductive success to try and increase reproductive rates in captivity.

PHYLOGEOGRAPHY OF THE BRACHYOTIS GROUP WITH RECOGNITION OF TWO SPECIES WITHIN PETROGALE BRACHYOTIS

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Historically, the short-eared rock-wallaby (*Petrogale brachyotis*) was described as four species, based on variable morphology across their distribution (Van Dyck & Strahan 2008). Currently only one species is recognised, ranging from the Kimberley eastward to just inside the Northern Territory/Queensland border. Here we examine the phylogeography of *P. brachyotis*, as well as phylogenetic relationships amongst the *brachyotis* group (*P. brachyotis*, *P. burbidgei* and *P. concinna*) using mitochondrial and nuclear gene sequences. Results show that *P. brachyotis* (*sensu lato*) represents two highly divergent species: *P. brachyotis* (*sensu stricto*) in the Kimberley and *P. wilkinsi* from the Northern Territory. There is also substantial genetic divergence within both *P. brachyotis* (*sensu stricto*) and *P. wilkinsi*, associated with several biogeographic barriers. Phylogenetic analyses indicate that *P. burbidgei* is not the sister species of *P. concinna* as previously thought. This study also presents new hypotheses about the evolution and timing of divergence for taxa within the *brachyotis* group.

PHYLOGEOGRAPHY OF THE BRUSH-TAILED ROCK-WALLABY AND IMPLICATIONS FOR CONSERVATION

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Little is known about the phylogeography of south-eastern Australia and the impact of long-term environmental fluctuations in this region. Due to its high site fidelity, the brush-tailed rock-wallaby (*Petrogale penicillata*) is an ideal species to investigate this area. We assessed the distribution and abundance of genetic diversity within *P. penicillata* using 11 microsatellite loci and DNA sequence variation at the mitochondrial control region, screened across 279 *P. penicillata* from 31 colonies throughout the species' range. We found extremely high levels of genetic structure throughout the species' range and at multiple spatial scales with all sampled populations being genetically unique. The control region data revealed three well supported, distinct lineages within *P. penicillata*, corresponding to populations in discrete geographic regions: northern NSW/southern Queensland, central NSW and Victoria. There was little evidence for geographic structure within each lineage. The three major *P. penicillata* lineages formed a polytomy with *P. herberti*, with lineage divergence dated to the late Pleistocene. While the break between the Northern and Central lineage appears to correspond to a known geographic barrier, the separation of the Central and Southern lineages does not. Differentiation at nuclear microsatellite loci was high for comparisons between populations from different mtDNA lineages (mean $F_{st} = 0.337$), while differentiation amongst populations within lineages was more moderate (mean $F_{st} = 0.196$). Nuclear genetic distances amongst colonies also revealed multiple well supported clusters that separate colonies from Queensland, central NSW and Victoria. These data confirm the existence of three evolutionarily significant units (ESUs) within *P. penicillata*.

SESSION 4: Management

TOWARDS AN ADAPTIVE INTEGRATED MANAGEMENT APPROACH FOR BRUSH-TAILED ROCK-WALLABIES: LESSONS FROM RECENT RESEARCH ON HEALTHY POPULATIONS IN THE NORTHERN EVOLUTIONARILY SIGNIFICANT UNIT

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Management of threatened species is often focused on sites where the species is most likely to disappear. However, it is important to study healthy populations if they exist to better determine the factors causing the species to be threatened. We studied the relatively healthy populations of brush-tailed rock-wallabies (*Petrogale penicillata*) in the northern Evolutionarily Significant Unit (ESU) in northeast NSW and southeast Queensland. We analysed the habitat at multiple scales using extensive field datasets complemented by structured elicitation of expert knowledge. This information was used to assess the potential of a model developed in one region to be extrapolated to another region. We also compared the importance of high-quality habitat to landscape connectivity and non-habitat factors, such as feral predator activity and land management practices, with respect to predicting species presence. Key lessons drawn from the research include: 1) habitat parameters at more than one spatial scale were important for predicting species distribution; 2) extrapolation of habitat models was successful at the site-scale but not at broader scales; 3) expert knowledge can be useful when hard data for complex habitat variables is poor or unavailable, but experts need to be sourced from the area of interest; 4) connectivity between suitable sites is potentially more important than within-site habitat quality; and 5) fire management and feral predator control is crucial for maintaining healthy populations. We offer an adaptive integrated management approach to maintaining healthy brush-tailed rock-wallaby populations for the northern ESU and potential solutions to restoring healthy populations in the south.

DISTRIBUTION, STATUS AND COMMUNITY INVOLVEMENT IN THE CONSERVATION OF WARRU IN THE ANANGU PITJANTJATJARA YANKUNYTJATJARA LANDS, SOUTH AUSTRALIA

Matthew I Ward¹, Amber Clarke¹, Anika Dent¹, Thalie Partridge¹, Jason van Weenen¹, John Read¹, David A Taggart², P Copley¹ and Roman Urban¹

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The black-footed rock-wallaby (*Petrogale lateralis* MacDonnell Ranges race), known as warru by Traditional Owners, occurs in the Musgrave and Tomkinson Ranges in the Anangu Pitjantjatjara Yankunytjatjara (APY) Lands of South Australia. The Warru Recovery Team (WRT) was established in 2006 and since that time has been working toward clarifying the population status and distribution of warru, and implementing conservation management with local communities. Trapping between 2005 and 2009 has demonstrated that there are no more than 40 warru remaining at New Well, the largest of the three remaining sub-colonies, and at least 30 animals at Alalka. Because of its connectivity with the larger expanse of the Musgrave Ranges, the Alalka population is very important for conservation of warru. Good adult survivorship has indicated that juvenile mortality might be the current driver in declines of warru. Surveys at over 500 sites have revealed that extent of occurrence and area of occupancy for warru across the Musgrave Ranges has increased by 2553 and 366 km² respectively. However, across the APY Lands the extent of occurrence and area of occupancy has decreased by 44896 km² and 707km² respectively. The total warru population in South Australia is estimated at 150 animals. A number of in-situ and ex situ conservation measures have been implemented including predator management and the establishment of a captive population. Importantly, the Warru Recovery Project has led to significant increase in employment and community participation in the Warru Recovery process, as well as the establishment of contemporary Tjukurpa.

INSIGHTS AND LESSONS LEARNT FROM THE LONG-TERM MONITORING OF THE YELLOW-FOOTED ROCK-WALLABY

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Despite the yellow-footed rock-wallaby (*Petrogale xanthopus xanthopus*) showing good recovery in threat-abated areas, less than thirty percent of this species' geographical range is currently protected in South Australia. Population monitoring for conservation requires an understanding of scale-specific processes and their implications for management. Moreover, monitoring programs require a clear understanding of the management objectives and the multiple scales within which they operate. Broad-scale population monitoring such as aerial surveying can reveal general trends at a landscape level, but sometimes fail to identify many of the processes that underpin these trends. Conversely, mark-recapture techniques, which target local populations, provide insights about the demographic and behavioural processes that influence local populations. In this presentation we summarise the analysis of 13 years of aerial surveys of this species, collected from over 800 km of transect lines, and 12 years of data collected at seven trap sites. Few single species studies have collected this quantity of information at a broad spatial and temporal scale. We provide some insights about what we have learnt and how the monitoring and management of the species could be improved. We also describe climate-change scenarios we have modelled using long-term population growth rate projections.

FOX PREDATION OF THE WARRU ON THE ANANGU PITJANTJATJARA YANKUNYTJATJARA LANDS IN SOUTH AUSTRALIA

Anika Dent

Anangu Pitjantjatjara Yankunytjatjara Land Management, PMB 227, Umuwa via Alice Springs, NT 0872.

The warru (*Petrogale lateralis* MacDonnell Ranges race) population has dramatically declined in numbers since European settlement and may now be South Australia's most endangered mammal. The two known remaining colonies occur on the Anangu Pitjantjatjara Yankunytjatjara Lands in the north west of the State. The New Well population, at the eastern edge of the Musgrave Ranges, has decreased significantly since 1998, despite sporadic ground and aerial fox baiting around the colony. Scat count surveys indicate the New Well population has remained stable since June 2006 and is now estimated to be less than 40 individuals. Since July 2007, Indigenous Rangers have conducted regular and systematic fox-baiting and used their traditional skills for track-based monitoring for the presence of predators. Transect monitoring results show fox and cat presence on 1% and 18% of transects, respectively. Radio-telemetry data has shown that 92% of radio-collared warru at New Well have survived since August 2007. The stability of the New Well population, despite low fox numbers, suggests that foxes are not the main limiting factor on population size. A combination of predation of juvenile warru by cats; the shortage of food caused by a dominance of unpalatable grasses; and, the over-grazing by other large herbivores are possibly as significant as predation by foxes on preventing a population increase.

A DECADE OF MONITORING AND MANAGEMENT OF REMNANT BRUSH-TAILED ROCK-WALLABIES IN VICTORIA

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The southern Evolutionarily Significant Unit of the brush-tailed rock-wallaby (*Petrogale penicillata*) once occurred throughout the southern Great Dividing Range. This range has now contracted to a single remnant Victorian population in the Little River Gorge in East Gippsland, and the species is listed as 'critically endangered' in Victoria. Here we summarise the key results from ten years of monitoring and management of the Little River Gorge population. The number of individuals trapped per annum has increased from a single individual in 2000 to 11 in 2008. More recent use of remote cameras and genetic analysis of scat have further contributed to the detection of individuals, with the current population estimate at 20 adults and sub-adults.

Effective future management of the population requires reliable *a posteriori* estimates of (i) the minimum size to which the population was reduced, (ii) the subsequent rate of population growth, and (iii) the extent to which past management techniques and natural events have contributed (e.g. predator baiting, fire). By applying demographic inference and accounting for an increasing sampling effort, we show that the population appears not to have contracted as severely as previously thought. However, the corollary is that the rate of population increase was lower than previous estimates, which has implications for future management decisions. A long-running program of predator baiting appears to have suppressed local predator density, but there is no direct evidence that this contributed to rock-wallaby population growth. It appears that survival of young individuals increased following a bushfire event, suggesting that prescribed burning may enhance population growth.

THE WARRU RECOVERY PLAN – NOVEL INITIATIVES TO SUPPORT THE ENDANGERED SOUTH AUSTRALIAN BLACK-FLANKED ROCK-WALLABY

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Contemporary evidence suggests that warru, or black-flanked rock-wallabies (*Petrogale lateralis* MacDonnell Ranges race) are continuing to decline in both range and abundance in South Australia. Following over a decade of conventional fox baiting, which has not resulted in predicted warru recovery, the Warru Recovery Team have developed a number of management and research strategies to reverse *in situ* declines and facilitate reintroductions into previously occupied regions.

Key challenges to warru recovery are believed to include:

- 1) predation of warru by foxes, and possibly inflated numbers of dingoes, in unbaited colonies
- 2) predation on juvenile warru by cats that are believed to have increased as a result of fewer foxes and dingoes in baited areas
- 3) shortage of drought forage caused by dominance of unpalatable *Triodia* and overgrazing by unsustainably high large herbivore numbers
- 4) maintaining satisfactory ecological balance between warru predators and herbivorous competitors at occupied and reintroduction sites

The Warru Recovery Plan outlines how these and other knowledge gaps and management objectives will be addressed by dedicated staff and indigenous rangers in the APY Lands with the assistance of ecologists and zoologists from the Warru Recovery Team.

SESSION 5: Reintroduction

DETERMINING RESOURCE AVAILABILITY AND HABITAT SUITABILITY PRIOR TO A TRANSLOCATION OF BRUSH-TAILED ROCK-WALLABIES

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Determination of potential site suitability and the subsequent examination of resource availability formed the basis for the selection of a release site for brush-tailed rock-wallabies (*Petrogale penicillata*) into the Grampians National Park which commenced in 2008. The process developed for the project had three key components. Firstly a landscape level investigation using GIS was developed using historical data to determine potential areas for finer scale site selection. The data was drawn from variables attributed to 82 former rock-wallaby sites in the Grampians. These variables included cliff proximity, ecological vegetation community, geology and aspect. Nine of the 16 general brush-tailed rock-wallaby sites identified in the Grampians were subsequently the subject of field survey as the second stage of the project. Of these sites five were selected based on their ranking as preferred sites for initial reintroductions into the Grampians National Park, these included Moora Moora Creek, Cultivation Creek, Youngs Creek, Asses Ears and East Goat Track sites. The third component of the project evaluated biotic resources for the nominated sites and included an assessment of the potential competition of sympatric herbivores as well as a vegetation biomass study. The methodology used here may be of use in future reintroduction projects where empirical discrimination applied at both a landscape and site specific level is considered necessary.

SUPPORTING BRUSH-TAILED ROCK-WALLABY REINTRODUCTION WITH LANDSCAPE-SCALE FOX CONTROL: GRAMPIANS ARK CASE STUDY

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Sixteen brush-tailed rock-wallaby (*Petrogale penicillata*) have been released as part of a trial reintroduction at an unfenced site in the Grampians National Park, Victoria, Australia. The release program is supported by the 151,860 ha 'Grampians Ark' landscape-scale fox 1080 poison baiting program commenced in 1996 that aims to protect a variety of nationally threatened fauna. Buried poison baits spaced at one kilometre intervals along the road and track network occurs for a two month 'pulse' followed by a one month rest, repeated four times per year. The baited area consists of a 102,300 ha FoxOff EconoBait zone consisting of 647 stations (0.63 baits/sq. km.) and a 49,560 ha FoxOff Cooked Liver Bait zone surrounding the release site consisting of 278 stations (0.56 baits/sq. km.). Fox activity monitoring (sand pads) is conducted across the landscape during the one month rest with fox presence monitoring (infra-red digital cameras) conducted continuously at the release site with monitoring of small fauna annually in spring. Integrated autumn rabbit warren implosion and spring fumigation is conducted to reduce prey species abundance and opportunity for resident foxes surrounding the release site. During the one month rest, alternative techniques such as leg-hold trapping and switching bait type is conducted to reduce individuals displaying behaviours of bait shyness, avoidance or caching. Presence monitoring has detected five foxes since November 2008. Poison bait take and fox activity has declined by approximately 50% and 30% respectively since 2003 with abundance of small fauna increasing by approximately 30% at baited sites.

REINTRODUCTION OF THE BRUSH-TAILED ROCK-WALLABY INTO THE GRAMPIANS NATIONAL PARK, VICTORIA

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The brush-tailed rock-wallaby (*Petrogale penicillata*; BTRW) is Victoria's most endangered species with fewer than 40 individuals remaining in the wild. The last western Victorian population became extinct in December 1999. In 2005 planning commenced for reintroduction back into the Grampians National Park (GNP). Fifty seven historic BTRW sites within the GNP were assessed qualitatively and quantitatively for their suitability for reintroduction. Population modelling suggested multiple small reintroductions may provide the greatest probability of long term survival of the newly established population. Animals were hardened off for three months prior to reintroduction, in their release groups at Dunkeld in the southern Grampians. Moora Moora Creek in the Serra Range was selected as the release site. Scats from individuals destined for release were scattered at this site the morning of release. Fifteen animals have currently been reintroduced, 10 in 2008 and 5 in 2009. Additional annual reintroductions are planned for 2010-2013. Following reintroduction animals did not disperse away from the Moora Moora Creek release site. Currently eight animals survive, six are dead (three to fox predation and three to misadventure), and two are missing in action (collar failure). Breeding commenced in April 2010. This study has highlighted the need for robust monitoring of animals post release and the benefits of frequent mortality assessment and regular physical examination in order to gather accurate information on the fate, breeding success and health of reintroduced individuals.

WHAT WE DON'T KNOW AND HAVEN'T LEARNED ABOUT PULLING ROCK-WALLABIES FROM AN EXTINCTION VORTEX

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Brush-tailed rock-wallaby (*Petrogale penicillata*) colonies are blinking out across the landscape in NSW, even while attempts to manage the multiple threats facing this species have been escalating over the past decades. Once colonies decline to a small number of individuals their limited reproductive output is unable to compensate for even low-level mortality, and logistically feasible threat abatement cannot pull a colony from its gradual decline. Were we to start over with larger colonies AND threat abatement, we might be able to recover the species to viability. Having established a captive breeding population, NSW is now supplementing colonies on the brink of collapse. Through these repeated translocations we are testing hypotheses 'on the hop' and reassessing assumptions in light of our observations. We have learned a great deal from this iterative process but, as is evident from rock-wallaby research across the nation, there continue to be many departures from predictions and dogma. Consequently, reliable knowledge will require gradual and repeated synthesis of facts and insights, mediated by confounding observations. This degree of uncertainty casts doubt on any attempt to accurately prioritise or predict future recovery strategies using expert opinion.

HEALTH MONITORING OF BRUSH-TAILED ROCK-WALLABIES PRIOR TO AND AFTER REINTRODUCTION

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Captive brush-tailed rock-wallabies (BTRW) were hardened off in a 2 acre fox free enclosure at Dunkeld, for at least two months, before release at sites near Moora Moora Creek, in the Grampians National Park. At these sites, they were periodically trapped, anaesthetized and physically examined, collared and blood sampled. Faeces were collected opportunistically.

We measured the following biochemical parameters: retinol (vit A), α -tocopherol (vit E), ascorbic acid (vit C), albumin, albumin globulin ratio, uric acid, creatinine, urea, creatine kinase, choline esterase. Most showed no significant differences between seasons. Three tests examining antioxidant capacity (FRAP, TEAC and total carotenoids), which provide information on the interaction between the animal and its environment, showed no significant differences between sites or seasons. Moora Creek animals had significantly higher α -tocopherol concentrations consistent with eating more browse. Wild Moora Creek animals had a significantly reduced volume of red blood cells compared to Dunkeld and captive animals. This is probably not due to a lack of dietary protein because albumin levels were normal and not significantly different between sites. Moora Creek animals had significantly lower lymphocyte to neutrophil ratios (LN), which suggests the animals are more stressed but this may be due to extended catching and handling. Serology has shown macropod herpes virus in 90% of other macropods in the Grampians and in 70% of the released animals. All animals tested for toxoplasmosis were negative.

HOME RANGES OF A REINTRODUCED POPULATION OF BRUSH-TAILED ROCK-WALLABIES IN GRAMPIANS NATIONAL PARK, VICTORIA

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In November 2008 brush-tailed rock-wallabies (*Petrogale penicillata*) were reintroduced into the Grampians National Park. In order to determine home range and dispersal patterns within the population radio-tracking was conducted in October 2009 and March 2010. Tracking utilised VHF radio collars with animal locations determined through triangulation. Eight rock-wallabies were included in the study comprising of three established individuals, released 11 months prior, and five individuals, released immediately prior to the initial tracking period. Data analysis and home ranges were mapped using triangulation software LOCATE III and spatial software ArcGIS 9.2. Overall home ranges were on average 26.6 ha (± 2.7 SE) in area with core home ranges representing an average area of 2.4 ha (± 0.3 SE). In October 2009 core home range overlap between newly introduced animals ($42.2\% \pm 9.7$ SE) was higher than established animals ($8.4\% \pm 5.5$ SE). As expected, by March 2010 animals showed dramatic changes in home range boundaries. Female rock-wallabies displayed distinct core home ranges with very little overlap with other females ($2.5\% \pm 1.6$ SE). Similar to previous studies, male intolerance was also found with the no overlap found between males. In March 2010 early indications of the establishment of two separate colonies were found, with potential polygamous breeding groups being formed. This study highlights the importance of home range information in developing reintroduction methodologies for the species as well as to aid in current management of the Grampians population.

Posters

WATER USE BY YELLOW-FOOTED ROCK-WALLABIES IN SEMI-ARID QUEENSLAND

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Drinking behaviour has been observed in all arid zone macropod species and is usually initiated when moisture content of pasture species reaches a critical low level. This study examined the patterns of water use by yellow-footed rock-wallabies (*Petrogale xanthopus celeris*) at a colony in semi-arid Queensland. The wallabies' visitation to an earthen tank was monitored, over three years, using radio-telemetry. No distinctive seasonal pattern was evident in the wallabies' visits to the tank and at least some individuals visited the tank in all seasons. Visitation to the tank was negatively linked to both rainfall in the previous month and rainfall during tracking, whilst being positively related to temperature. The regular visitation to the tank suggests that Queensland populations of wallabies rely more on free water than do their southern counterparts. In contrast to southern climates, most rainfall in Queensland falls in the summer months and the wallabies need to drink throughout the other seasons to supplement moisture gained from pasture. Drinking also occurs during the summer period, dependent on the timing of the arrival of the rains.

FORAGING BEHAVIOUR OF YELLOW-FOOTED ROCK-WALLABIES

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An animal's foraging behaviour often represents a trade-off between potential exposure to predators and access to resources. Rock-wallabies spend the daytime hours in steep, complex terrain, venturing out into the surrounding terrain at nightfall to forage. While rock-wallabies can negotiate rocky terrain with surprising speed and agility, they are somewhat slow and cumbersome on flat ground. In contrast, the main mammalian predators of adult rock-wallabies, the dingo and fox, both chase rather than stalk their prey and, therefore, have the advantage on flat ground. This study examined the nocturnal movement patterns and habitat usage by yellow-footed rock-wallabies (*Petrogale xanthopus celeris*) at a colony in central-western Queensland. Compositional analysis revealed that, in most seasons, the wallabies exhibited a preference for an open herbfield habitat on the flats adjacent to the colony. The balance between access to the resources of the herbfield and the threat of predation were expressed in several forms. First, the wallabies did not venture far from their refuge sites until nightfall, using darkness as a means of predator avoidance. Second, wallabies foraging to the east of the hill were observed to move further distances from the hill when foraging in the drier seasons than in the wetter seasons. This indicates that the wallabies would favour habitats closer to their refuge sites, if sufficient pasture is available. Third, the majority of wallabies foraged to either the north or east of the hill, despite abundant pasture being available on hill's the western slopes. This suggested that members of each social group foraged in close proximity to each other, thereby increasing their vigilance for predators.

AN EVALUATION OF FAECAL PELLET COUNTS TO INDEX ROCK-WALLABY POPULATION SIZE.

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This study reports the results of a trial conducted to assess the suitability of faecal pellet counts to index population size within yellow-footed rock-wallaby (*Petrogale xanthopus*) colonies. One hundred 1 m² quadrats were permanently located in two colonies and emptied of pellets monthly for two years. The total number of pellets accumulated within a season (all quadrats combined), the mean number of pellets accumulated per season (quadrats as replicates) and a presence/absence index were compared to mark-recapture population estimates at one site and direct observational counts at both sites. Although longitudinal trends in abundance were reflected by the pellet indices, seasonal point estimates often contradicted those reported by the other techniques. On one occasion, one pellet collection period was missed, producing a marked discrepancy in the pellet indices and highlighting the importance of a structured sampling regime. The results of this study suggest that while faecal pellet indices may provide a means to monitor gross changes in population size, they are unsuitable for finer scale ecological studies.

THE DEVIL IS IN THE ~~DETAIL~~ GENERALISATIONS

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The Warrumbungle Ranges of NSW formerly held an expansive population of brush-tailed rock-wallabies (*Petrogale penicillata*), which collapsed to seven small colonies by 1990 and only three now. Fox baiting and goat control have been unable to ameliorate this extinction vortex. In April 2009 we tested whether raising colony size to a level where reproductive output was again high could compensate for unavoidable mortality and create a viable population. In partnership with the World Wide Fund for Nature and Waterfall Springs Wildlife Sanctuary, we released 23 rock-wallabies into the small colony still extant on Square Top Mountain. Mortality in the initial months was high, due largely to movements by naïve animals away from rocky habitat and the inability of intensive baiting to fully control fox numbers during a major mouse plague. Nonetheless, many of the rock-wallabies adjusted well to the habitat and reproduction was evident. In a second trial in February 2010 we ‘hardened’ four rock-wallabies in fox-free habitat before relocation to Square Top. These animals showed more promising habitat choices and there was no predation. However, in a concurrent release of four animals directly from captivity their poorer choice of refuge habitat likewise did not trigger predation, perhaps influenced by fewer foxes, no mouse plague and better forage. These data, and other details from the study, suggest that generalisations must be drawn with care and we are not yet in a position to make accurate predictions based on the few observations so far available from rock-wallaby translocations.

TRANSLOCATIONS – SLOW AND STEADY – WILL WE WIN THE RACE?

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Brush-tailed rock-wallaby (*Petrogale penicillata*) colonies in the South Coast region of NSW are at the southern end of the species' range in NSW and are in the midst of a major extinction vortex, believed to be caused primarily by fox predation. Along with populations in western NSW and Victoria, these areas have suffered the greatest reduction in the species' range and numbers. In the Shoalhaven LGA alone, three of the six known colonies have gone extinct since 1998. By 2007 one of the Shoalhaven colonies had approximately six individuals remaining and another only one, all of which were females. Following extensive and ongoing fox control, we translocated eight animals (three males and five females) into these two colonies over the past three years. All individuals were released with radio-collars fitted with mortality switches, supported by remote cameras to monitor the success of each translocation. Seven individuals survived and integrated into the colonies, staying within the habitat of the resident animals despite extensive unused habitat nearby, suggesting a possible anchoring effect of the resident individuals. The two surviving males have fathered young with both resident and translocated females. These translocations highlight the benefits of using remote cameras in conjunction with radio-tracking to monitor translocation outcomes and offer a possible cautionary note in the release of too many males into a small group of females. Further translocations may be necessary if local recruitment is not sufficient to overcome their extinction vortex.

POPULATION DYNAMICS OF THE BRUSH-TAILED ROCK-WALLABY IN THE HUNTER VALLEY, NSW

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During 1997-2001, NSW DECC conducted a trapping study on two colonies of the brush-tailed rock-wallaby (*Petrogale penicillata*) in the Hunter Valley, as part of a broader program to determine the effect of fox control on wallaby abundance. Concurrent pellet monitoring indicated a decline in rock-wallaby abundance at both colonies at similar rates during the study, with some suggestion of the decline slowing down towards the end of monitoring. The population data indicates that survivorship was high at both colonies (88%), with no evidence of a difference in survivorship between colonies or between age classes. Whilst there was a significant effect between colonies and time for recruitment, there was no consistent pattern of one colony having higher or lower recruitment. Neither the closed population models nor the Chapman estimates on recapture data were able to provide adequate estimates of absolute abundance, at either colony. Demographic profiles suggest there was a change from strong male bias to a slight female bias at both colonies which was more than just a delay in the trapping of the resident females. There was a decrease in new males caught after winter 1998, particularly young males at both colonies, but this pattern was more marked at Drews. The male populations at both Drews and Ingles were aging. There were new females, young and adult, caught over time at both colonies. The reproductive rate was high at both colonies and there was the suggestion that there was breeding can occur year round although not conclusive on whether it is sequential.

BLACK-FLANKED ROCK-WALLABY RECOVERY IN KURU-KANTI (THE CALVERT RANGE), PILBARA, WA

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Extensive searches in the mid 1980s discovered a single extant western desert population of, the black-flanked rock-wallaby (*Petrogale lateralis lateralis*) at the Calvert Range, 360 km east of Newman. The persistence of this population relies upon conservation measures implemented by the Department of Environment and Conservation (DEC) in collaboration with Martu Traditional Owners. Recognised custodians of the Calvert Range and surrounding 13.6 million ha of arid hinterland, the Martu people maintain very strong cultural connection to country. Since the inception of active conservation management at Calvert Range, Martu have assisted DEC with wallaby monitoring and predator control. The rock-wallaby conservation program relies on the continuing support and cultural knowledge of the Martu Traditional Owners.

Following rediscovery of the Calvert Range population in 1985, numbers declined to near extinction in the early 1990s. Ground and aerial fox baiting was initiated in 1992 by DEC, with ground baiting between 1994 and 1996 and intense aerial baiting from 1997 to 1998. Wallaby numbers did not increase. DEC's Pilbara Region began an experimental cat baiting program in 2002, with 50 baits per km² delivered over approximately 170km², centred over the Calvert Range. Following this, trapping success for wallabies increased from 4 individuals per 100 trap nights in 1994 to 35 per 100 trap nights in 2008. It appears that control of fox or dingo alone is insufficient to allow rock-wallaby population recovery, if cat predation is still present.

POPULATION DYNAMICS IN THE BLACK-FLANKED ROCK-WALLABY IN THE CENTRAL WHEATBELT OF WESTERN AUSTRALIA

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The black-flanked rock-wallaby (*Petrogale lateralis lateralis*), a threatened species in Western Australia, was intensively studied for its response to fox control. However, relatively little is known about its population dynamics. Through a mark-recapture study, we explored aspects of population dynamics in the largest known population at Mt Caroline Nature Reserve in the WA wheatbelt from 2007-2010. The relative body condition of males and females varied significantly over time. Both sexes followed a general pattern of peak body condition in early summer, declining through to autumn and maintaining condition through late winter/early spring. However, males experienced greater fluctuations in body condition than females. Births occurred throughout the year with two reproductive peaks in autumn and late winter/spring. Reproductive rates averaged over 90% annually, except in 2007 when they averaged 76%. Logistic regression analysis indicated there were significantly less females breeding during the autumn peak in 2007 than all other autumn sessions (2008-2010), and those females were in poorer body condition. Correlation analyses suggest strong positive relationships between winter rainfall in the previous year and autumn reproductive rates ($R^2=0.87$), and relative BCIs ($R^2=0.84$). Females with a higher relative BCI were on average more likely to reproduce. Population size estimates for Mt Caroline averaged 194 ± 6 adult wallabies between autumn 2007 and autumn 2009. These figures should be considered as conservative, as it was not possible to trap all areas inhabited by the wallabies, and the high site fidelity observed means not all animals were equally at risk of being trapped.

Contributors

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