

New Zealand Ecological Society and the Ecological Society of Australia

Annual Meeting



Hosted by:

*Departments of Botany and Zoology
University of Otago, Dunedin, New Zealand*

With the assistance of:

*New Zealand Department of Conservation (Coastal Otago)
Manaaki Whenua Landcare Research (Dunedin)
Natural History New Zealand Ltd.*

Conference Major Sponsor:



Supported by:

**Montana Wines Ltd.
Mainland (Cheese) Products Ltd.**

Conveners:

Dr. Janice Lord (Botany) and Dr. Ian Jamieson (Zoology)

Scientific & Programme Committee:

*Dr. Kath Dickinson, Chair (Botany),
Colin Townsend (Zoology), Murray Efford (Landcare), Bill Lee (Landcare)*

Student Conference and Volunteer Coordinators:

Brent Sinclair (Zoology), Ann Cresswell (Zoology), Amelia McQueen (Botany)

Registration and Accommodation:

University College (Diane Daly)

Finances and Logistics:

Marj Wright (Zoology)

Word processing, Graphics and Website:

*Ronda Peacock (Zoology), Trish Fleming (Botany)
Ken Miller (Zoology), Erik Liepins (Zoology)*

Media Coordinator:

Alison Balance (Natural History Ltd)

Field Trip Coordinators:

Bruce McKinlay (DoC), Graeme Loh (DoC), Ralph Allen (Landcare)

General Information

Registration

Registration will take place at the University Union 3 - 8 pm Monday 23rd November (54 on map) and in the foyer of the Castle Lecture Theatres 8 - 12 noon Tuesday 24th November (49 on map). The registration desk will also serve as a general information desk and will be open from 8.00 am to 4.00 pm daily.

Messages

Messages can be placed on the noticeboard by the registration desk. The board will also contain information about field trips and any changes to the programme. Urgent messages can be conveyed to the registration desk by phoning the Botany Department (03)479-7577 or the Zoology Department (03)479 7976, 7986. A pay phone is located in the Castle Lecture Theatre Foyer. Temporary email and web access can be arranged through ITS (45 on map). Faxes can be sent via the Botany Department (10 on map) or Zoology Department (57 on map).

Room Locations

All sessions on Tuesday morning are in Castle 2. For Tuesday afternoon and the remainder of the conference presentations are divided into three concurrent sessions held in Castle 1, Castle 2 and Burns 1 (Arts Building, 48 on map). If you wish to move between sessions please do so during question times. Please do not smoke inside any of the buildings.

Lunches

We have not provided lunches because Dunedin has many wonderful places to eat within easy walking distance of the campus.

Miscellaneous

Nearby pharmacies are located on Albany Street between Great King and George, and on St David Street between Great King and George. Nearby Medical Centres are on the corner of St David and George Streets, and on Hanover Street between Great King and Cumberland (open 24 hours). There is a 24 hour dairy opposite the intersection between St David and George Streets, and a supermarket (next to a liquor outlet) on Great King Street just off the map past Hanover Street.

Instructions for Presenters

Information for Oral Presenters

All venues are equipped with two slide projectors, overhead projectors and computer presentation facilities. Familiarise yourself with the equipment in your venue well before your session. The chair of your session will be present at the venue in the break prior to your session and can help with problems. Presenters requiring data projection facilities must notify the convenor as soon as possible - NOT immediately prior to their talk.

Speakers are expected, as professionals, to keep within their allocated time. Symposium papers and open forum papers before morning tea are scheduled for 15 minutes with 5 minutes for questions. All other open forum papers have 12 + 3 minutes. Out of consideration for other speakers and for delegates wishing to move between venues, overruns will NOT be tolerated

Castle B, C & D are available for practices and slide previews. Please be considerate in your use of these rooms.

Take your slides to Castle A at least half a day before your session. Carousals will be supplied, labelled and stored for you, and taken to the appropriate room in time for your presentation. It is your responsibility to have your slides in order. After your presentation your slides can be collected from Castle A.

Information for Poster Presenters

The minimum area available is 1.2 m by 1 m. Some poster boards can accomodate slightly larger posters. Please put up your posters on Tuesday morning in Burns 7 with overflow into Burns 5. Posters in Burns 7 are to be on display for the entire conference. Posters in Burns 5 must be removed during lunchtime on Friday to accomodate afternoon talks. Presenters should stand by their posters during the poster session on Wednesday from 5 - 6pm.

Posters in Burns 7 must be removed by the end of the conference 6.00pm Friday.

Prizes

Society prizes will be awarded for the best student presentation. The Australian Flora Foundation will award a prize to the best student poster or talk about research on Australasian native plants.

Social Events

Monday 23 November

Cash Bar, University Union (8 - 12pm)

Tuesday 24 November

Wine & Cheese (\$10), Otago Museum (6 - 8pm)

Come celebrate the opening of the conference as well as the 50th anniversary of the re-discovery of the takahe, at the Otago Museum's Extinction and Survival Galleries (4th floor).

Tickets must be shown at the main entrance to museum.

Sponsored by:

Montana Wines Ltd., Mainland Cheese, and Flight Centre

Wednesday 25 November

Poster Session & Drinks, Burns Lecture Theatre (5 – 6pm)

Cash Bar & DJ, University Union (8pm – 1am)

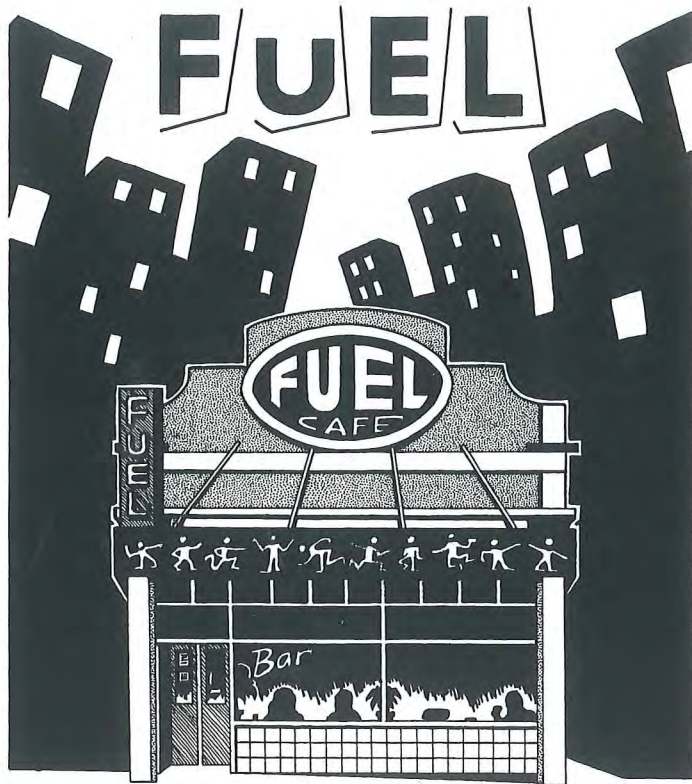
Thursday 26 November

Banquet & Dance (\$45) University Union (6:30pm – 1am)

Drinks 6:30pm

Dinner 7:00pm

Name tags and/or tickets must be shown at all social events



FUEL CAFE + LOUNGE
 - AN OASIS OF CALM IN THIS MAD LITTLE CITY.
 21 FREDERICK ST. DUNEDIN

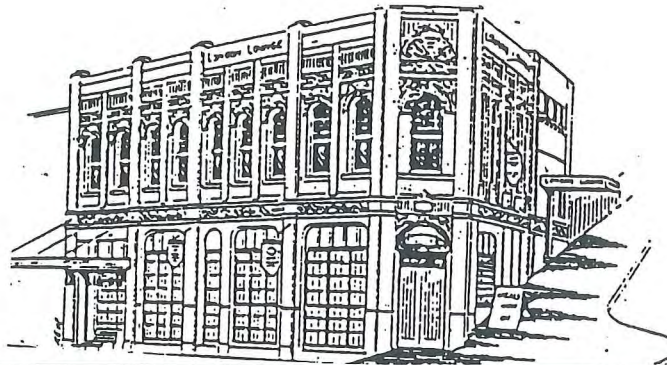


412 George Street

You'll find us
 opposite Knox
 Church on
 George Street

Capers is the place to visit
 if you like to enjoy delicious
 & nutritious food in a
 warm relaxed atmosphere

- ♦ Open 7 Days
- ♦ Monday - Friday 7.15am - 3.00pm
- ♦ Saturday & Sunday 7.45am - 3.00pm
- ♦ Groups of up to 60 people catered for



THE LONDON LOUNGE

Upstairs Cnr George & London Streets
Meals

Mon to Sat 12-2pm and from 5.00pm evening
All day Sunday

THE MIGHTY MIDDAY ROAST

MON - SATURDAY 12 - 2

ONLY

\$5.50

Ph 03 4778 035
Fax 03 4773 156

(Mon. 23rd Registration: 3 – 8pm, Cash Bar: 8pm; Univ. Union Building)

	Tuesday 24th		Wednesday 25th			Thurs	Friday 27th	
8.30 - 10.20	Official Opening. Opening symposium “Ecology across the Tasman”		Mutualisms Symposium	Seabirds Symp.	Hall Riley de Chazal Mulder Townsend	field trips	Species managem’t symposium	Forest pattern Symp. Roxburgh Fyfe Hilbert Williams Blaschke
tea	10.20-10.50		10.20-10.50				10.20-10.50	
10.50- 11.00	NZES President’s welcome Guest speaker Tom Martin NZES prize winner Nigel Barlow		Paterson Berry Moss Freuden- berger Bramley Westoby	Wagstaff Wardle Timmins Leishman Pyke Linklater	Wells Ulrich Evans Ross Tasker Fox		Norbury Ratz Bunce Jarrett Ward-Smith Reed	Coomes Collins Warton Tiver Pery Bridle Cresswell Harris SM McQueen BD Lloyd Ji Parkes
lunch	12.30-2.00		12.20-2.00				12.20-2.00	
2.00 - 3.40	Takahe Symp.	Weeds Symp.	Morgan Cullen Dangerfield Willems van der Ree	Kuchel Efford SA Davis Byrom Wright Steen	Jansen Driver A McQueen Wahren Wilmshurst Roshier	Andersen Clarkson Henderson Launonen Vernes Wardle	Loofs Blanks N Gibson Nelder Wiser Pharo	Bond Downes Collings Chapman Churchill Hillary Easterbrook Hunt Facelli Stol Meissner Sheppard
tea	3.40-4.00		3.30-4.00				3.30-4.00	
4.00 - 5.40	Takahe Symp. cont.	Costello Shea Standish Williams Zancola	Wearne Andrew Newell Overton Neil	K Lloyd Duncan Tennyson Holdaway 5-6 pm	SL Berry Ostendorf Hoffman Griffiths POSTER	Hochuli Peeters Lill Reddiex SESSION	Stubbs Anderson C.Taylor Wilson Was Bull	J.Taylor Swain Sydes Ward Poore Glasby Stern James RS Gibson Landsberg AR Davis W King
	6pm Wine & Cheese in Otago museum		7.00pm AGM 8:00pm Cash bar			6.30 Dinner 9pm Dance	5.30 Prize giving and closing	

8.30 Official Opening

OPENING SYMPOSIUM "Ecology across the Tasman"

Chair: Richard Hobbs, President, Australian Ecological Society

9.00 Steve Morton: Twelve things that fascinate me about Australia.

9.20 Lesley Hughes: Everything you need to know about Australian ecology but...

9.40 Henrik Moller: Australasian Nature Conservation: challenges, scientific ethics, and the burden of uncertainty.

10.00 Dave Kelly: New Zealand: not so stable, not so feeble, not so simple.

10.20-10.50 Morning tea

Chair: Craig Miller, President, New Zealand Ecological Society

10.50 NZES Presidential welcome.

11.00 Conference Guest Speaker: Tom Martin Alternative perspectives in life history evolution in birds: David Lack and north temperate biases led us astray.

12.00 NZES Prize Winner: Nigel Barlow Why most of the world is green but Australia brown: population regulation revisited.

12.30-2.00 lunch

Symposium to mark the fiftieth anniversary of the rediscovery of the takahe

Organisers: Bill Lee (Landcare Research), Ian Jamieson (University of Otago)

The aim of the symposium is to provide a forum for presenting an update on the research and management of the takahe in Fiordland and on the offshore islands. The last symposium on the takahe was in 1978 and since then there have been many major developments.

- 2:00 - 2:05 Opening remarks
- 2:05 - 2:40 National History New Zealand - video on the takahe
- 2:40 - 3:00 Bill Lee - Fifty years of takahe conservation and research: what have we learnt?
- 3:00 - 3:20 Steve Trewick and Trevor Worthy - Origins and prehistory of takahe: flightless Porphyrio (Aves: Rallidae)
- 3:20 - 3:40 Jane Maxwell - Fiordland takahe population; trends, dynamics and problems

3:40 - 4:00 Afternoon tea

- 4:00 - 4:20 Daryl Eason and Murray Willans - Captive rearing: a management tool for the recovery of the endangered takahe
- 4:20 - 4:40 Ian Jamieson and Christine Ryan - Island Takahe: Closure of the debate over the merits of translocating Fiordland Takahe to predator-free islands.
- 4:40 - 5:00 John Craig - Takahe: breaking ground in species recovery
- 5:00 - 5:20 Discussion

6pm Wine and Cheese Otago Museum

The symposium will be followed by a wine and cheese social at the Otago Museum during which a range of posters will be on display covering different aspects of research and management associated with the takahe project.

Tuesday 24 November

Castle 1

2.00 pm - 3.40 pm

SYMPOSIUM 2: Environmental weeds.

Organisers: Jann Williams and Carol West

- 2.00 Jann Williams and Carol West. Environmental weeds in Australia and New Zealand issues and approaches to management
- 2.20 Colin Ogle, Graeme La Cock, and Neil Mickleson. Impacts of old man's beard (*Clematis vitalba*) on plant biodiversity in indigenous forest, Taihape, New Zealand.
- 2.40 Peter Williams, Brain J. Karl, Peter Bannister and William G. Lee. Introduced small mammals as potential dispersers of weeds in New Zealand.
- 3.00 Jocelyn Howell and Doug Benson. Potential impacts of changes in water flow on riparian vegetation with environmental weeds on a coastal river, south-eastern Australia.
- 3.20 J. Vranjic & R. H Groves. Restoration of coastal Australian vegetation invaded by the South African weed *Chrysanthemoides monilifera* subsp. *rotundata*

Tuesday 24 October

Burns 1

2.00 pm - 3.40 pm

Open Forum: Fragments and boundaries

Chair: Jamie Kirkpatrick

- 2.00 Lynise Wearne and John Morgan: Is the subalpine grassland-forest boundary stable in snowplains of the Mt Hotham area, Victoria? *root suckers?*
- 2.20 ☺ Louise Cullen, Glenn Stewart, Richard Duncan and Jonathan Palmer. The effect of climate on *Nothofagus menziesii* treelines.
- 2.40 J.M. Dangerfield, I. Oliver, A.J. Holmes, M.R. Gillings and A.J. Beattie. The behaviour of biodiversity at a natural boundary. *relevant to Richard Harris' paper*
- 3.00 ☺ Nancy Willems, Glenn Stewart and Richard Duncan. The structure and dynamics of podocarps in isolated forest fragments.
- 3.20 ☺ Rodney van der Ree and Andrew Bennett. The spatial arrangement of the squirrel glider, *Petaurus orfocensis*, in a network of linear habitats.

3.40-4.00

afternoon tea Castle Complex

Are trees remnants of former continuous forest or have established since roads reserves established.

How did they react to your presence?

- abundance differs
- slight step or clines in richness
- no detectable composition change
- few boundary specialists

Tuesday 24 November

Castle 1

4.00 pm - 5.40 pm

Open Forum: Weed invasions

Chair: Ray Wills

- 4.00 David A. Costello, Ian D. Lunt and Jann E. Williams. The invasion of native, coastal grasslands by the indigenous shrub, *Acacia sophorae*.
- 4.20 Katriona Shea, Tim Woodburn and Andrew Sheppard. Models for the management of *Carduus nutans* (nodding thistle) in Australia.
- 4.40 ☺ Rachel J. Standish, Alastair W. Robertson and Peter A. Williams. Predicting the *Tradescantia* biomass threshold for forest remnant restoration.
- 5.00 Peter A. Williams, Euan Nicol and Melanie Newfield. The risk of invasive weeds entering New Zealand has been reduced by screening proposed plant imports.
- 5.20 Brian Zancola. Inhibition of an exotic weed by native flora and fauna.

Tuesday 24 November

Burns 1

4.00 pm - 5.40 pm

Open Forum: Gradients

Chair: Glenda Wardle

- 4.00 ☺ John Morgan and Lynise Wearne: Predicting richness in subalpine grasslands: effects of environmental disturbance factors.
- 4.20 ☺ Nigel Andrew: Changes in Bryophyte/Invertebrate community structure along altitudinal gradients in Tasmania and New Zealand.
- 4.40 Claire Newell and Robert Allen: Changes in plant species diversity patterns along an elevation gradient at Camp Creek, Westland.
- 5.00 J. McC. Overton, C.R. Fonseca, M. Westoby, and B. Lee: Responses of vegetation attributes to soil and climatic gradients: comparison of Australia and New Zealand.
- 5.20 ☺ Kerry Neil: The influences of chronic and catastrophic disturbances on a tropical rocky shore invertebrate assemblage.

6pm Wine and Cheese Otago Museum

Wednesday 25 November

Castle 2

8.30-10.20

8.30 SYMPOSIUM 3: Plant-animal mutualisms

Organisers: Dave Kelly and Alistair Robertson

- 8.40 R.J. Whelan, D.J. Ayre, F. Beynon and M. Richardson. Frauds or Friends? Birds and Bees as Pollinators of *Grevillea*.
- 9.00 Alastair Robertson¹, Dave Kelly², Jenny Ladley², and Kate McNutt. Native bird declines and the reproduction of New Zealand's flora: have mutualisms been disrupted?
- 9.20 Dave Kelly "Dispersal doesn't matter"
- 9.40 ☺ David Murphy and Dave Kelly. What is limiting pollination by bellbirds at Craigieburn?
- 10.00 ☺ Astrid Dijkgraaf. There's an aussie possum in my larder.

Wednesday 25 November

Castle 1

8.30-10.20

8.30 SYMPOSIUM 4 Seabird ecology and management

Organiser: Lloyd Davis

- 8.40 Stuart Bradley, Catherine Meathrel, Irynej Skira, and Ronald Wooller. Modelling the effects of harvesting on the life history traits of Short-tailed Shearwaters in Tasmania.
- 9.00 Peter Dann and F. Norman "Population regulation of Little Penguin colonies"
- 9.20 ☺ Richard Cuthbert and Lloyd Davis "Answering conservation issues with ecological questions"
- 9.40 Lloyd Davis and Martin Renner. Brood reduction in penguins: fighting, the odds and sods.
- 10.00 Henrik Moller, Christine Hunter and David Fletcher. A comparative approach to estimating survival and reproductive rates of Procellariiformes

Wednesday 25 November

Burns 1

8.30-10.20

8.30 Open Forum: Ecosystem functioning

Chair: Colin Townsend

- 8.40 Stephen J. Hall and S. Gray: The effect of resource supply rates on community assembly: experimental tests in the marine subtidal.
- 9.00 Ralph Riley, Colin Townsend, Dave Raffaelli and Alex Flecker: Sources and effects of subsidies along the stream-estuary continuum.
- x 9.20 ☺ Jacqueline de Chazal: Let's talk about Ecosystem Health: assessing nutrient 'leakage' in remnant forest patches in south eastern Australia.
- 9.40 ^u Christa Mulder and Julia Koricheva: Effects of invertebrates on diversity-ecosystem function relationships.
- 10.00 Colin Townsend, Todd Crawl, Alex Flecker, Angus McIntosh and Alex Huryn: Individual, population, community and ecosystem consequences of trophic cascade in some New Zealand streams.

10.20-10.50 morning tea Castle Complex

Wednesday 25 November

Castle 2

10.50-12.20

Open Forum: Behavioural ecology

Chair: Harald Steen

- 10.50 Jonathan Banks and Adrian Paterson: Territoriality in South Island Pied Oystercatcher: Resource defence or mate guarding?
- 11.05 ☺ Christopher Berry: European hedgehogs (*Erinaceus europaeus*) and their significance to the ecological restoration of Boundary Stream Mainland Island.
- 11.20 ☺ Kirsten Moss: Hedgehog diet and home range in braided riverbeds of the Mackenzie Basin.
- 11.35 David Freudenberger and John Barber: Movement patterns of feral goats in a semi-arid woodland in Eastern Australia.
- 11.50 ☺ Gary Bramley: Responses of wild Norway rats (*Rattus norvegicus* Berkenhout) to predator odours.
- 12.05 Mark Westoby, David Warton and Peter Reich: The time value of leaf area.

Wednesday 25 November

Castle 1

10.50-12.20

Open Forum: International comparisons

Chair: Alan Mark

- 10.50 Steve Wagstaff and Peter Wardle: Phylogenetic relationships of southern Andean and New Zealand plants.
- 11.05 Peter Wardle and Steve Wagstaff: Floristic comparison of Southern Andean and New Zealand plant communities.
- 11.20 Virginia Reid and Susan Timmins: Climbing asparagus, a South African in your forest patch.
- 11.35 Michelle Leishman and Mark Westoby: How much variation in plant traits is captured by the LHS plant ecology strategy scheme?
- 11.50 Graham H. Pyke and Arthur W. White: The green and golden bell frog (*Litoria aurea*) in Australia and New Zealand: biology and management.
- 12.05 ☺ Wayne Linklater: Publishing trends in the New Zealand and Australian Journals of Ecology compared.

Wednesday 25 November

Burns 1

10.50-12.20

Open Forum: Disturbance

Chair: John Ogden

- 10.50 ☺ Andrew Wells, Richard Duncan and Glenn Stewart: The importance of rare, earthquake-induced disturbance to landscape and forest history in Westland, New Zealand.
- 11.05 ☺ Stephen C. Ulrich, Glenn Stewart, Richard Duncan and Peter Almond: Species coexistence following periodic disturbances in a mixed conifer/beech/hardwood forest, Mt Harata, north Westland.
- 11.20 ☺ Alison Evans: The impact of sustainable beech (*Nothofagus* spp.) harvest on litter-dwelling invertebrates and litter decomposition.
- 11.35 ☺ Karen A. Ross, Barry J. Fox and Jennifer E. Taylor: Multiple disturbance effects of sand mining followed by fire on vegetation.
- 11.50 ☺ Elizabeth Tasker, Christopher Dickman and Ross Bradstock: Small mammal diversity and abundance in relation to understorey structure in the managed eucalypt forests of Northern New South Wales, Australia.
- 12.05 Barry Fox: Long-term studies of small-mammal communities in disturbed habitats in Eastern Australia.

lunch 12.20-2.00

Wednesday 25 November

Castle 2

2.00-3.30

Open Forum: Behaviour and population dynamics

Chair: Barry Fox

- 2.00 ☺ L.J.Kuchel: Cold, gluttony and a touch of debauchery: why do echidnas hibernate?
- 2.15 Murray Efford: The distribution and abundance of brushtail possums.
- 2.30 ☺ S.A. Davis, R.P. Pech, and E.A. Catchpole: The expected value of the response function - implications for population modelling.
- 2.45 Andrea Byrom and Andy Kliskey: Compensatory survival of adolescent ferrets in braided riverbeds in the Mackenzie Basin, New Zealand.
- 3.00 ☺ Jeffrey Wright and Peter Steinberg: Recruitment, mortality and population genetic structure in the subtidal red alga *Delisea pulchra*.
- 3.15 Harald Steen and Kjell Erikstad: Sensitivity of willow grouse population dynamics to variations in demographic parameters.

Wednesday 25 November

Castle 1

2.00-3.30

Open Forum: Rivers, lakes and wetlands

Chair: Barbara Downes

- 2.00 Amy Jansen, Alistar Robertson and Rohan Rowling. Developing an index of the condition of floodplain river riparian ecosystems.
- 2.15 P.D. Driver and G.P. Closs: Short-term resilience of a pond ecosystem to carp (*Cyprinus carpio*).
- 2.30 ☺ Amelia McQueen and Bastow Wilson: Using peat accumulation to predict successional changes of a raised bog.
- 2.45 C.H.A. Wahren, R.J. Williams and W.A. Papst: The ecology of alpine and sub-alpine wetland vegetation of the Bogong High Plains, South-eastern Australia.
- 3.00 Janet Wilmshurst and Matt McGlone: Recent South Island Sphagnum bogs: anthropogenic or climatic origins?
- 3.15 ☺ D.A.Roshier, A.I. Robertson and R.T. Kingsford: Variation in wetland availability and the responses of waterbirds in arid Australia.

Wednesday 25 November

Burns 1

2.00-3.30

Open Forum: Fire

Chair: Kath Dickinson

- 2.00 Alan N. Andersen, K. Ros Blanche, Lyn M. Lowe and John A. Ludwig: Responses of grasshoppers to experimental fire regimes in an Australian tropical savanna.
- 2.15 Bruce Clarkson, Kathryn Whaley and Patrick Whaley: The effect of recent Mt Ruapehu ash eruptions on subalpine and alpine vegetation.
- 2.30 ☺ Meredith Henderson: To burn or not to burn- antidotes for biomass accumulation in Western Basalt Plains Grasslands.
- 2.45 ☺ T.M. Launonen, D.H. Ashton and P.J. Keane: The effect of regeneration burns on the growth, nutrient acquisition and mycorrhizae of *Eucalyptus regnans* F.Muell. (mountain ash) seedlings.
- 3.00 ☺ Karl Vernes and Daniel T. Haydon: The effects of fire on the foraging patterns and habitat use of a mycophagous marsupial.
- 3.15 Glenda M. Wardle: Fire and rain: the demography of *Trachymene incisa* and *T. glaucifolia*.

3.30-4.00

afternoon tea Castle Complex

Wednesday 25 November

Castle 2

4.00-5.00

Open Forum: Commonness, rarity and extinction

Chair: Susan Timmins

- 4.00 ☺ Kelvin Lloyd, Bastow Wilson and Bill Lee. How do rare plants differ? A study of the comparative ecology of rare and common *Acaena* and *Chionochoa* species.
- 4.15 Richard P. Duncan and Jim R. Young: Extinction vulnerability in plants.
- 4.30 Alan Tennyson: The history of bird extinctions on Pitt Island, Chatham Islands.
- 4.45 Richard N. Holdaway: A model for the extinction of moas (Aves: Dinornithiformes).

Wednesday 25 November

Castle 1

4.00-5.00

Open Forum: Global change and atmospheric pollution

Chair: Peter Wardle

- 4.00 ☺ S.L. Berry: Predicting changes in vegetation structure in response to changing concentrations of atmospheric carbon dioxide.
- 4.15 Bertram Ostendorf, David Hilbert, Brett Buckley, Jeroen van den Muyzenberg and Mike Hopkins: Modelling the spatio-temporal response of vegetation to climate change: linking a cellular automata approach with artificial neural network modelling.
- 4.30 ☺ Benjamin D. Hoffman and Anthony D. Griffiths: Responses of ant communities to sulphur deposition in northern semi-arid Australia.
- 4.45 A.D.Griffiths: Sulphur dioxide and savanna biodiversity: assessing the impact of smelter emissions at Mt Isa, Queensland.

Wednesday 25 November

Burns 1

10.50-12.20

Open Forum: Diet

Chair: Glenn Stewart

- 4.00 Dieter F. Hochuli: The nutritional ecology of feeding by larval *Uraba lugens* (Lepidoptera: Noctuidae): Changes in morphology and feeding behaviour with development.
- 4.15 ☺ Paula J. Peeters: Are herbivorous insects influenced by the leaf anatomy of their host plants?
- 4.30 Alan Lill, Margaret Stanley, Susan Giles and Elizabeth Smallwood: The basis of fruit choice by captive silvereyes (*Zosterops lateralis*).
- 4.45 ☺ Ben Reddiex, Graham Hickling and Richard Duncan: Diet selection of a generalist herbivore: European rabbits (*Oryctolagus cuniculus*) in the semi-arid grasslands of the Mackenzie Basin.

5.00 -6.00 pm

Happy Hour and Poster session, Burns 5 and 7

Friday 27 November

Castle 2

8.30-10.20

8.30 SYMPOSIUM 5: The role of species management programmes.

Organiser: Rod Hay

- 8.40 Kelly Brock "Conservation of the endangered guam rail"
- 9.00 David Towns, Charlie Daugherty, Alison Cree "Raising the lid from a forgotten fauna: a ten year review of conservation effort for New Zealand reptiles."
- 9.20 Colin O'Donnell "Yellowheads and wise heads: single species management results in ecosystem restoration"
- 9.40 Rod Hay "Has the bird flown: measuring the benefit of species protection programmes"
- 10.00 Alan Saunders "The emergence of ecosystem-focused restoration projects in New Zealand"

Friday 27 November

Castle 1

8.30-10.20

8.30 SYMPOSIUM 6: Predicting the spatial distribution of forest species and processes

Organisers: Mike Austin and John Leathwick

- 8.40 Mike Austin Progress and problems in modelling species distribution in forests of south-east NSW.
- 9.00 John Leathwick. The role of soil and atmospheric moisture deficits in determining forest pattern in New Zealand.
- 9.20 N.A. Scott, J.D. White and N. Coops. Predicting productivity patterns in New Zealand forest ecosystems.
- 9.40 David Keith. Integrating explicit modelling procedures with expert knowledge in vegetation modelling for conservation planning.
- 10.00 P. Catling and N. Coops. Predicting fauna occurrence from habitat quality indices estimated from aerial videography.

Friday 27 November

Burns 1

8.30-10.20

8.30 Biodiversity- theory and strategy

Chair: Colin Townsend

- 8.40 Stephen Roxburgh, Katriona Shea and Bastow Wilson: The Intermediate Disturbance Hypothesis: Spatial aspects and mechanisms of species coexistence.
- 9.00 Suzanne Fyfe: Is it possible to trace the Pleistocene distribution of dry rainforest using Island Biogeography theory?
- 9.20 David W. Hilbert, Mike Hopkins, Jeroen van den Muyzenberg and Andrew Graham: Late Pleistocene rainforest distributions of the Australian Wet Tropics- stable and shifting refugia.
- 9.40 Stephen E. Williams: Multiple determinants of biodiversity patterns: the necessity of examining ecologically meaningful groups.
- 10.00 Paul M. Blaschke, Glen Lauder, Fiona Oliphant, William Shaw and Theo Stephens: Halting the decline in New Zealand's biodiversity.

10.20 - 10.50 morning tea Castle Complex

Friday 27 November

Castle 2

10.50-12.20

Open Forum: Species management

Chair: Murray Efford

- 10.50 Grant Norbury and Nigel Barlow: Effects of RHD-induced rabbit declines in predator trapping on predation of banded dotterels.
- 11.05 C. Lalas, C.Olympia, H. Ratz, S. McConkey, B. Templeton and D.McKay: When the threatened threaten the threatened: interactions between yellow-eyed penguins and otariid seals at Otago Peninsula.
- 11.20 ☺ Ashley Bunce: The effect of food availability on offspring growth and survival in Australasian gannets (*Morus serrator*).
- 11.35 ☺ Mark Jarrett: Lead, zinc, arsenic and organochlorine pesticide toxicity in kea (*Nestor notabilis*) that forage in areas of human occupation.
- 11.50 T.E.Ward-Smith and M.A. Potter: The response of captive and wild kiwi to a range of non-toxic baits used for pest control in New Zealand.
- 12.05 Christine E.M.Reed: Minimising health risks to newly translocated populations: baseline disease sampling of Wellington green geckos (*Naultinus elegans punctatus*), Duvaucel's gecko (*Hoplodactylus duvaucelii*) and goldstripe geckos (*H.chrysosireticus*).

Friday 27 November

Castle 1

10.50-12.20

Open Forum: Vegetation dynamics

Chair: Bev Clarkson

- 10.50 D.A.Coomes, R.B. Allen, J.A. Wardle and K. Platt: Determinants of growth in mixed-aged stands of mountain beech.
- 11.05 ☺ Lisette Collins, Bruce Burns and Warwick Silvester: Stand dynamics of kauri (*Agathis australis*)-hard beech (*Nothofagus truncata*) forest in the Hapuakohe Ecological District.
- 11.20 ☺ David Warton and Glenda Wardle: Spatial variation in the demography of *Acacia suaveolens*.
- 11.35 Fleur Tiver: Regeneration patterns in mulga (*Acacia aneura*) in southern and central South Australia.
- 11.50 George Perry and Neil Enright: A frame-based model of vegetation dynamics for Mont Do, New Caledonia.
- 12.05 Kerry Bridle and Jamie Kirkpatrick: Vegetation dynamics in treeless subalpine vegetation, Eastern Central Plateau, Tasmania.

Friday 27 November

Burns 1

10.50-12.20

Open Forum: Pest control

Chair: Alan Andersen

- 10.50 ☺ Ann Cresswell, Robert Poulin and Barbara Barratt: Development of the parasitoid wasp *Microctonus aethiopoides* loan (Hym.: Braconidae) in two host species.
- 11.05 Richard Harris and Travis Glare: Insect pathogens - can we exploit them for use as biological control agents for social wasps?
- 11.20 S.M.McQueen and B.D. Lloyd: Invertebrate consumption of 1080 baits in Rangataua Forest, Central North Island.
- 11.35 B.D.Lloyd, S.M. McQueen: Evaluating the impact of 1080 operations on short-tailed bats.
- 11.50 ☺ W.Ji, M.N. Clout and S. Sarre: Effects of female sterilisation on body condition and sex ratio in two possum populations.
- 12.05 G.L.Norbury, J.P.Parkes and R.P. Heyward: Rabbit haemorrhagic disease after one year in New Zealand.

lunch 12.20 - 2.00

Friday 27 November

Castle 2

2.00-3.30

Open Forum: Ecological survey, assessment and management

Chair: Alan Mark

- 2.00 M.Loofs: Effects of sewage irrigation in a Tasmanian heath.
- 2.15 Perpetua Blanks: The predictive value of ecological vegetation classes for the presence of bryophytes.
- 2.30 Neil Gibson, G.J. Keighery, and B.J. Keighery: Threatened plant communities of Western Australia. 1. The ironstone communities of the Swan and Scott Coastal Plains.
- 2.45 John Neldner: Remnant vegetation of south-eastern Queensland biogeographic region. An analysis of 200 years of change.
- 3.00 Susan Wiser, Peter Bellingham and Robert Allen: National vegetation survey database: applications to current environment environmental issues.
- 3.15 E.J.Pharo and D.H. Vitt: Lichen response to selective logging: managing a woodland caribou (*Rangifer tarandus caribou*) food source.

Friday 27 November

Castle 1

2.00-3.30

Open Forum: Scale

Chair: Susan Wiser

- 2.00 ☺ Nick Bond, George Perry and Barbara Downes: Dispersal in heterogeneous environments: the importance of spatial pattern.
- 2.15 Barbara J.Downes, Jeremy S. Hindell and Nick R. Bond: Effects of habitat complexity on density and diversity: A spatially-replicated experiment.
- 2.30 Greg Collings: Multiscale patterning in subtidal macroalgal communities.
- 2.45 Hazel Chapman: Clonal diversity in New Zealand populations of *Hieracium pilosella*.
- 3.00 Tracey B.Churchill: Sampling spiders in the Australian tropics with pitfall traps: effects of habitat structure, trapsize, drift-fences and time.
- 3.15 M.J. Hillery, J.M. Dangerfield, D.M Stafford-Smith and G. Griffin: Urban planning among arid zone mound building termites: where do they build and why?

Friday 27 November

Burns 1

2.00-3.30

Open Forum: Seeds and seedlings

Chair: Mark Westoby

- 2.00 ☺ M.J.Easterbrook and A.D. Sparrow: Microhabitat dependent survival and growth of *Nothofagus solandri* seedlings.
- 2.15 John E.Hunt and David L. McNeill: The influence of present-day levels of ultraviolet-B radiation on seedlings of two temperate tree species.
- 2.30 Jose M.Facelli, Peter L. Cheeson and David Bigham: Effects of variation of seasonal water availability and plant density on recruitment of annual species in arid lands of South Australia.
- 2.45 Jacqui Stol and Jill Landsberg: Regional variation in composition of arid rangeland seedbanks.
- 3.00 ☺ Rachel A.Meissner and John E. D. Fox: Establishment of *Triodia* spp. in response to seed depth and microtopography.
- 3.15 Andy Sheppard, Peter Hodge and Quentin Paynter: Factors affecting recruitment and survival of Scotch broom, *Cytisus scoparius*, in Australian invaded ecosystems.

3.30-4.00 afternoon tea Castle Complex

Friday 27 November

Castle 2

4.00-5.30

Open Forum: Mutualism and competition

Chair: Janice Lord

- 4.00 ☺ Wendy J.Stubbs and Bastow Wilson: Niche limitation in an Otago salt marsh.
- 4.15 Sandra Anderson: The birds and the bees and the flowers and the trees: the facts of life at the interface.
- 4.30 Charlotte E.Taylor: The pollination biology of pioneer rainforest trees: studies from the Euphorbiaceae.
- 4.45 ☺ Jenny Wilson and Andrew F. Bennett: The loss of large eucalypt trees from a box and ironbark forest: implications for floral resources for nectar-feeding animals.
- 5.00 ☺ N.W.Was and K.J. Wilson: Burrow occupancy of broad-billed prions (*Pachyptila vittata*) on South East (Rangatira) Island, Chatham Islands, New Zealand.
- 5.15 J. Smallridge and C.M.Bull: Ecological interactions at three levels: geographical patterns in lizards, ticks and protozoan parasites.

Friday 27 November

Castle 1

4.00-5.30

Open Forum: Sex and reproduction

Chair: Mick Clout

- 4.00 ☺ Jennifer E.Taylor and Peter Harlow: Consequences of temperature-dependent sex determination in a field population of agamid lizards.
- 4.15 Roy Swain and Corinna Kik: Eco-behavioural trade-offs associated with pregnancy in the Southern Snow Skink, *Niveoscincus microlepidotus*, from Tasmania.
- 4.30 ☺ Marita Sydes and Rod Peakell: Male sterility as a factor contributing to the lack of sexual reproduction in the endangered shrub *Haloragodendron lucasii*.

Open Forum: Habitat selection

- 4.45 ☺ David Ward: Recruitment and growth of the subtidal gastropod, *Turbo torquatus*, in New South Wales.
- 5.00 ☺ Alistair Poore and Peter Steinberg: Consequences of host plant use in a herbivorous marine amphipod.
- 5.15 T. Glasby: What makes marine organisms on artificial and natural substrata so different?

Friday 27 November

Burns 1

4.00-5.30

Open Forum: Effects of herbivory and invasions

Chair: Neil Gibson

- 4.00 Josh Stern: The varying effects of brown algal phlorotannins: animal physiology or phlorotannin structure?
- 4.15 Craig D.James and Melinda Hillery: Responses of ants to different long-term grazing intensities.
- 4.30 Gibson, R.S., Meurk, C., Espie, P. and Bosch, O.J.H. Vegetation dynamics during 1990-1998 of grazed and ungrazed Mackenzie Basin grasslands, New Zealand.
- 4.45 Jill Landsberg, Sandra Lavorel and Jacqui Stol: Classifying rangeland plants into functional types indicating response to grazing.
- 5.00 A.R.Davis and D.W. Ward: Shallow water encrusting communities: the importance of refuges from urchin grazing.
- 5.15 Warren King and G.M. Miller: Vegetation-environment relations in a naturalised perennial pasture community: the pattern of invasion by winter-annual grass weeds.

5.40 CLOSE AND PRIZE-GIVING CASTLE 2

Abstracts are alphabetical by first author, not presenting author.

☒ denotes a poster presentation (Burns 5 & 7)

☺ denotes a student poster or paper

~~~~~  
☒ Cathy Allan<sup>1</sup> Glenn Stewart<sup>2</sup> and Rob Allen<sup>3</sup> <sup>1</sup>Department of Conservation, P.O. Box 743, Invercargill. <sup>2</sup>Soil, Plant & Ecological Sciences Division, Lincoln University, P.O. Box 84, Lincoln, Canterbury. <sup>3</sup>Landcare Research, P.O. Box 69, Lincoln, Canterbury. **The effect of deer browse on the recruitment of mountain beech (*Nothofagus solandri* var. *cliffortioides* Hook f.) in the Kaweka Forest Park, North Island, New Zealand.**

The effects of deer browse on seedling populations of *Nothofagus solandri* var. *cliffortioides* (mountain beech) were investigated in the high altitude forest in the Kaweka Range. Browsing by sika (*Cervus nippon*) and red deer (*C. elaphus*) has slowed regeneration of mountain beech on sites where the forest canopy has collapsed naturally. Seedling density and heights of individually tagged mountain beech seedlings were recorded in 1995 within two fenced deer exclosures (established in 1981), and on adjacent unfenced plots. Rates of seedling height growth and mortality of the tagged seedlings were measured in 1996. Seedling growth rates were higher at each site within the fenced deer exclosure plots and highest under open canopy. Greatest mortality rates were under closed canopy within one exclosure, where seedling densities were high. Simple models of seedling growth and mortality based on initial densities were developed to predict the time required for sufficient seedlings for canopy replacement to grow above the deer browse height. Initial estimates indicate that 11 years would be required for seedlings to grow above the browse zone.

☺ ☒ Kim Allcock,. CSIRO Division of Wildlife and Ecology/VBCRC, PO Box 84, Lyneham, ACT 2602, Australia. **Browsing of seedlings by stock, kangaroos, and rabbits in white box woodland in Eastern Australia.**

This study is part of the Australian National RCD Monitoring and Surveillance Program. Grassy white box (*Eucalyptus albens*) woodland is one of Australia's most threatened ecosystems, and overgrazing is among the foremost conservation concerns. In February 1997 fences designed to test the impacts of different grazing species on woodland understorey were built at Burrendong Dam on the Central West Slopes of NSW. In autumn 1998, *Themeda australis*, *Eucalyptus albens*, and *Callitris glaucophylla* seedlings were planted inside fenced plots in cleared woodland and woodland with intact canopy. Subsequent health and browse events were recorded. The data are variable, due in part to patchy animal activity (indicated by dung pellet counts), but the trends are still apparent. *T. australis* was grazed frequently and severely by all species (though the grazer could not be identified in approximately 20% of grazing events), and some plants declined in health in ungrazed areas. Although the rabbit population has been low since the arrival of RCD, rabbits were the most frequently identified grazers of *T. australis*. Rabbits preferred *C. glaucophylla* to *E. albens*, while other grazers selected *E. albens*. In cleared areas, sheep had the greatest impact on tree seedlings and strongly preferred *E. albens*. These data indicate that grazing can impede regeneration, though other problems may arise with its cessation, and that all grazers do not affect the seedlings of important species equally. The differences must be taken into account when deciding how to manage woodland areas.



Alan N. Andersen, K. Ros Blanche, Lyn M. Lowe and John A. Ludwig. Tropical Savannas CRC, CSIRO Tropical Ecosystems Research Centre, PMB 44, Winnellie, Darwin, NT 0822, Australia. **Responses of Grasshoppers to Experimental Fire Regimes in an Australian Tropical Savanna.**

Up to half or more of northern Australia's savanna landscapes are burnt by fire, but little is known of its long-term ecological effects, particularly on key ecosystem processes such as herbivory. Grasshoppers are the dominant native herbivores throughout the region. CSIRO recently completed a landscape-scale fire experiment at Kapalga Research Station in Kakadu National Park, and here we outline the responses of grasshoppers to these experimental fire regimes. At Kapalga, many of the limitations of previous savanna fire experiments were addressed, including inappropriately small sizes of experimental units (ours were 15-20 km<sup>2</sup> catchments), and lack of replication (each treatment was replicated at least three times). Grasshoppers were sampled using sweep nets during February (middle of wet season) and May (end of wet season) in woodland and open forest habitats within catchments burnt early (May/June) each dry season, late (September/October) each dry season, and remaining unburnt over the 5-yr experimental period (1990-4). A total of 85 grasshopper species, mostly Acrididae and Tettigoniidae, were collected during the study. Multivariate analyses indicated that fire treatments caused changes in species composition, but this was patchy both in time and space. Overall grasshopper abundance and richness showed virtually no treatment effects, and abundances of the most common species were similarly unaffected by fire. Fire is therefore unlikely to have a significant long-term effect on general levels of herbivory by grasshoppers.

Sandra Anderson, School of Biological Sciences, Auckland University, Private Bag 92019, Auckland. **The birds and the bees and the flowers and the trees: the facts of life at the interface.**

Pollination and seed dispersal are plant /animal interactions fundamental to the maintenance of forest ecosystems. Recent research suggests that indigenous birds may play a greater role in pollination and seed dispersal of the New Zealand flora than previously supposed. To assess the effect of depletion in both the number and abundance of indigenous bird species on native forest ecosystems, plant /bird interactions at sites of high and low indigenous bird diversity and abundance were compared. Observations showed that although overall visitation rate by birds to flowering or fruiting plants was not always affected, in many instances the composition of visitors was reduced in diversity at the depleted site, and indigenous visitors were replaced by introduced visitors. Further investigation suggested that the replacement visitors were generally less effective than indigenous species as pollinators or seed dispersers. This was reflected in lowered fruit set, seed set and fruit take for the affected plants at the depleted site. The implications of these changes for forest regeneration may be as serious as the more visible impacts of introduced mammals which browse seedlings and flowers. These results suggest that an ecosystem approach to management, which considers the interactions between species (cf. the status of individual species), is required to conserve effectively the remaining diversity of New Zealand forests.



☺ Nigel Andrew & Louise Rodgers. Australian Flora and Fauna Research Centre, University of Wollongong, Wollongong, NSW, Australia, 2500. **Changes in Bryophyte/Invertebrate community structure along altitudinal gradients in Tasmania and New Zealand.**

The altitudinal gradient, that is the decrease in species diversity with increasing altitude, is thought to be one of the most general patterns of species diversity. However, this conclusion is based on data derived mainly from studies on vertebrates in the northern hemisphere. This study examined species diversity of bryophytes (moss and liverworts), and their associated invertebrates, along altitudinal gradients in Tasmania and New Zealand, at a number of different spatial scales (within plots, within sites, between sites, between regions and between Tasmania and New Zealand). Bryophyte assemblages are one of the few communities that are distributed along the entire length of an altitudinal gradient, and thus provide an ideal opportunity to test the generality of this pattern. The field work for this study was carried out along 2 gradients (250m to 2000m), at similar latitudes, in both Tasmania and New Zealand. Kerosene Phase Separation, an extraction technique developed specifically for bryophytes by the authors, was used to extract the invertebrates from the moss. Invertebrate taxa extracted included Collembola, Acari, and Diptera larvae. Species diversity varied within plots, within sites, between sites, between regions, and between Tasmania and New Zealand, and did not vary predictably with altitude. Therefore we believe that a reassessment of the generality of the altitudinal

☺ ✉ Tony Arthur, CSIRO Division of Wildlife and Ecology, PO Box 84 Lynham, ACT 2602, Australia. **The Role of Predation and Shelter from Predation in the Extinction of Prey Populations.**

Introduced predators such as the fox and cat threaten many of Australia's native wildlife populations, and cause many reintroduction programs to fail. A major aim of conservation management is to reduce the abundance of these predators, affording protection to prey populations. But how does predation lead to prey population extinction, and are there other factors we need to consider, beyond predator abundance, when defining management strategies for threatened populations? Specifically, what role does habitat structure play in determining the rates of predation and therefore whether prey populations persist or go extinct? My PhD study will focus on the interaction between predator abundance and shelter from predation and their effect on prey population dynamics. I explore the idea that at a given predator density habitat structure alone may determine whether prey populations persist or go extinct, by determining the rates of interaction between predators and their prey. I will carry out a number of controlled enclosure experiments, using feral house mice (*Mus domesticus*) as a model prey species, in which I manipulate predator abundance and available shelter. Here I outline these experiments, and present some preliminary results.



☺ ✉ Victoria Atkinson, School of Environmental Management, University of South Australia, Mawson Lakes, SA 5095. **Analysis of vegetation types that contain *Eucalyptus viridis*, Eyre Peninsula, South Australia.**

The South Middleback and Cook Range on the Eyre Peninsula, South Australia, support a large number of vegetation types. Some of these vegetation types contain locally rare and endangered flora species. One such species is an un-named sub-species of *Eucalyptus viridis*. It has not been previously recorded on the Eyre Peninsula and other previous records in South Australia are several small patches in the Flinders Ranges. Its patchy distribution is explained by its restriction to elevated positions near the summits of arid rocky ranges. It is associated with a range of similarly adapted species, many of which are also locally uncommon.

Tony D. Auld, and Mark G. Tozer. NSW National Parks and Wildlife Service, PO Box 1967, Hurstville, NSW 2220, Australia **A comparison of two indicators of the heat pulse in the soil during the passage of fires: depth of scorch in sedges and depth of emergence of *Acacia* seedlings.**

Methodologies for estimating the spatial variation in soil heating during a fire are important in allowing predictions of the response of vegetation to fire. We investigated the use of two post-fire indicators to estimate soil heating in southeastern Australia: scorch length in sedges and depth of emergence of *Acacia* seedlings. The indicators are highly correlated, and scorch length in sedges correlates well with soil temperatures measured beneath the soil within 25 cm of the point of sedge emergence from the soil. Scorch length varies linearly with the depth of penetration of a range of temperatures from 50 - 80°C, which suggests that tissue death is primarily related to exposure to temperatures that are instantaneously lethal. There is a minimum scorch length of 10 mm. This probably reflects tissue death caused by longer durations of heating at sub-instantaneously lethal temperatures. Neither mean scorch length nor mean seedling emergence depth correlates well with estimates of fire history, fuel accumulation and coarse fire intensity. The use of these two indicators shows that, even during extensive wildfires, variation in soil heating occurs across a local (tens of metres) and landscape scale (kilometres).

Mike Austin. CSIRO Wildlife and Ecology P.O. Box 84 Lyneham, ACT 2602 Australia. **Progress and problems in modelling species distribution in forests in South-east New South Wales.**

Statistical modelling to predict the floristic composition and distribution of forests in Australia and New Zealand has developed greatly in the last five years. An example of the use of Generalized Linear Modelling (GAM) and multivariate classification is given for South-east NSW. The vegetation composition for an area of 27,000km<sup>2</sup> was predicted and mapped with a Geographic Information System (GIS). GAM modelling of 88 eucalypt species with 9558 plots was used to predict the composition of 2.7 million one hectare pixels. These were then classified using the ALOC procedure to produce groups for conservation assessment. This formed part of the Interim Regional Assessment process for selecting conservation areas. Four issues arising from this example are then reviewed. (1) role of GIS; (2) need for ecological theory; (3) how to evaluate the performance of GAM and other statistical modelling methods; (4) new research directions.



Jonathan Banks, and Adrian Paterson; Ecology and Entomology Group; Soils, Plant and Ecological Sciences, Lincoln University, PO Box 84, Lincoln (PatersoA@Lincoln.ac.nz)  
**Territoriality in South Island Pied Oystercatcher : Resource Defence or Mate Guarding?**

The function of territorial behaviour in South Island Pied Oystercatcher (SIPO), *Haematopus ostralegus finschi*, was studied in mid-Canterbury farmland populations over two breeding seasons. Two possible explanations for territorial behaviour in monogamous birds were tested: defence of resources and mate guarding. Territory boundaries of 19 SIPO pairs were determined from observing interactions with non-resident birds and point observation of resident birds was used to examine the composition of SIPO behaviour. Vortex sampling was used to assess invertebrate numbers within territories. Large territories in SIPO were correlated with higher breeding success, expenditure of less energy while foraging, and higher invertebrate densities. A decoy bird was used to elicit territorial responses from breeding pairs throughout the breeding season. Male reaction to a non-resident male did not vary with risk of extra-pair copulation, such as greater vigilance at the pre-egg stage, and both the level of male-initiated responses and the time between observation and striking of a decoy were constant throughout the breeding season. Given that there was no evidence for mate guarding and that territories varied in quality, we concluded that territoriality in SIPO is a function of resource defence.

N.D. Barlow. Biological Control Group, AgResearch, Lincoln, New Zealand. **Why most of the world is green but Australia brown: population regulation revisited.**

Debates about population regulation were initiated by economic entomologists, particularly Australian ones. The key players are part of ecological folklore. First there were the biotic and abiotic schools of regulation: Howard and Fiske's work in 1911 on gypsy moth; Nicholson's quests for stability in the 30s, using blowflies and parasitoid/host models; Uvarov's treatise on insects and climate at around the same time; then Andrewartha and Birch's study on thrips in the 50s. These were followed in the 60s by genetic theories of regulation and attempts to synthesise, reconcile and compromise. Although much of the debate was semantic, it offered ecology a stimulating and useful focus for at least half a century. Yet the debate smoulders on, and the pervasiveness and significance of density-dependence has been repeatedly questioned from a variety of positions. Density-vagueness qualifies it out of existence. Most parasitoid/host theory ignores it. Metapopulations embracing random walk or unstable, deterministic local populations appear to offer alternative explanations for persistence. Authors working on cyclic populations or those in arid environments question the relevance of density-dependence and of equilibria. Finally, there are a number of studies citing an absence of empirical evidence and implying evidence of absence. In spite of this, the theoretical and empirical evidence for the significance of density-dependence is overwhelming. Fisheries and other sustained yield harvesting industries rely it. Whether the world is green because herbivores are regulated by predators or because they are regulated by resources, they are regulated by something. Even in Australia, where weather is particularly important and the world is brown, density-dependence is the only real rule in ecology.



✉Geoff Baylis, Botany Department, University of Otago, P O Box 56, Dunedin. **The most important plant hairs are on the roots**

Root hairs are often ignored though it is accepted that phosphorus is the element limiting growth in most natural soils and since it does not diffuse toward the root the tips of its hairs define the P depletion zone around it. Root hair length is constant for a species but between species ranges from zero to 5 mm. Differences in length explain differences in plant/soil reactions. In unfertilized soils most roots contain a symbiotic fungus converting them to arbuscular mycorrhizas (AM). These can greatly reduce the level of P necessary for growth. An inverse relationship exists between root hair length and the P level that supports growth without AM. Root hair length and P availability are the factors that govern mycorrhizal dependence (MD). The texture of the root system (coarse magnoloid or fine graminoid) cannot have more than secondary importance as thick roots have minimal MD if the hairs are long enough. It seems that the ultimate battle for P is fought between root hairs and AM hyphae in soil pores too narrow for rootlets to enter. There is now evidence of chemical warfare since the hyphae have exudates inhibitory to hairs.

☺Christopher Berry. School of Biological Science, Victoria University of Wellington, P. O. Box 600, Wellington. **European hedgehogs (*Erinaceus europaeus*) and their significance to the ecological restoration of Boundary Stream Mainland Island**

Telemetry and dietary studies were carried out on hedgehogs between December 1997 - March 1998 at Boundary Stream Mainland Island, Hawkes Bay. The aim of this study was to review the role of hedgehogs within a forest ecosystem and to assess their importance in ecosystem

restoration. Home ranges were found to be ten times larger than previously published data within New Zealand. Hedgehogs do not defend territories, therefore they are capable of reaching high population (i.e. 8+ animals per hectare in this study). Within Boundary stream, hedgehogs diet was found to consist of 80% invertebrates and 20% other material (plant, lizard, small mammals and carrion). This is similar to other published dietary analysis carried out in New Zealand. The effects of the hedgehog in mainland islands can be significant because:

- Important predator of invertebrates
  - Removes large amount of biomass from the system
  - Competes with insectivorous birds (e.g. robin, weka, kiwi)
  - Egg predator of some ground nesting birds (e.g. dotterel spp.)
  - Predator of lizards and frogs.

Thus, while hedgehogs are not currently listed as a pest within New Zealand, there is evidence to show that they need to be considered when looking at a full ecosystem restoration.



☺ S. L. Berry 15 Cockburn Street, Curtin ACT 2605, Australia. **Predicting changes in vegetation structure in response to changing concentrations of atmospheric carbon dioxide.**

During the Last Glacial Maximum the atmospheric CO<sub>2</sub> concentration [CO<sub>2</sub>] was about half the present level. Two hundred years ago [CO<sub>2</sub>] was 80% of the present. In the next 100 years the [CO<sub>2</sub>] may double. Models of the potential impact of changing [CO<sub>2</sub>] on vegetation distributions have till now largely focussed on the effect that increasing [CO<sub>2</sub>] may have on global air temperatures. It is known that increasing [CO<sub>2</sub>] directly reduces transpiration in an approximately linear manner. I use solar radiation and rainfall in a simple model to predict the fraction of photosynthetically active radiation, which is known to be correlated with vegetation structure, over Australia. Model predictions based on [CO<sub>2</sub>] over the last 150,000 years agree well with the vegetation derived from numerous pollen studies. Predicted vegetation structure at pre-industrial revolution [CO<sub>2</sub>] indicates a more open vegetation, with similarities to that described by European explorers of the period. Changes in vegetation have previously been used to infer changes in climate. My model shows that such inferences may be misleading.

✉ Adam Bester, and Nicholas Klomp. School of Environmental and Information Sciences Charles Sturt University PO Box 789, Albury, NSW 2640. **A comparison of the feeding ecology of seabirds on Montague Island, NSW.**

The foraging ecology of breeding Little Penguins, Wedge-tailed Shearwaters, Short-tailed Shearwaters, Silver Gulls and Crested Terns were studied on Montague Island, NSW. The prey type, size and abundance in the diets of these species were determined where possible. Chick provisioning behaviour, foraging locations, foraging times and foraging techniques of these species were also examined. The study was designed to consider any evidence of the potential for competition to occur among these seabirds given their diets and foraging behaviour. The study revealed that the birds largely reduced competition through their different methods of resource utilisation. However, high food consumption during mid-late January and significant chick mortality of Little Penguins at the same time are suggestive of increased competition for food resources and reduced prey stocks. Based on the foraging behaviour and diets of these birds on Montague Island, most competition is likely to occur between the island and the mainland, within the top metre of the water column and for food resources among Short-tailed Shearwaters, Wedge-tailed Shearwaters and Little Penguins in late January. This is due to these three species constituting the three biggest populations of seabirds on the island, having similar diets and foraging areas close to the colony.



Perpetua A.M Blanks. Arthur Rylah Institute for Environmental Research, Department of Natural Resources and Environment, PO Box 137, Heidelberg 3084, Victoria, Australia. **The predictive value of ecological vegetation classes for the presence of bryophytes.**

A subset of the bryophyte flora and all vascular plant species were recorded in 102 sites in seven Ecological Vegetation Classes (EVC): Wet Forest, Damp Forest, Cool Temperate Rainforest, Shrubby Foothill Forest, Riparian Forest, Montane Wet Forest and Montane Damp Forest. These sites were situated within the O'Shannassy Catchment and the adjacent Armstrong Creek Catchment of the Central Highlands of Victoria. The results indicate that the bryophyte flora is clearly not associated with EVCs. Cool Temperate Rainforest is characterised by a distinct bryophyte assemblage and the results provide strong preliminary support for the existing Cool Temperate Rainforest EVC based on vascular plants. The presence/absence of species in the bryophyte flora was linked to environmental variables and EVC by logistic regression analysis. Reserves must be selected carefully for the presence of individual species and appropriate microhabitats.

Paul M. Blaschke\*, Glen Lauder\*, Fiona Oliphant\*, and William B. Shaw<sup>^</sup>. \*New Zealand's Biodiversity Strategy, Department of Conservation, PO Box 10-420, Wellington, New Zealand. Email: pblaschke@doc.govt.nz <sup>^</sup>Wildland Consultants Ltd, 14 Foster Road, RD 4, Rotorua, New Zealand. Email: wildland@wave.co.nz **Halting the decline in New Zealand's biodiversity.**

New Zealand has experienced a history of indigenous biodiversity decline ever since human settlement. This decline was identified in *The State of the New Zealand Environment* report as our most pervasive environmental problem. The need to reverse this decline provides a context for the New Zealand Biodiversity Strategy and in particular for setting its goals. Two related goals for indigenous biodiversity are proposed in the draft Strategy: one for ecosystems and natural habitats and one for indigenous species. For each goal, there are many possible levels of achievement, ranging from doing nothing to attempting as complete a restoration of New Zealand's 'original' biodiversity as possible. These different levels of ambition are expressed as goal levels along a spectrum. Some characteristics of each goal level and examples of recovery or decline in particular species or ecosystems are given. The different goal levels are translated into alternative future trends which will reflect either a continuing decline in biodiversity, or the possibility of future recovery through a conscious effort to halt the decline in the short to medium term. Public discussion will guide the final selection of goals for the strategy.



☺ ✉ David Board,. CSIRO Division of Wildlife and Ecology GPO Box 284, Canberra ACT 2601, Australia. **Soil seed bank dynamics of grassy white box woodlands: A potential limitation on restoration success.**

This study is part of the Australian National RCD Monitoring and Surveillance Program at Burrendong Dam, NSW Australia. Grassy white box woodland is one of the most poorly conserved habitats in Australia. The remaining woodlands have been changed through grazing, altered fire regimes, clearing and introduction of weeds. Conservation of these woodlands will depend upon restoration. For restoration to be a success the factors limiting a return to the original state must be understood. One area that may be limiting is soil seed bank dynamics. This poster will present a study focusing on three general questions: 1. How does herbivory affect the soil seed bank dynamics? 2. How has past tree clearing affected the soil seed bank dynamics? 3. How do ant foraging rates vary? Three areas of seed bank dynamics, seed rain, post-dispersal seed predation and seed bank composition further focus the three questions. Hypotheses generated around these focal points and experiments designed to test the hypotheses will be presented. Some simple models are being developed to elucidate the interaction of the three areas of seed bank dynamics being emphasised and refine the hypotheses. Some preliminary data from the winter of 1998 has been collected and the analysis of this data will be presented.

☺ ✉ Nick Bond. Dept of Geography and Environmental Studies, University of Melbourne, Parkville, VIC 3052, Australia. **Flow regulation, fine sediment transport and macroinvertebrate communities in small upland streams.**

Results from a survey of sediment transport rates and macroinvertebrate communities at 12 sites on 3 regulated and 3 unregulated streams in an upland catchment, Victoria, Australia. This survey has illustrated with remarkable clarity that streams draining areas of granite contain far more moving sand than streams draining nearby catchments composed of acid volcanics and siltstone. However, this sediment transport does not occur downstream of diversion weirs built on the regulated streams. Multivariate analysis of macroinvertebrate samples clearly differentiates between sites that are regulated, and furthermore between those that are unregulated, but have naturally high or low sediment transport rates. Thus, although flow regulation has a marked impact on the macroinvertebrate community in all the regulated streams surveyed in the study, the impact is greater within granite catchments. Patterns of similarity would suggest that some of the differences in community structure between streams draining granite and acid volcanic catchments are related to the effects of sediment transport as well as the effects of flow. This has occurred on an ecological time scale, rather than being due to historical and evolutionary differences between the two catchment types.



© Nick Bond, George Perry and Barbara Downes. Department of Geography and Environmental Studies, University of Melbourne, Parkville, VIC 3052, Australia. **Dispersal in Heterogeneous Environments: The Importance of Spatial Pattern**

Previous work has suggested dispersal distances by stream biota could be related to the overall average proportion of flow within Dead Water Zones, places such as backwaters, pools or behind large obstacles, where the water is out of the main flow and is stored temporarily. However, this work does not distinguish between reaches containing many small DWZ compared with those having a few large ones, or other similar sources of small scale variability in flow. We constructed a spatial model of flow in stream reaches, in which we varied the number, types, or sizes of DWZ distributed through the reach. We defined flow conditions under which passive particles, similar in size and density to typical stream organisms, would settle or continue to drift downstream. We then examined the dispersal profiles of such particles through reaches differing in arrays of DWZ or flow conditions. Our results support those of previous studies, but suggest that the spatial arrangement of DWZ may be just as important as the overall proportion within a reach. The results highlight the need to consider changes in the variance of parameters as well as just their mean.

Bradley, J. Stuart<sup>1</sup>, Meathrel, Catherine E.<sup>2</sup>, Skira, Irynej J.<sup>3</sup> and Wooller, Ronald D.<sup>1</sup>

<sup>1</sup>Biological Sciences, Murdoch University, Murdoch WA 6150, Australia. <sup>2</sup>Environmental Management and Ecology, La Trobe University, Wodonga VIC 3690, Australia. <sup>3</sup>Parks and Wildlife Service, GPO Box 44A, Hobart TAS 7001, Australia. **Modelling the effects of harvesting on the life history traits of Short-tailed Shearwaters in Tasmania.**

Approximately 23 million short-tailed shearwaters *Puffinus tenuirostris* breed annually in Bass Strait making it easily Australia's most abundant seabird (Ross *et al.* 1995). The common name for this species, the muttonbird, has arisen from its traditional exploitation for food and oil. During the 1850s, the systematic harvesting of shearwaters, called muttonbirding, replaced sealing as the economic mainstay of this region. At its peak, aboriginal harvesters took more than one million chicks annually. At present several hundred thousand young per year are taken commercially and 'recreationally' by amateurs making it one of the most intensive bird harvests in the world. Although quantitative data are not readily available for 'recreational' or 'amateur' muttonbirding, detailed records exist from 1925 onwards for the 'industrial' harvest. In addition, since 1947, a longitudinal population study has continued on Fisher Island, a small islet in Bass Strait, where all breeding birds and fledglings have been banded annually. We use Fisher Island data, which have been extensively analysed and published, and Bass Strait harvesting records to explore the possible effects of harvesting on this species and to discuss the issues involved in determining effective strategies for ensuring sustainable yield in harvested seabirds.



© Gary Bramley. Biological Sciences Department, University of Waikato, Private Bag 3105, Hamilton, New Zealand. Email: [g.bramley@waikato.ac.nz](mailto:g.bramley@waikato.ac.nz). Responses of wild Norway rats (*Rattus norvegicus* Berkenhout) to predator odours

Some rodents use scents deposited by predators to assess risks when making foraging decisions. If rats in New Zealand could be shown to use such cues and avoid areas visited by predators, conservation managers could manipulate rat behaviour. To investigate the responses of wild caught rats to odours derived from faeces and urine of predators and non-predatory herbivores, rats were placed in a y-shaped maze where one arm contained an odour (either predator or herbivore) and the other arm contained a "no odour" control (distilled water). Six real and three synthesised smells were used. Five measures of rats' behaviour were recorded: latency to approach the odour, latency to approach the control, time spent in each arm, number of visits to each arm and an overall activity score (number of visits to either arm). Fourteen rats from Kapiti Island (which is free of mammalian predators) and 10 rats from the North Island (sympatric with predators) were tested using this procedure. Kapiti rats showed stronger avoidance behaviour of predator smells despite never having been in contact with predators. Real odours may be more successful than synthesised odours in deterring rats and odours derived from urine may be more effective than faecal odours. Despite some statistically significant results I consider it unlikely that the use of odours will be suitable as a management tool.

Kerry Bridle and Jamie Kirkpatrick. School of Geography and Environmental Studies, University of Tasmania, GPO Box 252-78, Hobart 7001. email [kerry@utas.edu.au](mailto:kerry@utas.edu.au)  
**Vegetation dynamics in treeless subalpine vegetation, Eastern Central Plateau, Tasmania.**

Vegetation data (cover to lifeform group) were collected from 32 slides of 3 m x 2 m quadrats established treeless subalpine vegetation in 1973. These quadrats were relocated and resurveyed in 1997. 16 quadrats are located within a grassy heath which is still subjected to domestic stock grazing. The remaining quadrats are located in heath which has been protected from stock grazing since 1989. Both sites have a history of burning but neither site has been burned since the quadrats were photographed in 1973. The results of changes in vegetation cover and lifeform dominance over time will be discussed in relation to the following hypotheses: the amount of vegetative recovery is inversely related to the degree of initial site disturbance; any increase in bare ground is directly related to the degree of initial site disturbance; the percentage change in recovery will differ between the grazed and ungrazed sites; most vegetative recovery will occur at the edges of large bare patches; heathy vegetation that has been protected from domestic stock grazing (and trampling) has a faster recovery time than grassy vegetation, especially if it is still grazed by domestic stock.



Kelly M Brock. Guam Department of Agriculture, Division of Aquatic and Wildlife Resources, 192 Dairy Road, Manglao, Guam, USA 96923. **Conservation of the Endangered Guam Rail (*Gallirallus owstoni*)**.

As the decline and disappearance of Guam's avifauna escalated in the early 1980s, due primarily to predation by the introduced brown tree snake, *Boiga irregularis*, emergency measures to prevent the extinction of eleven native forest bird species were undertaken. The Guam rail, *Gallirallus owstoni*, was one of two native forest birds that was rescued by collecting as many adults, chicks, and eggs that could be found left in nature (n=21). Following extirpation of the Guam rail in the wild, a successful captive breeding program was established early in the conservation program and by 1989, a program to re-establish the species in the wild began on Guam's neighboring island of Rota. Successful breeding of captive reared rails released on Rota was documented in December 1995, however a self-sustaining population is not yet established. Predation by feral cats, and wide-spread dispersal from the release area are limiting factors still to overcome. Meanwhile, significant advances in control of brown tree snakes on Guam make reintroduction to Guam possible in the near future. Partnerships between local commonwealth and territorial governments, several American federal government agencies, and the American Zoo and Aquarium Association are essential to the success of the conservation of the Guam rail.

☺ ✉ Claire Brown Australian Flora and Fauna Research Centre, University of Wollongong, NSW, Australia, 2522. **Science and law: the interface.**

Expansion of urban development within the Sydney Basin has had a significant effect upon flora biodiversity, particularly because of habitat degradation and fragmentation. Environmental management plans, policies and legislation attempt to reflect these concerns in the race to halt species extinction. Little consideration has been given to the interaction between science and law. The Threatened Species Conservation Act (NSW) 1995 has been viewed as a major government initiative in the field of threatened species conservation. The heart of the act includes licensing, recovery plans and development controls (eg. Species Impact Statements). The major player, local government, is still coming to grips with the Act's implications and is forced to make development decisions with inadequate scientific knowledge, often resulting in the non-implementation of the precautionary principle. This study aims to examine the interaction of science and law involving the threatened flora species *Tetratheca glandulosa* and *Darwinia biflora*. This will be achieved through a series of site-specific examinations of either pollinator movement or seed bank profiles and establishment success in relation to fire regimes. Realistically, development controls have not halted the rate of flora extinction but have they allowed for the co-occurrence of urban sprawl and viable threatened flora populations'?



☺ ✉ Judi Buckmaster Queensland Forestry Research Institute, m.s. 483 Fraser Road, Gympie, QLD, Australia. **Microclimatic edge effects in the mountain ash forests of south-eastern Victoria.**

Clearfall logging in mountain ash forests is thought to result in a zone of altered microclimate between the cleared area and the remaining forest. Continuous measurements of microclimatic variables were made along a 150 m transect extending from a harvested coupe into the remaining forest to test for presence of microclimatic gradients and for correlation of these with light intensity gradients. Variables measured were air temperature, understorey leaf temperature, relative humidity and light intensity. Microclimatic gradients were detected and were most pronounced when there was direct sunlight below canopy height on the forest edge, and variables were significantly correlated with light intensity only under those conditions. This means that when there is direct solar radiation below the canopy on the forest edge, there exists a zone of forest with a significantly changed microclimate. Therefore, the area affected by large scale tree removal is greater than the area actually harvested. The implications of these findings should be considered when setting aside forested areas for conservation purposes.

☺ ✉ Marcelle L. Buist<sup>a</sup>, Colin J. Yates<sup>a</sup> and Philip G. Ladd<sup>b</sup> <sup>a</sup>Kings Park and Botanic Gardens, Perth Western Australia 6005. <sup>b</sup>School of Environmental Science, Murdoch University, Perth Western Australia 6150 **Ecological characteristics of *Brachychiton populneus* (kurrajong) in relation to invasion of an urban bushland remnant in Perth, Western Australia**

The Kings Park Bushland is a highly significant, 267 ha conservation reserve, situated 1.5 km from Perth's central business district. The bushland has a long history of disturbance and has a severe weed problem with 36.5% of the 465 plant species recorded not native to the area. At present 11 species are identified as being of greatest conservation concern. This includes the small tree *Brachychiton populneus* (kurrajong). Studies of the ecological characteristics of *B. populneus* were undertaken to understand the process of invasion and inform management of the weed. The study observed that *B. populneus* produced large amounts of viable seed but rates of seed predation were high. Weevils, and omnivorous vertebrates such as Australian ravens and introduced black rats were observed eating seeds. The foraging behaviour of the vertebrates may result in the dispersal of seeds relatively long distances away from parent plants. Seeds which escape predation form a transient seed bank and germinate with the onset of the winter rains. Early in their development seedlings form a large root tuber with considerable starch and water reserves and have considerable drought resistance. *Brachychiton populneus* appears to have become a weed in Kings Park because firstly it is dispersed widely into new habitats through the foraging behaviour of Australian ravens and black rats and secondly, its development of a root tuber and ability to resprout means the seedlings are very resilient in a frequently disturbed Mediterranean environment. Management of the weed is discussed.



☺ Ashley Bunce. Department of Zoology, University of Melbourne, Parkville, Victoria, Australia. **The effect of food availability on offspring growth and survival in Australasian gannets (*Morus serrator*).**

The effects of food availability on the reproductive performance of Australasian gannets (*Morus serrator*) breeding in Port Phillip Bay, Victoria, was investigated by experimentally manipulating the levels of food demand within nests. Offspring were 'artificially twinned' by placing either two eggs (n=7) or two chicks (n=4) in a single nest, thereby creating an increase in food demand. Alternatively, in an additional set of five nests, chicks were given supplementary food; fresh pilchards at a rate of 5% body weight. The growth rates of chicks from each of these treatments were then compared to examine the effects of food availability on breeding performance. Of the nests provided with an additional egg, only 28% successfully hatched both eggs and none successfully raised both offspring. Overall hatching success was considerably lower in this group as compared with the rest of the population. The growth of twinned chicks was considerably slower than both single and supplementarily fed chicks, with one chick appearing to become dominant, growing at a rate similar to single chicks, whilst the other grew considerably slower. In contrast, chicks given supplementary food grew faster than single chicks. Australasian gannets appear capable of raising two offspring, however, they may be unable to successfully incubate two eggs. In addition, the slower growth rates observed for twinned chicks suggests that these chicks are of considerably poorer quality. The higher growth rates observed when chicks were given additional food suggests that the population of Australasian gannets breeding in Port Phillip Bay may be food limited and that the population is likely to be affected by changes in availability of prey. This is likely to have major implications given the recent fluctuations in pilchard numbers in recent times.

☒ Julia Ellis. Burnet. Department of Land & Water Conservation, Bourke, NSW, Australia. **Transformation of forest ecosystem components over time.**

The paucity of information relating to Mediterranean-type ecosystems and the anthropogenic impact which may have contributed to the extensive decline in regional forest reserves prompted a three year study of an eastern Mediterranean forest, the Makheras Forest, Cyprus, and its bioresources. Cyprus provides a classic example of an island as a spatially delimited "evolutionary laboratory", where the exploration and evaluation of specific social, economic, historical, or theoretical issues contribute to a growing body of cultural knowledge. Against a pattern of recent research it became apparent that there was a need to place known prehistoric and historic socio-economic shifts within an environmental context. In particular, the value of the Cypriot forest resource which lay adjacent to mineral-bearing deposits had not previously been evaluated. Neither had studies been made on the anthropogenic impact on a forest's dynamic, that is, on its structure and ability to maintain its internal integrity. Cyclical succession at several levels is evident within the forest ecosystem dynamic with the maturation rate for various tree species governing the longest period of cyclic return. These interact with forest harvesting regimes which to date have been governed by internal and external economic need. The complex aggregation of species, dominated by tree types, exists in close association with the physical environment. Therefore, the Makheras Forest has developed its own trends, features of inter- and intra-species competition, and a regeneration ecology for particular niche species.



✉ Bruce Burns, Patrick Whaley and Malcolm Douglas. Landcare Research, Private Bag 3127, Hamilton, New Zealand. **Foliar Chemistry of Surviving Northern Rata Populations in Relation to Possum Herbivory.**

Populations of the widespread native tree northern rata have been eliminated or much reduced because of sustained defoliation by the introduced brushtail possum. However, individuals of northern rata often survive with long-resident possum populations. In Australia, possums show diet and habitat selectivity on the basis of foliar nutritional quality. We investigated whether the levels of foliar constituents of surviving northern rata would be attractive forage for possums, and whether these levels varied with available soil nutrients. Foliage from 47 trees and 5 sites on soils differing in parent material was analysed for macronutrients and secondary metabolites. Trees were also scored for canopy health assumed to reflect current possum browse. Healthy survivors had foliar N levels low enough to suggest foliage would be unattractive to possums, but polyphenol levels were lower than reported in native possum habitat and may not deter browsing. Foliar N and P were negatively correlated with total phenols and foliar characteristics generally varied between sites. However, because populations on individual sites were even-sized, it was not clear whether site variation was attributable to differences in site or differences in tree size. These results suggest that the selection of forage by possums may be more chemically than taxonomically-based.

☺ ✉ Chris Bycroft. Department of Botany, University of Otago, P.O. Box 56, Dunedin. [chris@planta.otago.ac.nz](mailto:chris@planta.otago.ac.nz). **Burning and clipping experiments on copper tussock (*Chionochloa rubra* ssp. *cuprea*): Implications for management.**

Compared with other New Zealand tussock species, only a limited amount of research has been carried out on the ecology and management of *Chionochloa rubra*. Research on the effects of burning and grazing should help in the management of copper tussockland. Three study sites were set up in 1993 and 1994 to look at these issues in Southland and Otago, representing the wide geographical, elevational and climatic range of copper tussock. A spring fire was lit at each site with various clipping regimes on burnt and non-burnt plants. For each treatment, as well as controls, measurements of growth rates (leaf elongation, new leaf and tiller production) of tillers in marked tussocks, were made at monthly intervals. Ecologists have had mixed views as to whether information available on the effects of pastoral practices on narrow-leaved snow tussock (*Chionochloa rigida*) are relevant to the management of copper tussock. The recovery of copper tussock after burning and grazing appears to be different from that reported for other tussock species, particularly *Chionochloa rigida*, implying that data from other tussock species cannot be used as a basis for management of copper tussockland. Implications from this study for the future management of copper tussockland will be described.



Andrea Byrom<sup>1</sup> and Andy Kliskey<sup>2</sup> <sup>1</sup>Landcare Research, PO Box 69, Lincoln, NZ. E-mail: ByromA@landcare.cri.nz. <sup>2</sup>Department of Geography, University of Canterbury, Private Bag 4800, Christchurch, NZ. E-mail: andyk@geog.canterbury.ac.nz. **Compensatory survival of adolescent ferrets in braided riverbeds in the Mackenzie Basin, New Zealand**

Ferrets are a major vertebrate pest in New Zealand. They prey on indigenous fauna and are potential vectors of bovine Tb. Little is known about patterns of dispersal and survival of adolescent ferrets in braided riverbed and semi-arid grassland communities in New Zealand. We examined dispersal, survival, and settlement patterns of adolescent ferrets from January to April 1998. We radio-collared 27 young ferrets on six sites in braided riverbeds in the Mackenzie Basin, and radio-tracked them every 2 - 3 days using a global positioning system. On three sites, predator abundance (including ferrets) was reduced by kill-trapping until mid-January. Three other sites were control sites with no predator removal and with normal populations of ferrets. On control sites, survival of juvenile ferrets in the first four months after emergence from the natal den was 19%. On sites where predator abundance was reduced, adolescent survival was 86%. Predator removal may improve conditions for survival and settlement of young ferrets, and the expected impacts of seasonal predator control may therefore be offset by compensatory survival. We discuss the implications of these results for management of ferrets and conservation of indigenous birds in braided rivers and semi-arid grasslands in New Zealand.

P. C. Catling<sup>1</sup> and N.C. Coops<sup>2</sup>. <sup>1</sup>CSIRO Wildlife and Ecology, PO Box 84, Lyneham. ACT 2602, Australia. <sup>2</sup>CSIRO Forestry and Forest Products, PO Box E4008, Kingston, ACT 2606, Australia. **Predicting fauna occurrence from habitat quality indices estimated from aerial videography.**

Ultimately the management of forest fauna will depend on the availability of accurate maps of the diversity and extent of habitats over large areas and/or in difficult terrain. Recently, studies that utilise airborne videography data have predicted forest structure across landscapes. Long term studies of the fauna and habitat variables have demonstrated the relationship between forest structure (habitat complexity scores) and the distribution and abundance of ground-dwelling fauna. This paper unites these two fields of research. Habitat complexity scores were used to record forest structure and the relationship between the local variance of sites in the Near InfraRed channel on the videography and field habitat complexity scores was highly significant. From this relationship maps of the habitat complexity scores were predicted from the videography at 2 m spatial resolution and extrapolated across 1 km x 1 km subsets of the forest. Existing models of species abundance were applied to spatial estimates of habitat complexity to produce predictions of the distribution and abundance of two small ground-dwelling mammals commonly found in eucalypt forests. Linear regression showed a strong positive relationship between the predicted distribution and abundance from the videography and the recorded distribution and abundance for the species. The method and application are discussed for the management of fauna, including fire management and monitoring.



✉ Hazel Chapman. Department of Plant and Microbial Sciences, University of Canterbury, Private Bag, Christchurch, New Zealand. **Clonal diversity in New Zealand populations of *Hieracium pilosella*.**

Several species of the genus *Hieracium* subgenus *pilosella* are now recognised as being major weeds of New Zealand's tussock grassland communities. While *H. praealtum* and *H. caespitosum* are widespread and common the control of *H. pilosella* is of major concern to pastoral farmers in Central Otago and the McKenzie basin of the South Island, and the North Island Central Plateau. All three species reproduce vegetatively through stolon fragmentation, and from the formation of apomictic seed. As with most species of *Hieracium* in the subgenus *pilosella* seeds develop by apospory, a form of gametophytic apomixis. Clonal apomictic populations usually show low levels of within population genetic variation (and are consequently relatively easy to control with a host specific biocontrol agent). Investigations into clonality and intraspecific variation within *H. pilosella* have shown that six out of seven populations comprise at least three morphotypes and several genotypes. No population was found to be monoclonal. Morphotypes were identified through image analysis of peduncle and involucre bract hairs. Genotyping was carried out using SSR's (short sequence repeats). This work serves as a basis for investigations into reticulate evolution within introduced weedy species and as a means to understanding multiclonality.

✉ Chris Chilcott. Ecosystem Management, University of New England, Armidale, NSW. Current Address: Agricultural Production Systems Research Unit, Department of Natural Resources, Toowoomba, Qld. **The distribution of biomass and nutrients in a grazed eucalypt forest and cleared temperate native pastures.**

The nutrient status of ecosystems is a primary factor in the maintenance of their stability and productivity. A basic requirement for understanding ecosystem nutrition, is the estimation of nutrient and carbon pools in each ecosystem component. The aim of this work is to ascertain the biomass and distribution of nutrients (nitrogen and phosphorus) within a grazed Eucalypt forest (*Eucalyptus laevopinea*) and in long-term cleared native pastures (dominated by *Aristida ramosa*) of the Northern Tablelands in New South Wales, Australia. All ecosystem components (trees, shrubs, grass, litter, roots and soil) were sampled in the grazed forest and open grasslands, and biomass and nutrient content were estimated. Tree biomass accounts for a substantial proportion of the forest biomass, with the proportion contribution to nutrient pools substantially lower due to the low concentrations of nutrients in the wood. Within these systems the soils contain a majority of the ecosystem nutrients in the topsoil (0-5 cm). The soil acts as a large reservoir of nutrients, while the below-ground biomass (in roots) and nutrient pools therein are also large. In long-cleared native pastures, a small proportion of the biomass and nutrient capital is retained above-ground, with large losses in nutrient capital demonstrated. Landscape-level disturbances such as clearing to convert forests to pastures have a significant negative effect on nutrient conservation within ecosystems. The storage capacity of woody vegetation is lost with deforestation and with it nutrients previously stored in recalcitrant pools.



Tracey B. Churchill. Tropical Savannas CRC., CSIRO Wildlife and Ecology, Tropical Ecosystems Research Centre, PMB 44 Winnellie, Darwin N.T. 0822 Australia. **Sampling spiders in the Australian tropics with pitfall traps : effects of habitat structure, trap size, drift-fences and time.**

To develop protocols to use invertebrates as bio-indicators in Australian tropical savannas, the effect on spiders (abundance, dominant taxa, and composition) of certain sampling parameters were investigated : habitat structure (simple vs. complex); trap size (4.5 and 8 cm diameter); drift-fences (present/absent); and time (5 samples at monthly intervals). Significantly more spiders were collected in the structurally simple habitat, and in fenced traps. In the simple habitat, larger traps caught more adult spiders, and more total spiders, juveniles and salticids when unfenced. In the complex habitat, the “best” design varied across months, although larger traps often caught more spiders. Temporal changes were significant for dominant taxa, and in the simple habitat, for adult and juvenile spiders. The composition of the spider fauna varied most with habitat complexity (associated with five families :  $r > 0.95$ ), followed by trap size (particularly for unfenced traps in the complex habitat), as indicated by ordination analysis. The extent of temporal variation in the fauna across trap designs varied with habitat structure (complex : fenced < unfenced; simple : unfenced large traps << other designs). The “optimal” trap design changes seasonally and with habitat type, and will depend on survey logistics, goals and target taxa.

✉ B. R., Clarkson and L. A. Schipper. Landcare Research, Private Bag 3127, Hamilton  
**Sustainability of Moanatuatua Bog, a restiad peat bog remnant**

Moanatuatua Bog is an oligotrophic raised bog remnant dominated by *Sporadanthus traversii* s.l. and *Empodisma minus* (family Restionaceae), 17 km south-east of Hamilton. Less than 140 ha of the original 7500 ha remain, mostly protected as scientific reserve. This reserve is ring-drained, lacks buffer zones and is impacted by nutrient inputs from surrounding agricultural land, and by ongoing regional drainage. Sampling of transects established in 1974 and 1993 revealed that water tables had dropped some 30 cm, maximum vegetation height had virtually doubled, and vascular species number had declined by one-third. However, the restiad vegetation type had increased significantly in extent. Values for peat decomposition state (particularly von Post humification index) and nutrient content (total nitrogen and potassium, but not total phosphorus) for Moanatuatua were similar to those for Kopouatai, an intact restiad bog. We concluded that although there has been considerable modification to the bog remnant, the current peat condition and restiad vegetation expansion indicate that basic ecological processes have been maintained and that, at least in the short term, Moanatuatua Bog remains sustainable.



Bruce Clarkson, Kathryn Whaley and Patrick Whaley. Landcare Research, Private Bag 3127, Hamilton. **The effect of recent Mt Ruapehu ash eruptions on subalpine and alpine vegetation**

Vegetation of the central North Island volcanoes is strongly influenced by episodic ash eruptions. We report on the effects of the 1995 and 1996 Mt Ruapehu eruptions, the most significant since 1945, on subalpine and alpine vegetation based on monitoring of permanent plots between 1500m and 1760 m a.s.l. in the eastern sector. Here up to 7.5 cm of acidic, sulphurous ash was deposited by the 1995 eruption. Before the eruptions, a sparse vegetation of shrubs, grasses, herbs, mosses and lichens with between 5 species (1760 m) and 24 species (1500 m) was present. Following the 1995 eruption, foliage death ranged from 50% of total cover (1760 m) to 34% (1500 m). Nearly all individuals of the dominant species survived. Amount of foliar damage was correlated with different leaf morphologies. Size and growth form explained which species were killed in all plots (1 sp) or most plots (2 spp). Shrub recovery was checked by the 1996 eruption; many resprouts died back. No propagule establishment has been recorded. All recovery is by resprouting or new growth of surviving plants. The vegetation here is depauperate and less developed compared to other sectors of Mt Ruapehu because of the frequency and direction of ash eruptions.

✉ Anne Cochrane, and Leonie Monks. WA Herbarium, CALM Science Division, Department of Conservation and Land Management. Locked Bag 104, Bentley Delivery Centre, WA 6983. **Germplasm Collection, Storage and Reintroduction: Important aspects of an integrated strategy for the conservation of threatened flora in Western Australia.**

Flora Recovery Plans outline the actions required to address threatening processes affecting ongoing survival of critically endangered flora in Western Australia and begin the recovery process. Aspects of this process involve the scientific management of *ex-situ* collections, and their recovery and reintroduction into managed environments. As part of this integrated strategy, a seed-based genebank (Threatened Flora Seed Centre, TFSC) was established by the Western Australian Department of Conservation and Land Management (CALM). The principal objective of the TFSC is to ensure the maintenance of genetically representative seed collections of threatened flora under long term (>50 years) storage conditions as an interim solution for the prevention of species extinction and genetic degradation and/or local extinction of critical populations. In 1997 a project was established by CALM, to begin a series of experimental translocations. This is the first time that a large scale systematic approach to plant translocations has been undertaken in Western Australia. The ultimate aim of this project is to develop and implement protocols for the establishment of viable populations of a range of critically endangered taxa. The seed resources of the TFSC are being utilised to provide a broad genetic base for the re-establishment of these new populations.



Greg Collings. Department of Zoology, University of Otago, PO Box 56, Dunedin, New Zealand. **Multiscale patterning in subtidal macroalgal communities.**

Subtidal macroalgal communities of South Australia were studied at a range of scales, from 10cm to several kilometres. Using a variety of techniques, it was demonstrated that distinct patchiness in specific composition occurred at several scales despite a relatively homogenous environment. An inversion of the dataset further showed that the species associations were remarkably consistent across different scales and sites. This would appear to indicate that biotic processes exert a strong influence in an environment typically considered to be dominated by physical forces.

Lisette Collins<sup>1</sup>, Bruce Burns<sup>2</sup> and Warwick Silvester<sup>3</sup>. <sup>1</sup>Waikato Conservancy, Department of Conservation, Private Bag 3072, Hamilton. <sup>2</sup>Landcare Research, Private Bag 3127, Hamilton. <sup>3</sup>Department of Biological Sciences, University of Waikato, Hamilton. **Stand dynamics of kauri (*Agathis australis*) - hard beech (*Nothofagus truncata*) forest in the Hapuakohe Ecological District.**

Hard beech populations in kauri-hard beech stands have frequently been described as not regenerating and appearing unhealthy compared to co-occurring kauri. Hypotheses which have been proposed by other authors to explain these observations include: 1) kauri and hard beech replace each other reciprocally, 2) a linear succession from hard beech to kauri is occurring, 3) both species establish following stand-initiating disturbance, but kauri live longer. These hypotheses were investigated by conducting stand structural analyses of 9 stands in the Hapuakohe Ecological District. Within these stands basal area of one species was not positively correlated with sapling and seedling density of the other species, which does not support the reciprocal replacement hypothesis. Hard beech was not less abundant than kauri and was regenerating at some sites, which does not support the theory of linear succession. Stand age structures suggested that kauri and hard beech populations were broadly even-aged. This suggests that both species establish in stands initiated by forest disturbance. The poor health of hard beech in kauri-hard beech stands elsewhere may be caused by the senescence of relatively even-aged cohorts, or a result of the health of hard beech declining as it nears its northern limit.



✉ Jaimie Cook, Cas Vanderwoude and Alan House. Queensland Forestry Research Institut, MS 483, Fraser Rd, Gympie, Queensland, Australia. **The use of ants as bio-indicators in woodland modified by grazing.**

Ant community dynamics have been successfully used as bio-indicators in forest management and minesite restoration. Our aim was to determine if existing techniques were useful in assessing ecosystem status in a heterogeneous grazing environment. Pitfall traps were established at 4 paired sites on a beef grazing property (in south-east Queensland, Australia 25°45'S, 150°40'E) subjected to a range of management practices. Sites were selected and pitfall grids established in one day without the benefit of assessing the entire property in advance. Soil types and boundaries were known and visual estimates of vegetation (percentage cover and dominance of species) were made. Samples were taken in October 1997 and March 1998. Triangular ordination results show little change in functional group composition between samples, indicating that the first sample provided enough species information to determine functional group composition. Small changes in functional group composition at 3 of the 8 sites between the two samples could be seasonal or grazing induced. Cluster analyses on presence/absence and abundance data reveal soil type as the primary factor influencing species composition. In this system, edaphic, rather than management factors exert greater control over ant community composition.

☺ ✉ Simon Cook. Department of Zoology and Tropical Ecology, James Cook University, Douglas, Queensland, 4811. **Thermal microhabitat restrictions on rainforest skinks.**

Thermal considerations are integral to heliotherm ecology and distributions. This study investigated the effects of thermal environment in a closed canopy tropical forest on the distribution and abundance of small skinks. Available thermal microhabitats were assessed by analysing hemispherical canopy photographs in concert with thermal data loggers. Skinks were censused using hand capture and felid active temperatures recorded. Thermal preferences were determined in laboratory thermal gradients for each species. The results indicate that to achieve their preferred temperatures individuals were restricted to areas in which the canopy had been disturbed to allow sunlight through. Logistic regression analysis showed a strong association of heliothermic species with canopy openings, rather than other habitat variables. This has implications for distributions of individuals and species at a variety of spatial scales.

Coomes DA\*, Allen RB\*, Wardle JA, Platt K. \*Landcare Research, PO Box 69, Lincoln. **Determinants of growth in mixed-aged stands of mountain beech.**

The growth and mortality of 22,000 mountain-beech trees in the Craigieburn Range were recorded on eight occasions from 1974-1994, providing a unique dataset with which to investigate how biological processes vary with site and stand characteristics. The data consist of repeated diameter measurements made on tagged individuals within 250 quadrats, each of 0.4 ha. A mixed-modeling approach was used to fit Bertalanffy growth functions to the trees in each quadrat, modifying the standard function to incorporate the effects of competitive suppression on smaller trees. Then we investigated how the Bertalanffy parameters varied across the landscapes, relating them to measures of altitude, soil nutrients, exposure, rainfall, solar radiation, and phase of regeneration.

- competition detected in  $\frac{1}{3}$  of plots
- no indication of switch from symmetric to asymmetric competition.
-



David A. Costello<sup>1</sup>, Ian D. Lunt<sup>1</sup> and Jann E. Williams<sup>2</sup>. <sup>1</sup>School of Environmental and Information Sciences, Charles Sturt University, PO Box 789, Albury, NSW 2640. <sup>2</sup>Land and Water Resources Research and Development Corporation, GPO Box 2182, Canberra ACT 2601. **The invasion of native, coastal grasslands by the indigenous shrub, *Acacia sophorae*.**

The native Australian shrub *Acacia sophorae* (Labill.) R. Br. has recently been identified as a potential environmental weed in coastal south-eastern NSW where dense acacia scrub is replacing open grasslands. The aim of this study was to quantify the impact of *A. sophorae* on the distribution and plant species diversity of grassy headlands in Eurobodalla National Park. Aerial photo analysis indicated that between 1967 and 1994 the expansion of *A. sophorae* reduced the area of grassland by 20%. A more detailed study of grassland species composition showed that increasing cover and abundance of *A. sophorae* was negatively correlated with species richness. This change was gradual and closely correlated with the age of *A. sophorae* at each study site. For example, a dendrochronological study demonstrated that where *A. sophorae* had been present in grassland for 20 years, plant species richness was reduced by up to 83%. The presence of *A. sophorae* in these coastal grasslands represents a significant threat to their ecological viability and conservation value. Given the rapid expansion of *A. sophorae*, and the associated reduction in species richness, prompt action is required to prevent further grassland species decline. The cessation of regular burning and grazing appears to have facilitated the spread of *Acacia sophorae*. Research is therefore needed into the most appropriate disturbance regimes to maintain species richness in the grasslands.

John L Craig. School of Environmental & Marine Sciences, University of Auckland, Auckland, New Zealand. **Takahe: Breaking ground in species recovery**

Scientific and political factors along with a mix of successes and failures have kept takahe a subject of debate. As a result takahe are a model of an effective species recovery programme. Scientifically they received intensive research from a range of viewpoints included large scale experimental manipulations. The science interpretations have been varied ensuring ongoing attention. Politically, discovery immediately before the formation of the Wildlife Service and receiving attention from the organisational head ensured attention. The response to pressure from 'outsiders' moved from exclusion to inclusion. Ongoing commitment to captive breeding in two locations resulted in techniques that subsequently led to excess individuals that were used to test establishment of populations in new areas including islands. Island populations have become the growth phase of management with future concerns for dealing with the inevitable population surplus. Importantly, island releases of takahe took a virtually extinct species into the lives of everyday New Zealanders.

Advances in science and advocacy were initially not matched by accountability. A number of recent studies have monitored past experimental releases, reversed previous waste of money and seen real advances in management. The challenge of sustained funding and removal from the threatened species listing is next. This paper will use the history of the takahe research and management to show how this species is a model for conservation management that is unsurpassed in New Zealand. The author has a 30 years history as advisor, critic and research supervisor on takahe.



✉ Simon Cramp, Ian Williamson and Darrell Storey. School of Natural Resource Sciences, Queensland University of Technology, GPO Box 2434, Brisbane, QLD, 4001, Australia. **The distribution of anurans in relation to habitat modification in the northern Darling Downs, Queensland, Australia.**

Although there has been increased understanding of anuran demography in recent years, there are few broad scale studies of frog distribution across a region, particularly in terms of relationships between land use and species distribution. Such data may provide important information on how different levels of habitat modification influence anuran populations. We examined the broad scale distribution of anurans in a 5000 km<sup>2</sup> area in the northern Darling Downs in southern Queensland, Australia. A total of 132 sites were visited from September 1997 to August 1998, and searched for adults, metamorphs, eggs and larvae of anurans. Habitats ranged from undisturbed open forest to cropland. Eighteen of the twenty one species known to occur in the area were located during the survey period. Species use of water bodies was strongly influenced by water body characteristics such as longevity and presence of predators. However, once these factors were accounted for, a number of species showed distribution patterns that were strongly influenced by habitat and land use. The distribution data are providing a basis for investigation of anuran dispersal, colonisation and persistence in natural habitats.

☺ Ann Cresswell<sup>1</sup>, Robert Poulin<sup>1</sup> and Barbara Barratt<sup>2</sup> <sup>1</sup>Department of Zoology, University of Otago, Dunedin, New Zealand. <sup>2</sup>Biocontrol and Biodiversity Group, AgResearch, Invermay, Mosgiel, New Zealand. **Development of the parasitoid wasp *Microctonus aethiopoides* Loan (Hym.: Braconidae) in two host species.**

*Microctonus aethiopoides* Loan (Hymenoptera: Braconidae, Euphorinae) was introduced to New Zealand from Australia in 1982, as a biological control agent for the lucerne pest *Sitona discoideus* Gyllenhal (Coleoptera: Curculionidae). It has subsequently been found to parasitise 13 non-target weevil species (Coleoptera: Curculionidae) within seven genera including 10 species which are native to New Zealand. The species chosen for this study, *Nicaeana cervina* Broun, is one of these native weevil species. *M. aethiopoides* females were raised in the laboratory through three generations of *N. cervina*, in the 1996-1997 season and a single generation in 1997-1998. These experiments were used to determine whether *M. aethiopoides* was capable of sustained development in *N. cervina* without recourse to its intended host *S. discoideus*. In the first experiment, *M. aethiopoides* developed through three generations of *N. cervina*, with parasitism levels increasing from 38% in field collected individuals to 70% in 3rd generation wasps. However, in the second experiment parasitism levels in *N. cervina* showed no change after a single generation. *M. aethiopoides* was shown to be capable of sustained development through a non-target host without recourse to its target host *S. discoideus* over multiple generations. Aspects of wasp morphology with respect to host species will be discussed.



☺ Louise Cullen, Glenn H. Stewart, Richard Duncan and Jonathan Palmer. Ecology and Entomology Group, Soil, Plant and Ecological Sciences Division, P.O. Box 84, Lincoln University, Canterbury. **The effect of climate on *Nothofagus menziesii* treelines.**

Over the past century global temperatures have increased by 1-1.5°C. Treelines of the Northern Hemisphere have been shown to be sensitive to this level of change, with researchers documenting increases in treeline altitude through seedling establishment and increased stem density within treeline forests. If increased temperatures are affecting New Zealand treelines then we might expect: (1) Recent establishment of trees within the last 100 years at treeline and above; and (2) Increased growth of established individuals, evident as increases in annual tree-ring widths and new stem production. Data was collected on the age and size structure, and spatial patterns of silver beech (*Nothofagus menziesii*) treelines from seven plots at Mt Haast and Rahu Saddle, north Westland. We found an upsurge in the establishment of individuals in several plots within the last 100 years. However, it is not clear whether this recent regeneration is temperature related as: (1) the marked pulse in regeneration was initiated during a cooling period; and (2) regeneration was often patchy and typically not at timberline. These results suggest that New Zealand treelines are not showing a simple response to climate warming. Rather, the patchy regeneration found could be due to other causes, principally disturbance.

☺ R. J. Cuthbert and Davis, L. S. Department of Zoology, University of Otago, PO Box 56, Dunedin, New Zealand. **Answering conservation issues with ecological questions: Threats and monitoring of Hutton's Shearwater.**

Conservation biology has been criticized for its inability to test ecological hypotheses and that the often species and site specific nature of research fails to address the broader ecological processes that conservationists are interested in. Research into the decline and retraction of range of Hutton's Shearwater (*Puffinus huttoni*) identified stoats (*Mustela erminea*) as a key threat. Two years of monitoring found that breeding success was low and stoat control was initiated in the colony. Breeding success dropped further in the two years of control, but has subsequently and in the absence of stoat control been high for the last 5 years. Whilst stoat control was a justifiable management response, the monitoring had failed to test the key hypothesis that years of low breeding success were causally related to stoats. Furthermore, an understanding of the life history tactics of seabirds reveals that the high variability observed in breeding success are what should be expected. An analysis of the importance of different demographic parameters for the population, along with the natural variability in these parameters and their associated measurement error has identified adult survival and numbers of non(breeders as the most critical and sensitive parameters to monitor. Research within the remaining colonies indicates that the level of stoat predation appears to be low, but this fails to answer why some colonies have become extinct. By asking the question "what is different about the extinct colonies?" another predator, feral pigs (*Sus scrofa*) have been identified as the key threat to the survival of Hutton's Shearwater.



J. M. Dangerfield, I. Oliver, A.J. Holmes, M.R. Gillings and A.J. Beattie. Key Centre Biodiversity and Bioresources, Macquarie University, NSW 2109, Australia. **The behaviour of biodiversity at a natural boundary.**

If ecosystems and habitats, communities or assemblages exist in nature then they should be measurable. Physical features and structural changes to vegetation are often used as the edges that define and classify these entities. Do the less visible biota, that constitute the bulk of species and gene level biodiversity, also recognise these edges? As part of a larger study of the spatial arrangement of plants, invertebrates and microbes within and between land systems in Sturt National Park, northwest NSW, we assessed microbial diversity and ground active invertebrates across a natural boundary between riparian woodland and stony chenopod shrubland. Molecular methods were used to assess microbial DNA in 150 soil samples stratified across 1km<sup>2</sup> in 10 paired transects, the soil coming from excavations for pitfall traps used to capture invertebrates which were identified to Order and then to morpho-species for five taxa. We used various statistical techniques to search for spatial discontinuities in invertebrate and microbial variety. Our results have implications for 1) the measurement and characterization of biodiversity, 2) the value of land classification systems as surrogates for biodiversity and 3) land management.

Peter Dann<sup>1</sup>, and Norman, F. I. <sup>2</sup> <sup>1</sup>Penguin Reserve Committee of Management, P.O. Box 97, Cowes, Phillip Island, 3922, Australia. <sup>2</sup>Arthur Rylah Institute, Department of Natural Resources and Environment, P. O. Box 137, Heidelberg, 3084, Australia. **Population Regulation in Little (Blue) Penguins *Eudyptula minor***

Although studies of seabirds have had fundamental influences on the development of theories of population regulation, the role and influence of factors regulating seabird populations remain unresolved. In this paper we review the evidence for factors limiting populations of Little Penguins *Eudyptula minor* in south-eastern Australia. Typically there are at least seven factors considered to have potential roles in seabird population regulation; namely food in the breeding or non-breeding periods, breeding site limitation, predation, parasites, natural catastrophes and anthropogenic influences. Food supply is commonly thought to be a significant limiting factor but the difficulty of measuring prey availability has meant that direct evidence is generally lacking. Little Penguins are particularly amenable to an examination of the effects of food supply on population size as they have one of the shortest foraging ranges of any seabird and thus are perhaps more likely to experience density-dependent food shortages when breeding. However current models of food supply limitation (e.g. hungry horde, hinterland & stochastic) do not explain the observed distribution and numbers of penguins well. Breeding site limitation and, in some cases, several other factors appeared to do so. The management implications of these findings will be discussed.



A.R. Davis and D.W. Ward. Australian Flora and Fauna Research Centre and Department of Biological Sciences, University of Wollongong, NSW 2522 Australia. **Shallow water encrusting communities: the importance of refuges from urchin grazing.**

In the shallow (<15m) subtidal zone of southeastern Australia a 'barrens' habitat is maintained by the diadematoïd sea urchin *Centrostephanus rodgersii*. High densities of this urchin remove all algae and encrusting invertebrates with the exception of grazer-resistant coralline algal crusts. Nevertheless, sponges and other sessile invertebrates maintain space in this habitat in the face of this intense grazing pressure. Sessile invertebrate cover was positively correlated with the density of the large barnacle *Austrobalanus imperator* while the intensity of urchin grazing, as determined by scrape marks on plastic disks, was negatively correlated with barnacle density. Manipulation of barnacle density at two sites, involving the addition and removal of barnacles, indicated that invertebrate recruitment and the cover of sponges was highest among high densities of *Austrobalanus* (>220 barnacles m<sup>-2</sup>). These experiments also revealed that well established sponges do not require barnacles to maintain space. Urchin feeding trials with sponge extracts indicate that a number of common sponges in this assemblage possess chemical antifeedants. These data suggest that sponges maintain space by (i) recruiting to refugia from urchin grazing and (ii) they dissuade urchins from grazing by using secondary metabolites. Identifying the natural products responsible for the feeding-deterrent properties is the focus of current work.

Lloyd S. Davis and Renner, Martin. Department of Zoology, University of Otago, P.O. Box 56, Dunedin, New Zealand. **Brood Reduction in Penguins: fighting, the odds and sods**

Penguins lay a clutch of two eggs, with the exception of emperor and king penguins, which lay only a single egg. The likelihood of penguins rearing two chicks is, however, very much dependent on the degree of hatching asynchrony of their chicks. Penguins exhibit all possible degrees of brood reduction, from little hatch asynchrony and no brood reduction to obligate brood reduction where the parents eject the first-laid egg. As many penguin species are endangered and subject to intense conservation efforts, understanding the reason for these "self-inflicted" losses can potentially have important management implications. Here we present data from our studies of brood reduction in Little, Adelie and Erect-crested penguins and review data from other studies. We conclude (i) brood reduction relates to the foraging patterns of penguins, and (ii) the egg ejection behaviour of crested penguins may be a consequence of their mating behaviour. Finally, we consider the relevance of this for the conservation and management of penguins.



☺ S.A. Davis<sup>1</sup>, R. P. Pech<sup>2</sup> and E.A. Catchpole<sup>1</sup> <sup>1</sup>School of Mathematics and Statistics, University College, ADFA, Canberra, ACT 2600 <sup>2</sup>CSIRO Division of Wildlife and Ecology, PO Box 84, Lyneham, ACT 2006. **The Expected Value of the Response Function - Implications for Population Modelling.**

Population modellers often write the rate of increase of a population as a function of food supply (termed the numeric response function). For some species, food supply is a stochastic variable whose distribution can be modelled. We show that the Ivlev form of the response function is particularly useful in such cases since there exists an analytic form for its expected value. We may then ask if there are advantages for species having low values of the demographic efficiency constant as opposed to high values, particularly in times of possible climate change. Density-dependent variants of the Ivlev form are more complex but can be analysed in a similar way.

☺ Jacqueline de Chazal Ecosystem Dynamics Group, Research School Biological Sciences, Australian National University, ACT 0200. **Let's talk about Ecosystem Health: measuring nutrient 'leakage'**

Rapport et al. (1985) proposes eight indicators of ecosystem 'ill health'. One of these indicators relates to nutrient 'loss', where less 'healthy' ecosystems are more likely to 'lose' nutrients. In this presentation I will discuss how one might approach measuring nutrient 'loss', drawing on results from a fertility experiment derived from a field study of remnant forest patches in a pastoral/rural-residential landscape in south eastern Australia. The field study represents a case study of defining and measuring ecosystem health. To conduct the fertility experiment, a standard amount of 'nutrients' in the form of an NPK fertiliser was applied to one square metre quadrats of forest soils over three time intervals. Soil samples from the quadrats were later collected and nutrient 'loss' measured with a phytometer experiment conducted in the glasshouse. Some of the lessons that can be drawn from this experiment include: the importance of making comparisons between forest patches with similar background nutrient levels; distinguishing between nutrients that are incorporated into the soil and nutrients from the residual soil surface fertiliser; and choosing carefully how nutrient 'loss' over time is to be interpreted.

☺ Astrid Dijkgraaf. School of Biological Sciences, University of Auckland (now DoC, PO Box 3016, Wanganui) **There's an Aussie possum in my larder**

In the absence of possums, fruiting patterns of large fruited species, in bush remnants around Auckland, appear to be consecutive and contiguous. The plant species may vary from site to site, but a continuous year-round food supply is available to New Zealand pigeons (*Hemiphaga novaseelandiae*), the main disperser of large fruited species. The arrival of the fruit loving Australian Brush-tailed possum (*Trichosurus vulpecula*) has thrown a major spanner in the works. Data from paired bush remnants, one in each pair with possum control, provide graphic illustration of the possum impact. Possum preferred foods are targeted well before they are ripe, and possums also impact non-fleshy fruit species. The timing of possum predation can be predicted by fruit size.



☺ ✉ Astrid Dijkgraaf<sup>1</sup> and Mick Clout<sup>2</sup> 1) School of Biological Sciences, University of Auckland (now DoC, PO Box 3016, Wanganui) 2) School of Environmental and Marine Sciences, Tamaki Campus, University of Auckland, Private Bag 92019, Auckland. **Kereru and fruit compote**

The New Zealand pigeon (*Hemiphaga novaeseelandiae*) is currently the only native bird species capable of dispersing large native fruits. Pigeons swallow the fruits entire and the seed is excreted unharmed and viable. Therefore, pigeons are vital elements in extending and maintaining forest diversity and ecology. But, what do pigeons get out of it? The nutritional characteristics of the fruit species may be one attribute that governs fruit selection. We present nutritional data for various fruit species and attempt to relate this to fruit choice by pigeons. Timing and availability of fruit is another factor that influences pigeon's choice. Data from the Auckland region illustrate some of the sequential fruiting patterns that limit food choice.

✉ Melissa Dobbie<sup>1</sup> and James Noble<sup>2</sup>. <sup>1</sup>CSIRO Mathematical and Information Sciences, GPO Box 664, Canberra, ACT 2601, Australia. <sup>2</sup>CSIRO Wildlife and Ecology, PO Box 84, Lynham, ACT 2602, Australia. **Controlling woody weeds in semi-arid woodlands in Eastern Australia.**

Woody weeds are native shrubs, principally species of *Eremophila*, *Dodonaea* and *Cassia* (*Senna*), that thrive on degraded grazing land across Australia's temperate semi-arid rangelands. Prescribed fire has shown considerable promise for treating large paddocks of shrub-infested range. Whilst fire generally kills top growth of all shrub species, resprouters regenerate rapidly after fire by coppicing at ground level. Such species are vulnerable, however, if a second defoliation can be applied early in the regeneration cycle, and in the appropriate season of the year. Chemicals applied at normally sub-lethal concentrations are being tested as a possible second defoliation treatment. The dosage, timing, age of coppice and type of chemical require accurate coordination with the initial fire treatment. The effects of these variables have been investigated through a series of experiments. This paper summarises the results obtained from these studies, together with the procedures followed during the data analysis.



✉ J. A. Douglas<sup>1</sup>; M. H. Douglas<sup>2</sup>; S. Halloy<sup>2</sup> N.Z. Institute of Crop and Food Research,  
<sup>1</sup>Ruakura Research Centre, Private Bag 3123, Hamilton. <sup>2</sup>Invermay Research Centre, Private  
Bag 50034, Mosgiel. **Weeds - noxious plants or valuable crops - a need for flexible  
regulation and attitudes.**

The national surveillance plant pests are plants that are considered to have a serious adverse effect on agricultural production, human health and enjoyment or on natural ecosystems. Under the umbrella of the 1993 Biosecurity Act, Regional Councils have developed regional plant pest management strategies, and have agreed to prohibit from propagation, sale, distribution and commercial display, 110 national surveillance plant pests. A number of these have potential as valuable phyto-medicinal crops and if produced would aid innovation in land use, improved rural development and economic well being, and are relevant to the issues of organic farming and natural health products. There is a need to weigh the positive aspects of plants already in the country against their negative aspects. We will do this by assessing sample species for weed potential and evaluating their commercial potential. The plants burdock (*Arctium lappa*), St John's wort (*Hypericum perforatum*), variegated thistle (*Silybum marianum*), brier (*Rosa rubiginosa*) and hawthorn (*Crataegus monogyna*) will be examined by the weed risk assessment model (as a biological model), and in lieu of a cost benefit model the authors will assess issues in relation to human desires. The paper will examine the issues of serious adverse effect, commercial potential, biological control of weeds, the administration of the Biosecurity Act, and discuss the wider issues of when a plant is undesirable.

Barbara J. Downes, Jeremy S. Hindell and Nick R. Bond. Department of Geography and Environmental Studies, University of Melbourne, Parkville, Victoria 3052 Australia. **Effects of habitat complexity on density and diversity: A spatially-replicated experiment**

Few studies have tested whether the results of a small-scale experiment, done at one site, have any predictive capacity at other locations. We tested whether rough- vs smooth-surfaced substrata had similar effects on macroinvertebrate diversity and density at 3 sites on each of 3 rivers. Rough and smooth colonization substrata were set out at each site for 28 days. Textural effects explained a small but consistent % of the variation in species richness, total numbers of individuals and the abundances of most (7/9) of the common taxa; in each case high numbers were recorded on rough surfaces. Nevertheless, most variation was explained by site, which accounted for 30% of variation in species richness, 60% of total numbers of individuals, and between 9 and 75% of variation in abundances in all 9 common taxa. Site differences were also associated with significant shifts in faunal composition at the family level. Differences between rivers explained 0% of the variance in most cases. Our results indicate that a small-scale effect can produce a consistent effect on measures of community structure and have some predictive capacity at other locations. However, efforts must be directed to discovering what factors cause such large fluctuations between sites.



Driver, P.D.<sup>1</sup> and Closs, G.P.<sup>2</sup> <sup>1</sup>CRC for Freshwater Ecology, University Of Canberra, ACT, Australia, 2601. <sup>2</sup>Department of Zoology, University of Otago, PO Box 56, Dunedin, New Zealand. (patrickd@lake.canberra.edu.au). **Short-term resilience of a pond ecosystem to carp (*Cyprinus carpio* L.).**

Carp have been described as an ecological dominant whose effects at high densities lead to dramatic modification of water quality and invertebrate community structure. Their impact may vary with size due to factors such as ontogenetic diet shifts. The impact of the biomass density of large & small carp on the community and water quality of a shallow pond was examined in an enclosure experiment. Overall, carp interacted weakly with most invertebrate species, however they did have strong effects on selected vulnerable species. Species that utilised refuges were able to thrive under carp predation. Species impacted varied with prey size suggesting prey size-specific effects are important. Considerable variation in invertebrate community structure not associated with carp presence/absence was detected suggesting that factors other than carp may be more important determinants of community structure. The interaction between carp, the invertebrate community and key physical and chemical factors will be discussed.

Richard P. Duncan, and Jim R. Young. Ecology and Entomology Group; Soil, Plant and Ecological Sciences Division; P.O. Box 84; Lincoln University, Canterbury. **Extinction vulnerability in plants**

We analyse a 114 year historical record (1871-1985) of the change in abundance of 373 native plant species in an area of what is now urban Auckland, New Zealand, with the aim of identifying factors that contribute to local extinction risk. Following European settlement in 1840 most of the original vegetation of the Auckland area was cleared for farming and subsequently transformed to an urban landscape. Eighty of the 373 native plants recorded in the area in 1871 were locally extinct by 1985 and the majority of survivors had declined in abundance. Extinction rate was significantly higher among species most common in habitats that suffered the greatest loss of area between 1871-1985, consistent with the idea that habitat destruction was a cause of local extinctions. But by far the strongest predictor of extinction risk was initial abundance in 1871; species that were rare in 1871 were more likely to be locally extinct in 1985. In addition, short-statured species were more likely to go extinct than tall species, while dispersal ability and capacity for clonal spread failed to consistently predict extinction risk.

☺ ☒ Petrina J. Duncan, Department of Zoology, University of Otago, P O Box 56, Dunedin, in collaboration with Landcare Research, Private Bag 1930, Dunedin. **Trapability differences of two sympatric skinks in the upper Buller Valley.**

Landcare Research is undertaking a long-term mark-recapture study of sympatric speckled skinks (*Oligosoma infrapunctatum*) and spotted skinks (*O. lineoocellatum*) in the Upper Buller Valley. Speckled skinks have a higher trappability rate than spotted skinks in pitfall traps baited with pear. The objective of this study is to determine why spotted skinks are less trappable. Three hypotheses are: (1) pear bait is a particularly poor attractant for spotted skinks compared to live invertebrate bait, (2) spotted skinks are less active, thus encounter traps less frequently and (3) spotted skinks are more adept at escaping from traps. The bait hypothesis was tested using two different bait types, pear and live mealworms, as attractants in pitfall traps. Mealworm bait was inferior to pear in attracting spotted skinks. Timing of skink activity was determined by checking traps at five set times each day. There was no evidence of a species difference in the time-dependence of activity, indicating that spotted skinks do not spend less time active. To test if skinks escape from traps, animals were held in pitfall traps for 24 hours. Few of either species escaped, indicating that trap escapes by spotted skinks rarely occur. Results so far have led to the rejection of the first three hypotheses. Future work is discussed.

Daryl Eason and Murray Willans. Department of Conservation, P.O. Box 29, Te Anau. **Captive rearing - a management tool for the recovery of the endangered takahe.**

Captive rearing of takahe (*Porphyrio mantelli*) has played a key role in the establishment of island populations and stabilising the decline of the remaining Fiordland population. Since 1982, 179 takahe have been reared to one year old, using continually improving techniques, minimising mal-imprinting and maximising skills necessary for survival in Fiordland. Burwood Takahe Rearing Unit is now among the leading institutions world wide for captive rearing and release. Surplus eggs collected from Fiordland and captive pairs are artificially incubated using a weight loss regime (initiated in 1987), with an average annual hatch rate of 80.5% (n=182). Chicks are reared to two months using hand rearing techniques and more recently a combination of hand rearing and short periods of takahe foster parenting. During winter, juvenile takahe are held in large enclosures with natural vegetation where they learn important foraging skills and experience weather conditions similar to Fiordland. Behavioural skills have recently been enhanced by use of foster takahe parents caring for multiple juveniles. Takahe yearlings have been released annually in the Murchison Mountains since 1991, with a 50-69% survival rate (n=78) to February 1998. This compares favourably with a 32-62% survival rate of wild reared birds (n=63), tagged over the same period. During the 1997/98 breeding season 40% of the 43 Murchison Mountain takahe pairs comprised of at least one Burwood reared takahe. The population of 59 takahe on four islands was founded from 1983 to 1996, by 18 Burwood and seven other captive takahe. Nine (36%) of the founders survive.



☺Easterbrook, M.J. and Sparrow, A.D. Plant and Microbial Sciences, University of Canterbury, Private Bag 4800, Christchurch, New Zealand. **Microhabitat dependent survival and growth of *Nothofagus solandri* seedlings.**

Rarity of mountain beech (*Nothofagus solandri*) establishment into grass and shrubland habitats surrounding remnant forest patches was investigated at Cass, inland Canterbury, New Zealand. A factorial seedling transplant experiment was set-up to test the effects of habitat type, light, water and root competition on the survival and growth of transplanted beech seedlings. Seedling survival was limited by high light levels and low soil moisture wherever taller plants fail to provide sufficient shade. Seedling mortality occurred during periods of low rainfall, therefore a simple soil moisture model was developed. This model incorporates precipitation and a drying constant which is dependent on temperature, to predict the moisture content at the study site over the census period. Seedling mortality increased significantly during periods when the field soil moisture content dropped. Survival was best in shaded microsites because they provide lower heat loads and higher moisture availability, allowing seedlings to maintain a tolerable heat budget. Seedling growth was significantly greater in unshaded microsites indicating a dichotomy between microsites for seedling survival and growth. The main limit to beech spread seems to be a lack of shaded microsites in non-forested habitats.

Murray Efford, Landcare Research, Private Bag 1930, Dunedin [effordm@landcare.cri.nz](mailto:effordm@landcare.cri.nz).  
**The distribution and abundance of brushtail possums**

The pest status of brushtail possums in New Zealand has focused research on control methods and on interactions with the native biota. This paper advances the possum instead as a model species for the study of mammalian population dynamics. Such an approach mirrors the established role of possums as laboratory marsupials in Australia (Clout & Sarre 1997 Wildl. Soc. Bull. 25: 168-172). Possum life history in many respects follows a typical mammalian pattern e.g., dispersal is male-biased and mostly precedes sexual maturation; annual mortality increases rapidly beyond middle age, and this senescent decline occurs earlier in males than females. The relevance of possums as population dynamic models will be argued from mark-recapture studies in the Orongorongo Valley, Wellington, and elsewhere. The Orongorongo population time series from 1967 to 1997 has remained relatively stable at around 9 possums per ha (range 5-13 ha<sup>-1</sup>). However, the formal demonstration and interpretation of population regulation in this study is problematic, as in so many others. Part of the difficulty is caused by the arbitrary limits placed on the study population, and the potential for sex-specific net migration across the boundary. Spatially explicit models will probably be required for a robust understanding of these local dynamics.

✉Murray Efford<sup>1</sup>, Nick Spencer<sup>1</sup> & Bruce Thomas<sup>2</sup> <sup>1</sup>Landcare Research, Private Bag 1930, Dunedin. <sup>2</sup>Landcare Research, Private Bag 6, Nelson. **Coexisting endemic skinks: do they compete?**

Three endemic skink species were pitfall trapped in the Upper Buller valley, South Island in seral vegetation dominated by bracken. Two of these species, *Oligosoma infrapunctatum* and *O. lineoocellatum*, are of very similar size and are potential competitors. Faecal analysis indicated that both species were dietary generalists. Habitat units were defined by cluster analysis. The capture rate of each species was compared between habitats, and by spatial linear modelling of abundance. *O. infrapunctatum* preferred 'closed' sites with a higher canopy that often included *Coriaria arborea*, whereas the third species *O. nigriplan tae polychroma* preferred 'open' sites with bare ground or low-canopy vegetation with *Leucopogon fraseri* and grasses. *O. lineoocellatum* showed no overall preference. Spatial linear modelling confirmed the pattern for *O. infrapunctatum*, and also suggested that *O. lineoocellatum* avoided grassy or bare ground. Abundance of the alternate species had a positive effect on the numbers of *O. infrapunctatum* and *O. lineoocellatum* caught in each trap. We conclude that these species have not evolved effective means of niche partitioning, and that there is a strong potential for competition. We present preliminary results from a field experiment designed to detect competition between these species.

😊Alison Evans. Ecology and Entomology Group, Division of Plant, Soil and Ecological Science, P.O. Box 84, Lincoln University, CANTERBURY. **The impact of sustainable beech (*Nothofagus spp.*) harvest on litter-dwelling invertebrates and litter decomposition.**

Little is known about the diversity of invertebrates in New Zealand's beech forests or the degree to which disturbance impacts on forest biodiversity. In order to minimise the potential impact of forest management, it is critical to have an understanding of the key elements of forest biota and their role in maintaining ecological function. A replicated study was established in Maruia State Forest (South Island, New Zealand) to assesses the potential impact of sustainable beech harvest on invertebrates involved in leaf decomposition. A series of litter-bags containing pre-weighed defaunated leaf-litter were placed in three natural forest (control) sites, three harvested sites (removal of 2-3 trees) and three simulated wind-throw sites. Millipedes (Diplopoda), earthworms (Annelida), tipulid larvae (Diptera), weevils (Coleoptera), moth larvae (Lepidoptera), woodlice (Isopoda), oribatid mites (Acari) and hoppers (Amphipoda) were extracted from the litter-bags and the invertebrate diversity was compared between the three treatments. Weight loss from the litter-bags and the carbon and nitrogen content of litter were used to measure the rate of decomposition in each treatment. The amount of litter fall from the canopy and abiotic factors such as the temperature and moisture of the leaf-litter were also monitored. Preliminary results suggest that invertebrate diversity and the rate of decomposition are unaffected by disturbance. However, changes in abiotic factors and the amount of litter-fall were apparent in the selectively harvested and simulated wind-throw sites. The results from this study are intended to increase understanding of the links between biodiversity and forest ecosystem function and assist in the development of ecologically sound forest management strategies.



☺ ☒ Katharine Evans. Department of Zoology, University of Melbourne. **A study of the pollination systems of *Banksia* species at Wilson's Promontory, Victoria.**

In many plant-pollinator systems flowers are visited by a variety of pollen vectors, not all of whom will be equally effective. A variety of birds are known to be important pollinators of members of the Proteaceae but, it has recently been demonstrated that small marsupials are also pollinators. It has been suggested that due to the relative sedentary nature of these small marsupials, plants pollinated primarily by small marsupials may suffer reductions in reproductive success due to inbreeding. The patterns of pollen flow affected by birds compared with non-flying mammals is being investigated in 2 species of *Banksia*, *B. integrifolia* and *B. spinulosa* found at Wilson's Promontory National Park, Victoria. Both are known to be pollinated by birds and non-flying mammals, in particular, the Eastern pygmy-possum, *Cercartetus nanus*. Patterns of pollen flow will be inferred from aspects of pollinator foraging behaviour, such as inter- and intra-plant movements and the number of inflorescences visited per plant. In addition, the effectiveness of birds and pygmy-possums is being investigated by manipulation of some plants to allow access to only one pollinator group. Relative effectiveness will be measured in terms of numbers of seed set and on levels of genetic variation present in the seeds using species-specific primers. To investigate the optimal outcrossing distance for the plant, a series of hand pollination experiments using pollen from known distances are being conducted. These combined with seedling growth trials will assess the affect of outcrossing distance on progeny fitness. It has been suggested that *B. integrifolia* is clonal which would have an important effect on gene flow in the population. Also, at Wilson's Promontory, for reasons unknown, the population is in decline. The possible influence of population genetic structure on this decline is being studied.

☺ ☒ Lisa Evans. Co-operative Research Centre for Freshwater Ecology, University of Canberra, ACT 2601. **Response of five south-eastern Australian riparian plants to experimental flooding in relation to field zonation patterns.**

The growth rates of *Kunzea ericoides*, *Casuarina cunninghamiana*, *Leptospermum obovatum*, *Callistemon sieberi* and *Acacia dealbata* seedlings were measured for a range of flooding treatments under glasshouse conditions. Four treatments were used over a 30 day period, ranging from total immersion to soil saturation with a control of no flooding. Based on factorial ANOVA of relative growth rates (RGR) of biomass and height, two response groups were evident. *L. obovatum* and *C. sieberi* had higher RGR and a positive response to flood treatments compared with *A. dealbata* and *C. cunninghamiana*. *K. ericoides* generally showed a positive response to the intermediate flood treatments. The results were supported by an experiment on long-term inundation tolerance, which found *C. sieberi* to have the longest tolerance to inundation. The experimental results are reflected in zonation patterns found in the field, with *C. sieberi* and *L. obovatum* found closest to the river. *C. cunninghamiana* is also in this position in the field, contrary to experimental results. A one-way ANOVA for *C. cunninghamiana* RGR height finds this species to have a similar response to flooding as *C. sieberi* and *L. obovatum*. Therefore differing responses and tolerances to flooding of riparian vegetation are partially responsible for field riparian vegetation zonation.

José M. Facelli,<sup>1</sup> Peter L. Chesson<sup>2</sup> and David Bigham<sup>1</sup>. <sup>1</sup>Department of Botany, The University of Adelaide, and <sup>2</sup>Research School of Biological Sciences, Australian National University. **Effects of variation of seasonal water availability and plant density on recruitment of annual species in arid lands of South Australia.**

Models that predict coexistence of species driven by environmental variability require that the recruitment of various species respond differentially to different combinations of environmental conditions, and have distinct responses to density dependent processes. We tested the effects of increasing water availability in autumn, winter and spring, and thinning 1/3 or 2/3 of the established plants, on the community structure of the annual guild in chenopod shrublands of South Australia. Increased water availability in autumn increased the emergence of one of the most abundant species, *Crassula colorata*, while winter watering promoted the establishment of another abundant species, *Carrichtera annua*. Spring watering increased emergence of grasses (mainly *Danthonia caespitosa* and *Stipa nitida*). Overall there was high survivorship, and watering treatments had only slight effects on the survivorship of late cohorts. Thinning had little effect on further establishment or survivorship. Because of low background rainfall during that particular year, densities may have not have reached limiting levels. Our results show that there is less variation in seasonal responses in this arid lands than in most other arid lands studied so far. Coexistence may thus depend on finer differentiation of the specific responses to temporal occurrence of rainfall

✉ Evelina Facelli<sup>1</sup> and José M. Facelli<sup>2</sup> <sup>1</sup>Soil Science Department, <sup>2</sup> Botany Department, University of Adelaide, SA, Australia. **Interactive effects of mycorrhizal symbiosis, plant density and soil nutrient heterogeneity on *Trifolium subterraneum*.**

We grew plants of *Trifolium subterraneum* inoculated or not with a mycorrhizal fungus, in trays with homogeneous or patchy distribution of phosphorus (P), at low or high plant density. Populations of *T. subterraneum* growing in patchy environments had higher biomass and higher size inequality. Mycorrhizas increased plant biomass and size inequality in low density populations, independently of nutrient distribution. The size of the individuals was determined by local P concentrations and little affected by the number of adjacent patches with high P. Mycorrhizal infection but not patchy P distribution affected relative competition intensity. Thus, in environments with patchy distribution of P, plants of even-aged populations that grow in a nutrient rich patch and/or plants that become infected by mycorrhizal fungi early, will have an initial advantage over the others, leading to asymmetric competition. If size differences are maintained after strong competition for light occurs, those larger individuals might competitively exclude others, and have greater chance of reproductive success.



☺ ☒Foley, JW and Buckney, RT. Department of Environmental Sciences, University of Technology, Sydney, PO box 123, Broadway, Australia 2007. **The effect of road edges on suburban and conservation area bushland in the northern Sydney area.**

Previous research in disturbed communities within the study area has focused on a small number of environmental variables and their effects on plant community composition. In this study, a wide range of environmental variables was incorporated into the experimental design to more accurately describe changes arising from the edge effect. Community composition, structure and the physical and chemical characteristics of the soil were recorded at set distances from a road edge, within a belt transect. Native species richness and abundance was shown to be inversely proportional to that of exotic species in suburban areas, with the richness and abundance of native species increasing with distance from most road edges. Suburban road edges were believed to have effects on soil pH, cation concentration (potassium, magnesium, calcium, aluminium, sodium) and nutrient levels (phosphorus, nitrogen). Conservation area edges displayed a number of responses, primarily changes to the soil pH and concentration of various cations. These changes are reflected in the abundance and richness of native species in conservation area and suburban road edges and the presence of exotic species in suburban areas.

☒ Simon V. Fowler, Richard Hill\* and Pauline Syrett. Manaaki Whenua - Landcare Research, Private Bag 92170, Mt. Albert, Auckland. \*R. Hill and Associates, 237 Ashgrove Terrace, Christchurch. **The role of biological control introductions in the management of environmental weeds in New Zealand**

Environmental weeds can pose difficult problems for chemical or mechanical weed control. The scale of the problem is often large and sustaining chemical or mechanical control can become prohibitively expensive. There may be undesirable effects from herbicide use on environmental weeds or from disturbance created by mechanical control. The release of specific biological control agents, usually from the native range of an alien weed, can have advantages over other control methods. Once established and effective, biological control is self-sustaining and cost effective. Using deliberately introduced organisms to control alien weeds raises valid concerns about the potential effects on non-target organisms. These concerns are particularly strong when the non-target organisms in the environment where the weed is invading are indigenous or endemic species. However the safety record in the 100 years that biological control has been used against alien weeds is excellent. Herbivorous insects and plant pathogens used in the biological control of weeds are subjected to rigorous testing to ensure that there is virtually negligible risk of any non-target plants being damaged following their release. This paper discusses the issues of safety and predictability of weed biocontrol with reference to examples of current and potential programmes in New Zealand.

Barry Fox, School of Biological Science, University of NSW, Sydney, 2052. **Long-Term Studies of Small-mammal Communities in Disturbed Habitats in Eastern Australia.**

Long-term monitoring of small mammals provided much information not available from shorter-term surveys. A forest study identified repeating mammal successions in 26 years since the last fire. Monitoring individual sites through extended time periods support published chronosequence analyses. Repeated mammal successions appear driven by changes in the structure of the vegetation. In heath the post-fire succession becomes a species replacement sequence when sufficient time is allowed, rather than change in relative dominance of species previously suggested. Regeneration of sand-mined forest is a valuable system for study and validation of chronosequence techniques, when individual sites are followed through time. In heathland, data 18 years after sand-mining confirm earlier predictions about New Holland mouse populations. Few of these results would be apparent from short-term data sets, or even from chronosequences covering longer time spans, and long-term monitoring of the same sites delivered more interpretable information than either alternative approach. A second wave of mammal succession in response to late succession vegetation senescence could not be predicted from 'short-cut' methods. A strong case can be made for the value of long-term studies: superior returns in time and effort relative to investment in short projects.

David Freudenberger and John Barber. CSIRO Wildlife and Ecology, PO Box 84, Lyneham, ACT 2602. email: d.freudenberger@dwe.csiro.au. **Movement Patterns of Feral Goats in a Semi-Arid Woodland in Eastern Australia.**

The movement patterns of ten feral goats fitted with radio transmitters were examined over a 20 month period in a semi-arid woodland of western New South Wales. The mean distance between locations (fixes) was 3.1 km at 42 day intervals. The mean interfix distance for male goats was 1.1 km greater than for females. The mean home range for the five males was 29.4 km<sup>2</sup> (95% convex polygon) and 10.9 km<sup>2</sup> for the five females. We found that the movement patterns of feral goats in this woodland system were predictable. Goats usually moved small distances and remained close to intermittent lakes and creeks with abundant tree and shrub cover. Goats commercially harvested in this area were likely from local populations living in an area of 15-35 km<sup>2</sup>, an area encompassed by 1-2 paddocks on a single property.



☺ Suzanne Fyfe. School of Geosciences, University of Wollongong, NSW 2522. **Is it possible to trace the Pleistocene distribution of dry rainforest using Island Biogeography theory?**

The subtropical dry rainforests of the Southern Blue Mountains region of NSW currently exist on the "edge" of normal environmental tolerances for rainforest species. Three scenarios were postulated to account for the distribution of these rainforests during the Pleistocene and their dynamics since the last glacial maximum. For each historic scenario, expected directional trends in diversity and floristics were predicted using the Equilibrium Theory of Island Biogeography. Multidimensional scaling on the basis of floristic similarity separated 28 subtropical Southern Blue Mountains rainforest patches from 4 patches of warm temperate affinity and allowed an Illawarra site to be selected as a 'null model' by which to compare species-area curves. The Southern Blue Mountains patches were found to be significantly less diverse than would be expected if area alone influenced richness. Multiple regression showed that species richness was significantly influenced by patch size but not by distance from a presumed source of recolonisation, distance to a nearest neighbour patch, patch shape or altitude. Floristic and geographic nearest neighbours were significantly correlated but no strong directional trends were uncovered. Nevertheless, floristic similarities and a predominance of vagile "pioneer" species suggests Holocene recolonisation of dry rainforest from Illawarra coastal relicts. A small component of warm temperate vegetation probably persisted *in situ* through the Pleistocene Ice Ages.

☺ ☒ Eamonn Ganley and Shane Wright. Ecology and Evolution Research Group. University of Auckland **Rehabilitation of the western Waikato coast.**

The coastal environment is an important part of the New Zealand identity. The Waikato coastline extends from Mokau in the south to Port Waikato in the north. This rugged coast is broken by three extensive estuarine harbours and consists of three separate ecological districts; (Waikato, Kawhia, and Herangi). Modification of coastal habitat and the resultant increasing vulnerability of this ecosystem, is of major concern to Environment Waikato. The objective of this research is to survey the natural vegetation along the Waikato Coast in early, mid and late successional stages. The method of point center sampling is used to suggest future rehabilitation design, by describing the distribution and abundance of species of importance in these communities. From this the most important species in pre-existing coastal natural vegetation remnants may be identified and revegetation programmes based on these species developed. Increasingly intensive use of the coastal environment has created an interest in the sustainable management of these areas. The present study will provide information for Environment Waikato's community-based Beach Care programme, which attempts to address issues associated with coastal ecosystem reconstruction.

Neil Gibson<sup>1</sup>, G.J. Keighery<sup>1</sup>, and B.J. Keighery<sup>2</sup>. <sup>1</sup>Department of Conservation and Land Management, PO Box 51, Wanneroo, WA 6065. <sup>2</sup>Department of Environmental Protection, 141 St Georges Terrace, WA 6000. **Threatened plant communities of Western Australia.**  
**1. The ironstone communities of the Swan and Scott Coastal Plains.**

The restricted plant communities of the massive ironstones (laterites) of the Swan and Scott Coastal Plains are described. These communities are among the most threatened in Western Australia. The major source of threat has been agricultural clearing with the remaining remnants being impacted on by *Phytophthora cinnamomi*, grazing and activities associated with mineral exploration. Nineteen taxa have been recorded as being endemic to or having the major distribution centered on these ironstone areas, a further three taxa may have forms restricted to this habitat. Major differences in community composition were related to geographic, and edaphic factors. Species richness ranges from an average of 14 to 67.8/100m<sup>2</sup> across the six communities described. Only half of the communities have been recorded from secure conservation reserves. Little is known of the process of formation of the ironstone areas, they are however much younger than the Tertiary aged laterites of the nearby Darling Plateau.

Gibson, R.S.<sup>1</sup>, Meurk C.<sup>2</sup>, Espie P.<sup>3</sup>, Bosch O.J.H. <sup>1</sup>Landcare Research, PO Box 282, Alexandra. <sup>2</sup>Landcare Research, PO Box 69, Lincoln. <sup>3</sup>AgResearch, Private Bag 50034, Mosgiel. **Vegetation dynamics during 1990–1998 of grazed and ungrazed Mackenzie Basin grasslands, New Zealand**

Changes in vegetation composition were examined at ten localities representing: fescue tussock (5), tall tussock (2), red tussock (2), and silver tussock (1) grassland communities within the Mackenzie Basin, New Zealand. At each locality three treatments were established: ambient sheep and rabbit grazing, rabbit grazing only, and no grazing. Vegetation cover were assessed on eight 0.5 m<sup>2</sup> quadrats within each treatment. Data analysed were collected when the sites were initially set up in 1990, remeasured in 1993 and again in 1997. Vegetation dynamics were examined by ordination methods. Quadrats that were already dominated (>50% cover) by *Hieracium pilosella* had little change in species composition regardless of grazing treatment. In fescue tussock communities with had a low *H. pilosella* abundance (<5%) in 1990, *H. pilosella* has generally continued to increase regardless of grazing treatment. Cover of other species, such as *Aira caryophylla*, *Rumex acetosella*, *Vulpia bromoides*, and *Festuca novae-zelandiae*, which had previously characterised these communities, has reduced. Quadrats with a dense cover of red tussock (*Chionochloa rubra*) or narrow leaved snow tussock (*C. rigida*) have demonstrated the greatest resistance to *H. pilosella* invasion. At the silver tussock (*Poa cita*) locality, where there is very little *H. pilosella* present, an increase in adventive species, such as hare's-foot trefoil (*Trifolium arvense*) and viper's bugloss (*Echium vulgare*), has occurred where sheep and rabbit grazing have been excluded. In summary, results show the main change in species composition has been the invasion of *H. pilosella*, whilst any changes observed between grazing treatments have been small in comparison. The findings suggest cessation of grazing is unlikely to lead to recovery of these communities to their previous vegetation composition at least within a time frame measured in decades.



Tim M Glasby. Centre for Research on Ecological Impacts of Coastal Cities, Marine Ecology Labs, A11, University of Sydney, N.S.W. 2006, Australia. **What makes marine organisms on artificial and natural substrata so different?**

Recent studies have demonstrated that assemblages of marine invertebrates growing subtidally on artificial structures are very different from those on nearby natural rocky reefs. The types of artificial structures sampled included some of the most common urban developments in coastal waterways, such as pier pilings, pontoons and retaining walls. Although there is the potential for different organisms to settle and grow on different materials (e.g. wood, fibreglass, concrete, sandstone), experiments indicate that other factors are primarily responsible for the observed differences between these substrata. Specifically, differences in shading and position in the water column are likely to explain many of the differences between assemblages on artificial and natural substrata. Rocky reefs, unlike most artificial structures, are close to the seafloor and to the shore and are relatively unshaded.

A.D Griffiths. Tropical Savannas CRC and CSIRO Wildlife and Ecology, PMB 44 Winnellie, NT Australia 0822. **Sulphur dioxide and savanna biodiversity: assessing the impact of smelter emissions at Mt Isa, Queensland**

A terrestrial vertebrate survey was carried out at Mt Isa, Queensland, to determine the impact on the species richness and abundance of sulphur dioxide emissions from a copper smelter. No pre-emission biological data were available, so the survey design was based on detecting differences in spatial patterns from the point source. Standard fauna survey techniques were used to sample reptiles and birds, and soil samples were collected. Soil sulphate levels were highly correlated with distance from the point source ( $r^2 = 0.65$ ). Numerous environmental sample variables exhibited a strong correlation with distance to the emission point source. Reptile species diversity and abundance were substantially lower (75% or less) within the "High" deposition zone. Insectivorous reptile species that forage during the day (primarily skinks and dragons) were the most heavily impacted. Mean bird species richness was substantially lower in the "High" sulphur deposition zone. In contrast, mean bird abundance was similar among all zones. Bird species that primarily feed on insects recorded the largest decline in diversity and abundance. The large amount of sulphur dioxide has had a substantial impact on the terrestrial vertebrate community within 10 km of the point source (approximately 50 km<sup>2</sup>). However, the influence of mechanical disturbance and fire may have contributed to some of these observed differences.

© Philip Grove, Alan F. Mark, Katharine J.M. Dickinson. Botany Department, University of Otago, Dunedin. **Monitoring vegetation trends in recently-protected tussock grasslands, southern South Island, New Zealand**

In recent years a number of areas of indigenous tussock grassland vegetation, with associated shrubland, wetland, and high-alpine plant communities, in Otago and Southland have been reserved for nature conservation after up to 150 years of pastoral use. Because of a general lack of experience, questions have arisen as to how best to manage such areas, and what changes may occur in the vegetation after cessation of pastoralism. A suitable monitoring programme can provide information on the direction, rate and spatial extent of vegetation change, and is therefore essential if successful conservation management strategies are to be developed. This paper presents results from several monitoring studies in a range of recently-protected tussock grassland reserves. Monitoring showed that the removal of grazing aids recovery of the dominant tussock species, with an increase in tussock height and cover accompanied, in some cases, by a decline in abundance of both native and adventive inter-tussock species. For fire-induced tussock grassland below climatic tree line, displacement of tussock by taller woody shrub species has been widely predicted. However, results from these studies shows that the rate and extent of shrub-displacement of these tussock grasslands varies considerably and a general model of succession to woody vegetation can not be assumed.

Stephen J Hall and S. Gray. School of Biological Sciences, Flinders University of South Australia., GPO Box 2100, Adelaide 5001. **The effect of resource supply rates on community assembly: experimental tests in the marine subtidal.**

This study examines a number of hypotheses concerning the effect of differing rates of inorganic nutrient supply on levels of biodiversity and the process of community assembly in a marine system. This was achieved using replicated artificial habitat patches placed in the shallow subtidal. Nutrient supply rate was manipulated using varying levels of slow release fertilizer and 'crossover' treatments were included to examine the reversibility of effects. The assembly process was followed for bacterial, algae, and invertebrate assemblages, providing an opportunity to explore the whether and how assembly processes for these various groups are coupled.



✉ Richard Harris<sup>1</sup>, Peter A. Williams<sup>1</sup>, Richard Toft<sup>1</sup>, Rachel Standish<sup>2</sup>, Brian Karl<sup>1</sup>.

<sup>1</sup>Landcare Research, Private Bag 6, Nelson, New Zealand. <sup>2</sup>Massey University, Private Bag 11222, Palmerston North, New Zealand. **Impact of Invasive Weeds on Forest Ecosystems .**

Relatively few lowland forest remnants remain in New Zealand. Often these are small fragments that have been modified by selective logging, grazing and edge effects. As a result they are prone to invasion by exotic weeds. In addition, there are large areas where native early successional systems have been replaced entirely by adventive species. Knowledge of the resulting impacts on ecosystem function and biodiversity would enable predictions of the long-term health of these systems and the development of appropriate management actions. We have begun a project to quantify impacts of three different invasive weeds - wild kahili ginger (*Hedychium gardnerianum*) and wandering Jew (*Tradescantia fluminensis*) in forest remnants, and gorse (*Ulex europaeus*) as a replacement to early successional communities of kanuka (*Kunzea ericoides*). For each system we aim to determine the impact of the weed on community structure, ecosystem function and biodiversity, by replicate sampling in invaded and non-invaded plots. The impacts of the three weeds on community composition and ecosystem function will be synthesised to predict the long term fate of the community in the presence of each weed and to identify common themes.

Richard Harris<sup>1</sup>, Travis Glare<sup>2</sup>. <sup>1</sup>Landcare Research, Private Bag 6, Nelson, New Zealand.

<sup>2</sup>AgResearch, PO Box 60, Lincoln, New Zealand. **Insect pathogens - can we exploit them for use as biological control agents for social wasps?**

Social wasps (*Vespula* spp.) are a major pest in New Zealand and are becoming a significant problem in Australia. Biological and chemical control options exist, but more effective control options are needed. Few pathogens have been isolated from wasps, and the majority of these are generalists or are likely to have been brought in with their prey. None of the reported pathogen fauna has potential as a classical biological control agent. Use of pathogens in inundative management strategies may have potential if key criteria are met. We investigated the susceptibility of wasps to generalist insect fungi and bacteria, both isolates from wasp colonies and novel forms. In the laboratory adults and larvae were highly susceptible to fungi but not bacteria. Field trials of fungi using different application methods have had mixed results. Transfer of spores occurred between treated and untreated individuals and the activity of colonies was reduced. However, individuals that died did not sporulate within the nest to cause further spread of infection. We relate our results to wasp behaviour, potential environmental limitations, outline the direction of ongoing research, and assess the potential of pathogens to achieve advancements in wasp control technology.

✉ Greg Hay, José M. Facelli, and Russ Sinclair. Department of Botany, The University of Adelaide, SA, Australia. **Effects of canopies of *Acacia papyrocarpa* on water relations and growth of *Atriplex vesicaria* in chenopod shrublands of South Australia.**

Large plants create microenvironmental conditions that may alter the performance of smaller plants growing underneath. It has been suggested that in arid lands these changes can result in facilitation (i.e. enhanced performance of the smaller plant). To determine the effects of the presence of trees on the performance of the dominant shrub, we measured environmental and ecophysiological variables of shrubs growing in open areas or under the canopies of large trees through spring, summer and autumn. Growth was unaffected by position of the shrub, but responded to soil water availability. Pre-dawn water potential of shrubs under the canopies of trees was higher under canopies late in the season, even though soil water contents were not different. This was seemingly due to higher soil matric water potential under tree canopies, most likely as a result of increased organic matter content. The absence of growth response was probably due to the short term of the study. Overall we found some indication of enhanced performance of shrubs growing under tree canopies during the most stressful part of the year, but no effect during the periods when water was not as limiting. These results support the hypothesis that facilitation becomes more important as conditions become more stressful.

Rod Hay<sup>1</sup>, Theo Stephens<sup>2</sup> and John Innes. <sup>1</sup>Department of Conservation, Private Bag 4715, Christchurch. <sup>2</sup>Department of Conservation, PO Box 112, Hamilton. **Has the Bird Flown? Measuring the Benefit of Species Protection Programmes**

Conservation in New Zealand has focused largely on species recovery and land protection. The challenge now is to integrate such efforts within a biodiversity paradigm aimed at maintenance and restoration of whole ecosystems. In order to most efficiently reach this goal, it is necessary to compare the cost-benefit of projects that have a range of objectives and operate at a range of scales. In order to avoid tossing out the baby with the bath-water by rejecting single species recovery proposals on the grounds of narrow benefit, it is necessary to fully account for their value. Benefits accrue not only to the target species, but also to wider species assemblages and in the development of new capability. This paper reviews bird conservation programmes in New Zealand in order to assess their contribution towards conserving all of New Zealand's biodiversity.

☺ ✉ Simon Heemstra. Department of Biological Sciences, University of Wollongong, NSW, Australia. **Bush Fire Patchiness**

Bushfire patches are unburnt islands of vegetation within a fire boundary. Patches are important as refuges for plants and animals during a fire as well being sites for recolonisation and shelter after a fire. An accurate assessment of patchiness can also assist in assessing the effectiveness of prescribed burning. In this project a method for assessing the patchiness of bushfires has been developed. This involves transect assessment of the landscape using GPS. In addition spatial modelling using GIS is used to determine the relative influence of environmental variables allowing maps to be produced that predict the patchiness of a particular fire.



☺ ✉ Meredith Henderson. School of Life Sciences, Victoria University of Technology (St Albans), PO Box 14428, MCMC Melbourne VIC 8001, Australia. **To burn or not to burn – antidotes for biomass accumulation in Western Basalt Plains Grasslands.**

Native grasslands in the west of Victoria need to be actively managed for conservation. Native grasslands of the Western Basalt Plains are typically a mosaic of grass tussocks, inter-tussock spaces and, contained within those spaces, native forbs. The dominant grass species *Themeda triandra* (Kangaroo Grass) is known to outcompete native forbs when regular biomass reduction does not occur. Biomass reduction can be in the form of grazing, burning or slashing. This paper will address the changes in aboveground biomass when burning and slashing occurs. The implications of biomass reduction for conservation management within grassland reserves will also be addressed. Burning and slashing occurred in two of Victoria's largest grassland reserves at different frequencies. Biomass samples were taken to assess the effect of each treatment on the production and type of aboveground biomass occurring within each treatment. Annual burns reduced detrital accumulation of the dominant grass species whilst slashing treatments did not. Productivity of the dominant grass species was different between treatments.

David W. Hilbert, Mike S. Hopkins, Jeroen van den Muyzenberg, and Andrew W. Graham. Co-operative Research Centre for Rainforest Ecology and Management CSIRO Tropical Forest Research Centre, Atherton, Queensland. **Late Pleistocene rainforest distributions of the Australian Wet Tropics - stable and shifting refugia.**

Knowledge of the past distribution and spatial dynamics of vegetation is essential in order to interpret present patterns of vegetation and species richness and to predict the future impacts of climate change. We have used an artificial neural network model of fifteen forest types in the wet tropics region of N. Queensland to estimate the environmental suitability of the landscape for these forest types under four climates representing the extremes experienced in this region from the last glacial maximum to the present. The potential distributions of rainforest types, wet sclerophyll forests, and dry open woodlands shift dramatically in response to regional climate change. Certain landscape locations are occupied by rainforest in only one of the climates while others always remain appropriate for rainforest despite large changes in regional mean annual temperature and precipitation. The implications of these long-term patterns of change for conservation and management of the region are discussed along with hypotheses relating to patterns of biodiversity in the wet tropics landscape.

☺ Hillery, M.J.<sup>1</sup>, Dangerfield, J.M.<sup>2</sup>, Stafford Smith, D.M.<sup>1</sup> and Griffin, G.<sup>1</sup> <sup>1</sup>CSIRO Division of Wildlife and Ecology, Alice Springs, NT. <sup>2</sup>Key Centre for Biodiversity and Bioresources, Macquarie University, North Ryde, NSW 2109. **Urban planning among arid zone mound building termites: where do they build and why?**

Mound building termites do not just live 'anywhere'. In arid Australia termite mound 'citadels' are a prominent feature of the landscape, contrasting with surrounding less populated areas. This pattern is likely to be an important clue to understanding the requirements for persistence of organisms in the arid zone, a landscape characterised by patches of varying resource availability in space and time. Termites are known to be important in the concentration and redistribution of scarce resources like water and nutrients. They provide an opportunity to study the relationship between resource supply and spatial distribution at different scales. At the initial stage of this study we present hypotheses and early results to explain the distribution of mound building termite species in an area of groved mulga woodland in Central Australia. Specifically: (i) that the distribution of the mound building species in the study area are associated with the distribution of perennial grasses; and, (ii) that there is a relationship between the number of intergrove mounds and the distance between groves, with larger intergrove spaces supporting proportionally more mounds.

Dieter F. Hochuli, School of Biological Sciences, Zoology Building A08, The University of Sydney, NSW 2006 Australia. **The nutritional ecology of feeding by larval *Uraba lugens* (Lepidoptera: Noctuidae): Changes in morphology and feeding behaviour with development.**

Larval Lepidoptera exploit many different plants and plant parts and often adopt several different feeding strategies throughout their life cycle. The aim of this study was to investigate the relationship between morphology and feeding behaviour of larval *Uraba lugens* (Lepidoptera: Noctuidae). I observed the feeding behaviour of larval *U. lugens* and related it to how head and mandible morphology changed with growth. The larvae of *U. lugens* skeletonise plant material from the surface of their eucalypt hosts in early instars and bite larger pieces from leaves in later instars. Developmentally related differences in mandibular morphology, gape and maximum bite depth were found and correlated with changes in feeding behaviour. The functional significance of allometric changes in head and mandibular morphology was assessed with respect to the properties of the diet and their potential to limit herbivory. The morphological changes are likely to be related to the mechanical challenges larvae face when consuming plant material in different ways and constrain herbivory by limiting which plant parts can be consumed.



✉ Hodgkinson K. C. ., Müller W. J. CSIRO Wildlife and Ecology and CSIRO Mathematical and Information Sciences, Canberra, ACT. **A drought index for predicting perennial grass survivorship.**

Drought drives important ecological processes including tissue death, plant death and grazing pressure. Indices of drought, based on meteorological measurements alone, lack biological foundations and are difficult to link with management. Grazing pressure on native vegetation in semi-arid lands becomes important for plant survivorship when the biomass ratio between herbivores and edible plants becomes wide. Knowing when adverse vegetation change is likely would assist managers in decision making about sheep, cattle, goat and kangaroo management. In developing an early-warning system for managing perennial grass survival we faced the problem of how to define drought. Mortality of individual plants was determined for 3-month intervals. Drought levels were defined by total rainfall, rainfall/evaporation, and other indices based on these, over the preceding 3 months or longer. Each index was assessed on its ability to explain variation in plant mortality and the nature of its relationship with plant mortality. Rainfall/evaporation was found to be the best index of drought for predicting perennial grass mortality and although rainfall alone was less satisfactory it could be more easily used by managers. Both are now used in the death-trap model developed for predicting perennial grass survival.

☺ Benjamin D Hoffmann<sup>1</sup>. and Anthony D. Griffiths<sup>2</sup>. <sup>1</sup>School of Biological and Environmental Sciences, Northern Territory University, Darwin, NT 0909, Australia. Email: Ben.Hoffmann@terc.csiro.au. Address for correspondence: CSIRO Wildlife and Ecology, Tropical Ecosystems Research Centre, PMB 44 Winnellie NT 0822, Australia. <sup>2</sup>Tropical Savannas CRC CSIRO Wildlife and Ecology, Tropical Ecosystems Research Centre, PMB 44 Winnellie NT 0822, Australia. Email: Tony.Griffiths@terc.csiro.au. **Responses of ant communities to sulphur deposition in northern semi-arid Australia**

The impact of sulphur dioxide emissions on ant community composition and structure was investigated at Mount Isa in semi-arid northern Australia. Ants were surveyed at 40 sites, covering high, medium, low and natural sulphur concentrations. Sites were further divided into two habitat types, rocky ridge and alluvial flat. A total of 174 ant species from 24 genera were identified. Mean species richness per site was highest (32 and 42, 29 and 23) in the controls and lowest in the high sulphur category (25, 13) on both habitat types. Mean abundance per site was lowest (103, 178) in the high sulphur category in both habitat types, and highest (179 and 179) in the controls on rocky ridge and low sulphur category (293) on the alluvial flat. Individual species showed strong patterns to SO<sub>2</sub> concentration. Relative abundances of all ant functional groups were stable and not significantly different between all sulphur categories on both habitat types. Only mean relative richness of Dominant Dolichoderinae and Others proved significantly different across sulphur categories, with both increasing their relative richness with decreasing sulphur concentrations. Ordination analysis clearly separates the high sulphur sites from all others with vector fitting showing SO<sub>2</sub> concentrations as a primary cause.

Richard N Holdaway. Palaecol Research, P.O. Box 16 569, Christchurch, New Zealand. **A model for the extinction of moas (Ayes: Dinornithiformes)**

Fossil evidence shows that all moa species survived until the time of Polynesian settlement at about 1300 AD. Analyses of moa extinction have concentrated on the archaeological evidence, including number of individuals represented in sites and required food value for various human population sizes, and on sustainable cropping rates based on exploitation of modern mammal communities. An alternative approach is to use numerical population models based on life history parameters. Population size for all moa species was calculated from the most recent distribution and body mass data, using carrying capacities based on data for modern ratites. A Leslie Matrix model was applied, after adjusting conservative population parameters to produce long-term population stability, with stochastic variation in the parameters. Crop rates derived from conservative estimates of human population size and consumption levels were applied to moa populations in the Coromandel and Canterbury-Otago areas, and for all New Zealand. Time to extinction for the moa populations are reported and some conclusions drawn on the Archaic period of Polynesian settlement. Application of the model and parameters was tested by running known it with parameters and cropping rates measured in a modern population of long-lived birds for which population data were available.

☺✉Clayson Howell, Dave Kelly and Matthew Turnbull. Department of Plant and Microbial Sciences, University of Canterbury. E-mail [c.howell@botn.canterbury.ac.nz](mailto:c.howell@botn.canterbury.ac.nz). **Photoinhibition in New Zealand's divaricate shrubs.**

Divaricate shrubs are a characteristic and abundant feature of New Zealand's flora. There is debate over whether climate (frost protection) or moa browsing is responsible for the convergent evolution of the divaricate form. This thesis investigates a third hypothesis, cold induced photoinhibition, as a principal factor for this uniquely New Zealand feature. Chlorophyll fluorescence has been used to measure photochemical efficiency (dark adapted Fv/Fm), in three species (*Aristotelia fruticosa*; *Coprosma propinqua* and *Corokia cotoneaster*) at Cass. Photochemical efficiency of internal leaves exposed to the North dropped 22-30% within 14 days, while leaves exposed but artificially shaded and control leaves showed no reduction. These measurements, in conjunction with gas exchange measurements, seem to indicate severe photoinhibition in exposed treatments, despite a comparatively mild winter. The network of interlacing branches thus positions leaves within the volume of the shrub where partial shading provides net benefits, particularly under chilling temperatures. The divaricate habit of these species appears have greatest benefit in minimising the effects of photoinhibition. Shoot architecture measurements, coupled with photosynthetic information, will be utilised to identify other species of divaricating shrubs and divaricate juvenile stages of heteroblastic trees, which are likely to be affected by cold-induced photoinhibition.



Jocelyn Howell and Doug Benson. Royal Botanic Gardens, Mrs Macquaries Road, Sydney, N.S.W. 2000, Australia. **Potential impacts of changes in water flow on riparian vegetation with environmental weeds on a coastal river, south-eastern Australia.**

Remnants of native riparian vegetation on the floodplain of the Hawkesbury-Nepean River in Sydney contain a large component of weeds, placing constraints on the potential for changed water management to improve river health. Potential impacts of alterations in water regimes on exotic and native riparian plant species were assessed. The likely effects of frequency, duration, depth and season of inundation were considered in relation to microhabitat, dispersal season and tolerance to waterlogging for 242 native and 128 exotic species recorded along 215km of the river. Depth and season of inundation appear to be the variables with the greatest potential for differential effects on weeds and native plants. Because of likely spread of propagules and enhancement of growth under the present nutrient-enriched conditions, additional flows of water were judged to be of more benefit to weed species than native species except in two cases. These cases are 1) where habitat for native water-edge plants would be improved by choosing a volume of flow that will maintain continuous low-level flow in the river, rather than resulting in episodic high levels, and 2) the greatest potential advantage to native species relative to weeds could be achieved by restricting higher flows to the season in which a greater proportion of native species than weed species disperse propagules.

L. Hughes. School of Biological Sciences, Macquarie University, NSW 2109, Australia. **Everything you need to know about Australian ecology but...**

What makes Australian ecosystems distinctive? Physically, Australia is old, flat, stable and dry, and as a consequence, a large proportion of Australian soils are coarse and infertile. These soils support a highly endemic flora, characterised by evergreen, woody sclerophyllous species. Many plants display morphological and life history adaptations to recurrent fires, and many plant communities have distinctive suites of pollination and dispersal modes. The evolution of Australia's fauna has been influenced by climatic unpredictability, the long period of human habitation, and the large quantity of relatively indigestible foliage. While the marsupials and monotremes are the animal groups universally recognised as being distinctively Australian, other taxa such as granivorous ants, arid-zone lizards, and nectar-feeding birds, reach levels of diversity in Australia that are unknown elsewhere. This talk will be a selective (and personal) tour of the wonder and weirdness of the Australian environment.

John F. Hunt<sup>1,2</sup> & David L. McNeil<sup>2</sup> <sup>1</sup>Landcare Research, PO Box 69, Lincoln, New Zealand.  
<sup>2</sup>Department of Plant Science, PO Box 84, Lincoln University, New Zealand. **The influence of present-day levels of ultraviolet-B radiation on seedlings of two temperate tree species**

Seedlings of two Southern Hemisphere temperate trees species (mountain beech: *Nothofagus solandri* var. *cliffortioides* (Hook. f.) Poole and broadleaf: *Griselinia littoralis* Raoul ) were grown in the field to determine the effects of present-day levels of ultraviolet-B radiation (UV-B) on growth, biomass, UV-B absorbing compounds, leaf optical properties and photoinhibition. Plants were covered with either UV-B transmitting or UV-B absorbing filters. After 125 days of typical summer weather, total biomass of both species was not affected by the UV-B treatments. Without UV-B, height increased (23%) and the number of leaves produced decreased (-21 %) in beech, but broadleaf was unaffected. Leaves of both species were essentially opaque to the transmission of UV-B. In the absence of UV-B the transmission of photosynthetically active radiation through leaves of both species increased, foliar nitrogen concentrations increased and levels of UV-B absorbing compounds decreased. As leaves of both species aged, midday photoinhibition decreased, with the result that UV-B had no effect on photoinhibition in mature leaves. Results of this experiment show that under present day levels of UV-B the physiology, optical properties and secondary compounds of leaves of both beech and broadleaf seedlings are modified relative to what would be expected if there was no UV-B in the radiation environment

✉ Maria Ignatieva<sup>1</sup> and Colin D. Meurk<sup>2</sup>. <sup>1</sup>Lincoln University, PO Box 84, Lincoln 8152.  
<sup>2</sup>Landcare Research NZ Ltd, PO Box 69, Lincoln 8152. **Urban Plants in New Zealand Ecology**

Urban ecology in New Zealand is in its infancy although several research programmes in Australasia now address this theme. The well-developed European terminology and methodology for describing urban plants and vegetation should be tested in New Zealand. These basic descriptive tools will facilitate systematic and comparative studies and provide the foundation for process orientated research. The goal is to better understand the biotic elements and their functional relationships, thereby improving management of urban biodiversity, sustainability, and ecological integrity. We use degrees of nativeness and adventiveness to compare plant associations in Christchurch and Auckland with those in European cities. There is global homogenisation of urban floras, but also retention of indigenous species, even in highly modified environments. Although we have similar numbers of introduced species to northern temperate countries, the proportion that are naturalised is much greater. Of total introduced plants, <5% are naturalised in Europe, compared to 15% in New Zealand. Here, the indigenous-exotic debate is polarised because of the large impact of alien species, but widespread indifference to this fact. Depiction and interpretation of urban ecosystems is vital if the urban public is to make sense of their predominant experience of the natural world – that is, near their homes.



Craig D. James and Melinda Hillery CSIRO Wildlife & Ecology, PO Box 2111, Alice Springs, NT, 0871, Australia. **Responses of ants to different long-term grazing intensities**

There is widespread concern about the effects of pastoralism on ecosystems in the arid and semi-arid zones of Australia but there is a paucity of data linking the intensity of grazing with changes in faunal assemblages. We report on assemblages of ants from a ten paired sites (fenceline contrasts) in five regions of the semi-arid woodlands of eastern Australia that have experienced different long-term grazing intensities. There was no consistent relationship between the overall abundance of ants or species richness despite the seemingly large differences in the habitats at high and low grazing sites (each side of fence). There were, however, differences in the species composition among sites relating to grazing, presence of behaviourally-dominant ant groups, differences in the habitat (caused by grazing?) and spatial separation of the sites. These results give some indication as to the usefulness of ants as indicators of disturbance from grazing.

Jamieson, I.G. and Ryan, C.J. Dept. of Zoology, University of Otago, PO Box 56, Dunedin, New Zealand. **Island Takahe: Closure of the debate over the merits of translocating Fiordland Takahe to predator-free islands.**

A vigorous debate developed in the 1980's over whether Fiordland Takahe translocated to small, predator-free islands with pasture grasslands would establish self-sustaining populations. The sceptics considered the Takahe to be a specialised tussock feeder that was adapted to breeding in alpine tussock habitat. They therefore believed that Takahe might survive on islands with pasture grasses but would not be able to obtain the proper nutrients for successful breeding. The proponents saw the broad distribution of Takahe in the sub-fossil record as evidence that Takahe once lived and bred in a more diverse range of habitats than that of the present relict population and therefore believed Takahe would prosper in the predator-free environment that offshore islands had to offer. Examining this debate 15 years after the first Takahe were released on Maud Island, we show that both sides were right and wrong in their predictions. Although Takahe were quick to establish and showed high survival rates on all four islands on which they were eventually released, growth in numbers has been slower than expected because of poor breeding success caused by high proportion of infertile eggs and low juvenile production. The exact cause of the poor reproductive success is unknown but may be a result of inbreeding depression brought on by taking individuals from an inbred population that is adapted to a specific type of environment and translocating them to a vastly different environment and habitat. However, despite the poor breeding success island populations have clearly become self-supporting and are a major reason why the overall numbers of takahe have increased over the last 15 years. Thus islands have played a significant role in reversing the decline in numbers and ultimately in reducing the likelihood of Takahe going extinct.

Amy Jansen, Alistar Robertson and Rohan Rowling. School of Science and Technology, Charles Sturt University, PO Box 588 Wagga Wagga NSW 2768. **Developing an index of the condition of floodplain river riparian ecosystems.**

Floodplain rivers of the Murray-Darling Basin in south-eastern Australia have been heavily degraded by water regulation, grazing and the introduction of exotic fish. However, the riparian ecosystems associated with these rivers have been little studied. This project aimed to develop an index of riparian ecosystem condition to rapidly survey large parts of the Murrumbidgee River and to determine the relationship between condition and grazing by domestic stock. We developed a condition index with the following components: (1) Habitat continuity and extent; (2) Vegetation cover and structural complexity; (3) Vegetation biotic integrity; (4) Debris as habitat; (5) Banks and soil; and (6) Indicative species. Unfortunately, there are no sites without a history of grazing. 138 x 1 km sites were surveyed along 600 km of the Murrumbidgee River between Gundagai and Hay. The resulting scores were scaled and totalled to give an overall condition score for each site. Two measures of grazing impact, stocking rates and numbers of cow pats on the river bank, were found to explain high proportions of the variance in condition scores, while other factors such as distance downstream and presence of other watering points also explained significant proportions of the variance. Condition scores were highest in the sites least impacted by grazing.

☺ Mark Jarrett. Ecology and Entomology Group B535A, PO Box 84, Lincoln University, Canterbury, New Zealand. **Lead, zinc, arsenic and organochlorine pesticide toxicity in kea (*Nestor notabilis*) that forage in areas of human occupation.**

Kea (*Nestor notabilis*) scavenge for food at rubbish dumps and villages in alpine areas of the South Island, New Zealand. At these sites they are exposed to toxic materials. The risks that lead, zinc, arsenic and organochlorine pesticides pose to kea in areas of human occupation were investigated. Lead, haematocrit and haemoglobin levels in the blood of 11 live kea that were captured at Halpin Creek dump, Arthur's Pass in 1997, were analysed. Eight had raised blood-lead levels, the two highest of which were considered toxic for parrots. Raised blood-lead levels were associated with reduced haematocrit and haemoglobin levels. Lead, zinc and arsenic levels in kea livers (N=16), and organochlorine pesticide residues from kea fat (N=12) were analysed for individuals that had been found dead at seven sites. Three had liver-lead levels that were three to five times higher than that which is considered toxic for birds and two had gross pathological changes attributed to lead poisoning. Five kea had raised zinc levels, but no evidence of arsenic or organochlorine pesticide toxicity existed. These findings suggest that ingestion of lead is fatal for some kea and has subclinical effects on others, and that zinc poisoning may also have an impact on this species.



☺ Ji, W.<sup>1</sup>, M.N. Clout<sup>1</sup> and S. Sarre<sup>2</sup>. <sup>1</sup>University of Auckland, Auckland, New Zealand  
<sup>2</sup>Massey University, Palmerston North, New Zealand. **Effects of female sterilisation on body condition and sex ratio in two possum populations**

Sexually transmitted immunocontraception causing female sterility has been considered as a possible method to reduce possum populations in New Zealand. To mimic the effects of such biocontrol, we surgically sterilised females in two possum populations and monitored the effects on body condition and sex ratio. Body condition of females showed no change after sterilisation, either during the autumn mating season or in the winter post-mating period. The body condition of males, although unaffected in the autumn mating season, was significantly poorer in the presence of sterilised females in the winter post-mating period after the treatment. More male possums were recorded after the sterilisation, resulting in a change to the originally female biased sex ratio. Implications of these results for possum management are discussed.

☺✉ Anne Jul<sup>1</sup> and Mike Hilton<sup>2</sup> <sup>1</sup>Postgraduate Diploma in Wildlife Management, Department of Zoology, University of Otago, P. O. Box 56, Dunedin, New Zealand.  
<sup>2</sup>Department of Geography, University of Otago, Dunedin. **Invasion patterns of marram grass (*Ammophila arenaria*), Mason Bay, Stewart Island, New Zealand**

Marram grass (*Ammophila arenaria*) was deliberately introduced to New Zealand early this century to stabilise sand dunes. It has since spread naturally and has largely replaced the native sand binding plants throughout New Zealand. Mason Bay, Stewart Island is one of the largest and least modified dune systems in New Zealand. It contains a number of localised or rare plants, including *Gunnera hamiltonii* and *Euphorbia glauca*. Marram was first planted in Mason Bay in the 1930s and now covers the foredune and adjacent areas. Pingao (*Desmoschoenus spiralis*) and sand tussock (*Poa triodioides*) are, however, still common further inland. The rate of marram grass invasion in Mason Bay has been determined by interpretation of aerial photographs. Maps of marram cover, land form, patterns of sedimentation and plant communities have been produced using a GIS. A conceptual model of marram invasion has been developed. Invasion is closely linked to landform evolution and is most vigorous in areas of recent sand deposition. For example, marram invasion is occurring rapidly in the depositional lobes of parabolic dunes. We evaluate several marram control strategies based on our interpretation of the rate and pattern of marram invasion. Without active management marram will continue to invade the Mason Bay dunefield with significant loss of natural character.

☺✉Kattel, G. R. and Closs, G. P. Department of Zoology, University of Otago, P.O.Box 56, Dunedin, New Zealand. **Seasonal and diel variation in distribution, species richness and abundance of pelagic fish in Lake Waihola, South Island, New Zealand.**

Diel variation in the abundance of pelagic fish was studied in a shallow New Zealand, South Island coastal lake (<2m deep). Sampling was conducted using a front mounted 66 by 61cm push net with a 2mm inner fine mesh liner and 7mm outer main mesh along ten, 50 metre sampling runs. Sampling runs were conducted at a speed of 1ms-1. A total of seven species (common bully, perch, smelt, inanga, short finned eel, yellow eyed mullet and lamprey) were collected, with significantly ( $p^2$  0.0001) greater abundances of fish present at night. Maximum numbers of fish were collected during the third week of May at night and in the first week of March during the day. The fish community was dominated by juvenile common bullies (*Gobiomorphus cotidianus*) with an average of 7.33 fish per sample being collected. A number of European perch (*Perca fluviatilis*), smelt (*Retropinna retropinna*) and inanga (*Galaxias maculatus*) were also collected in a few sampling runs in the summer nights with average catches of 0.87, 0.11 and 0.18 fish per run respectively. Species diversity was highest in February with a total of five fish species being collected. Our results suggest that shallow eutrophic coastal lakes in New Zealand support an abundant pelagic fish fauna. These fish undergo marked diel and seasonal changes in abundance due to local changes in environmental factors such as tidal inflow, depth, macrophyte density and food (e.g. European perch) and larger scale migrations (e.g. inanga and possibly smelt).

David Keith. NSW National Parks and Wildlife Service, Hurstville, NSW. **Integrating explicit modelling procedures with expert knowledge in vegetation mapping for conservation.**

Distributional maps of species and assemblages of species are fundamental tools for planning and management in natural areas. There are two contrasting approaches to the preparation of such maps. The traditional approach is based on the subjective interpretation of remote data, such as aerial photographs, using past experience and qualitative field reconnaissance. The alternative approach applies mathematical models to spatial data layers to interpolate distributions from point samples. Both approaches have their strengths and weaknesses. The traditional intuitive approach lacks repeatability and may reflect personal biases of interpreters. Mathematical models reduce subjective biases but their outputs are sensitive to insufficient, poorly stratified or poor quality data, which may lead to intuitively obvious mapping errors. A new hybrid mapping approach described here aims to capture the strengths of both alternatives by incorporating expert knowledge explicitly into a model framework. The approach was implemented in a decision tree model, ALBERO, which was applied to map vegetation in south-eastern NSW. The software presents users with alternative model solutions that are consistent with patterns in formal sample data. Expert intervention is allowed during several stages of the modelling process, and may override a statistically feasible model options if reliable qualitative information indicates artefacts caused by deficiencies in the quantity, quality or coverage of the formal data.



☺ ✉ Brendan Kelaher. Marine Ecology Laboratories A11, University of Sydney, NSW, 2006. Email [bkelaher@bio.usyd.edu.au](mailto:bkelaher@bio.usyd.edu.au) **Experimental methods for investigating spatial variation among faunal assemblages in mats of coralline algae on temperate rocky shores.**

Mats of coralline algae are common in low- and midshore areas on temperate rocky shores. The dense algal fronds within coralline mats provide habitat for a variety of animals. In New South Wales, there is a diverse assemblage of invertebrates that are larger than 500  $\mu$ m in coralline mats. This includes more than 150 taxa from 12 different Phyla. Investigations have shown that there is a difference in the faunal assemblage in coralline mats between low- and midshore areas. There are many possible explanations for this pattern (e.g. difference in the morphology of algae or in the amount of sediment or epiphytes between low- and midshore areas). Designing experiments to determine which combination of physical factors or biological processes are responsible for these differences will require being able to manipulate live mats of coralline algae with and without the faunal assemblage. In this study, methods for manipulating coralline mats and the associated faunal assemblages have been evaluated experimentally. Hypotheses were tested to determine (a) the re-colonisation time of coralline mats that were defaunated, (b) the most appropriate size of core for transplanting live mats of coralline algae, and (c) if the faunal assemblages at the edges of transplanted cores are different from the centre. The results of these experiments have provided a basis for investigating experimentally the physical factors or biological processes which determine the spatial variation in the faunal assemblage in mats of coralline algae at different height on the shore.

Dave Kelly. Plant and Microbial Sciences, University of Canterbury, Christchurch 8001, New Zealand. Email [d.kelly@botn.canterbury.ac.nz](mailto:d.kelly@botn.canterbury.ac.nz). **New Zealand: not so stable, not so feeble, not so simple**

Four well known features characteristic of New Zealand ecosystems are: (1) stable, equable, mesic, oceanic climates; (2) many species-poor communities, with generalist native species; (3) relatively large numbers of established introduced species; and (4) major declines in native species due to the impact of exotic predators (especially mammals). Recent work has given much more detail and a few surprises on these themes, including (1) important climatic and biological variation driven by forces like El Nino and Pinatubo; (2) the reliance of many introduced species on human disturbance; and (3) evaluation of the relative importance of exotic carnivores and herbivores in disrupting native ecosystems. These themes will be illustrated from an unashamedly South Island viewpoint, largely using examples from *Nothofagus* forest ecosystems.

D. Kelly, Plant and Microbial Sciences, University of Canterbury, Christchurch 8001, New Zealand. Email [d.kelly@botn.canterbury.ac.nz](mailto:d.kelly@botn.canterbury.ac.nz) **Dispersal doesn't matter: the relative importance of pollination and dispersal mutualisms.**

Plant-animal mutualisms include pollen transfer and seed dispersal. The relative importance of both to plant populations has rarely been evaluated. On theoretical grounds at least four factors suggest that pollination will be much more likely to negatively affect plants. Pollination generally requires larger numbers of visits, is compressed into a shorter period of time at a site, and has a narrower period during which the flower must be visited, compared to dispersal of fruits. Moreover, very few plants have an absolute need for disperser treatment of seeds. The only factor which makes pollination less sensitive to disruption than dispersal is that exotic invertebrates such as honey bees may replace some native pollinators, whereas dispersal is largely dependent on vertebrates. Therefore dispersal is predicted to be relatively unimportant for plant populations, compared to pollination and herbivory of adult plants. These predictions are tested with *Peraxilla tetrapetala* and *Alepis flavida* (Loranthaceae) at Craigieburn, South Island, NZ, where pollen limitation is known to occur.

✉ Scott A. King and Rod T. Buckney. Department of Environmental Sciences, University of Technology, Sydney. PO Box 123, Broadway, NSW 2007, Australia.  
**Urbanisation and Aquatic Plants in Sydney Streams**

The aquatic plants and sediment of urban and undisturbed streams in the northern Sydney region were compared to determine possible effects of urbanisation on stream macrophytes. Many sediment characteristics were significantly different in urban streams. At least one exotic species was found in each urban stream sampled, but no exotics were found in the undisturbed streams. Many of the native species in urban streams were typical of streams in areas of naturally higher sediment nutrient content. The aquatic plant communities were related to the sediment characteristics using the constrained ordination technique Canonical Correspondence Analysis (CCA). The differences between the aquatic plant communities in the urban and undisturbed streams sampled were suggested as being related to the increasing level of nutrients in the urban stream sediment. Several multivariate techniques were used to assess the relative importance of the different nutrients measured. No individual nutrient was directly responsible for the observed communities. The general increase of nutrients, and the influence of increasing pH on the availability of these nutrients in urban stream sediment, is suggested as enhancing exotic invasion and the alteration of the native aquatic plant communities in Sydney streams.



Warren McG King and G.M. Millar. CRC for Weed Management Systems, NSW Agriculture, Orange Agricultural Institute, Orange, NSW 2800, Australia. **Vegetation-environment relations in a naturalised perennial pasture community: the pattern of invasion by winter-annual grass weeds.**

A survey of the vegetation and physical environment of a 60 hectare paddock near Carcoar, on the Central Tablelands of New South Wales, was conducted in summer and the results visualised and interpreted using Geographic Information System (GIS) software. The strong effect of topography and soil fertility on the vegetation was revealed. For example, the pasture community present at higher elevations tended to contain far fewer species - presumably a response to reduced water availability and lower soil pH and P. At each sample point, soil cores were also taken and grown out until the following spring to quantify the occurrence of annual grass weeds present in the seedbank. Two of most important annual grass weeds in this pasture are vulpia (*V. bromoides*) and barley grass (*Hordeum leporinum*). Whereas vulpia was widely distributed and only weakly correlated with perennial pasture components, barley grass! was patchily distributed and positively correlated with pasture species characteristic of higher fertility sites (e.g. *Lolium perenne*). The implications of these patterns for the ongoing management of this pasture are discussed.

☺ L.J. Kuchel Department of Zoology, University of Queensland, Brisbane, Qld, 4072.  
**Cold, gluttony and a touch of debauchery: why do echidnas hibernate?**

Mammalian hibernation is traditionally considered to be a response to cold or reduced food availability. Hibernation in the short-beaked echidna (*Tachyglossus aculeatus*) appears not to conform to either of these theories. The echidna is found in a wide range of climatic zones, from deserts to alpine areas. Hibernation in echidnas begins around March-May, and ends either in July-August (the coldest time of year) or around October for non-breeding individuals. Thus echidnas do not hibernate strictly to avoid the cold. Moreover, echidnas that are active throughout the winter are shown to maintain body mass. Why then do echidnas hibernate? Is it to do with energy savings to remain in prime condition for the breeding season? Perhaps it is an ancestral trait? Or is it just because they are plain lazy? In the first study to investigate the energetic significance of hibernation and torpor in detail in a mammal in the field, heart rate telemetry was used to monitor the metabolic rate of echidnas at various times throughout the year. Preliminary telemetric data and field observations on behaviour will be presented and discussed in the above context.

✉ Jenny J. Ladley<sup>1</sup>, Dave Kelly<sup>1</sup>, and Alastair W. Robertson<sup>2</sup>. <sup>1</sup>Plant and Microbial Sciences, University of Canterbury, Christchurch 8001, New Zealand. <sup>2</sup>Ecology Dept, Massey University, Palmerston North, New Zealand. **Forest fragmentation suits declining New Zealand mistletoes.**

New Zealand's six endemic species of Loranthaceous mistletoe have all declined since European settlement 150 years ago. The declines had been attributed largely to forest clearance and herbivory by introduced Australian brushtail possums. Recent work shows that pollination and dispersal mutualisms are also important in *Peraxilla tetrapetala* and *P. colensoi*. Native honeyeaters (Meliphagidae) have declined so that *P. tetrapetala* is strongly pollen-limited at some sites. Another factor limiting reproduction is a native lepidopteran, *Zelleria maculata*, which destroys >80% of flower buds in some places. Here we report that flower predation, pollination, fruit set and plant growth all vary with the degree of forest fragmentation. Flower predation is highest in continuous forest and lowest on isolated trees. Bird pollination service is lowest in forest, and highest on isolated trees. Fruit set is therefore lowest in intact forest and highest on edges near larger forest areas. Adult mistletoe density and flowering effort are all higher on edge hosts. Therefore *P. tetrapetala* seems to benefit by a degree of fragmentation, as long as enough forest habitat is preserved to maintain bird densities. The benefits of fragmentation may partially offset declines from habitat loss and introduced herbivores.

C. Lalas, C. Olympia, H. Ratz, S. McConkey, B. Templeton, D. McKay. Author for correspondence: Hilrun Ratz, Box 31, Portobello, Dunedin, New Zealand. Email: [penguin@deepsouth.co.nz](mailto:penguin@deepsouth.co.nz). **When the threatened threaten the threatened: interactions between Yellow-eyed Penguins and otariid seals at Otago Peninsula**

Yellow-eyed Penguins (*Megadyptes antipodes*) at Otago Peninsula are regarded as regionally threatened and are the subject of a major conservation management project. New Zealand sea lions (*Phocarctos hookeri*), a threatened species, and New Zealand fur seals (*Arctocephalus forsteri*) are re-colonising Otago Peninsula after an absence of at least 200 years. Through the combination of a structured study and anecdotal accounts we aimed to deduce if the viability of Yellow-eyed Penguins at Otago Peninsula is threatened by increases in numbers of sea lions and fur seals. Yellow-eyed Penguins ashore can distinguish between these two species. They can habituate to the proximity of fur seals and no detrimental interactions have been recorded. In contrast, sea lions have killed Yellow-eyed Penguins ashore for the first time recently. Patterns of departure to sea and arrival ashore by the penguins were disrupted by the presence of sea lions within 50 m of a penguin landing site. However, this avoidance behaviour was not consistent. Nest numbers have increased at the penguin colony abutting the main sea lion haul-out site at Otago Peninsula indicating that the proximity of sea lions has not been a negative influence on breeding site selection by penguins. Also, penguins have moulted successfully in close proximity to sea lions. We suspect that the kills were attributable to atypical behaviour by one or two sea lions.



Jill Landsberg<sup>1</sup>, Sandra Lavorel<sup>2</sup> and Jacqui Stol<sup>1</sup> <sup>1</sup>CSIRO Wildlife arid Ecology, PO Box 84, Lyneham, ACT 2602, Australia; <sup>2</sup>CNRS, 34293 Montpellier, Cedex 5, France. **Classifying rangeland plants into functional types indicating response to grazing**

We analysed attributes of the understorey flora along grazing gradients in arid rangelands in south-west Queensland, Australia, to determine the impact of grazing on the composition of life-forms and species characteristics in two different vegetation communities. This was part of a GCTE task involving coordinated studies in Europe, North America and Australia. The general aim of the task is to classify species into functional types for predicting regional or global patterns of response to disturbance. Our specific aim in this study was to identify “grazing response types” characterised by attribute syndromes indicative of different levels of grazing. We found that grazing interacted with type of vegetation patch (woody or open) in its influence on species composition, life-forms and attributes. Heavy grazing was associated with loss in differentiation of species composition between patches, rather than loss in numbers of species overall. Grazing resistance was variously associated with small plant size, prostrate habit, low meristems, small leaves, coated leaves, high regrowth potential, plasticity, and high fecundity; and grazing sensitivity with opposing attributes. However, attributes tended to vary independently of each other and attribute syndromes were too diffuse for defining distinctive grazing response types.

☺ ✉ Gail Langley. School of Environmental Management, University of South Australia, Mawson Lakes, SA 5095. **What ecological variables determine the distribution of *Maireana suaedifolia* on Eyre Peninsula, South Australia?**

A rare plant species survey was conducted in the South Middleback and Cook Ranges, Eyre Peninsula, South Australia. The endangered species, *Maireana suaedifolia*, (lax bluebush, Chenopodiaceae), was found in a diverse range of vegetation types and environments within the region. This species was found to be much more common locally than previous records suggest which may be due to its inconspicuous appearance rather than true rarity.

☺ T. M. Launonen, D.H. Ashton and P.J. Keane. Department of Botany, La Trobe University, Bundoora, 3083 Victoria, Australia. **The effect of regeneration burns on the growth, nutrient acquisition and mycorrhizae of *Eucalyptus regnans* F. Muell. (mountain ash) seedlings**

The regeneration of *E. regnans* forests in Australia is dependent on major disturbance, such as fire. The changes in soil microflora caused by heating may contribute to the stimulation of seedling growth after regeneration burns. This study was designed to separate direct nutrient effects from biological effects. In two experiments, *E. regnans* seedlings were grown either in differentially heated soil (red burnt, black burnt and unburnt) collected from logging coupes and adjacent forests or in sterilised soil/gravel mix inoculated with the mycorrhizal roots of the seedlings grown in heated soils. The seedling dry weight, phosphorus, zinc, iron and nitrogen content, mycorrhizae and root ergosterol concentration were determined. The soils were analyzed for extractable phosphorus. The seedling growth and phosphorus acquisition were enhanced in all black burnt soils compared with unburnt controls. Root ergosterol concentration was promoted only in seedlings grown in black burnt soils which had relatively low levels of soil phosphorus. Also the root inocula from these black burnt soils stimulated seedling growth. The ectomycorrhizae were morphologically different in differentially heated soils. These results suggest that both biological and direct nutrient effects may contribute to seedling growth promotion after regeneration burns.

J. R. Leathwick<sup>1</sup> and D. Whitehead<sup>2</sup>. <sup>1</sup>Landcare Research NZ, PB 3127, Hamilton, New Zealand. <sup>2</sup>Landcare Research NZ, P O Box 69, Lincoln 8152, Canterbury, New Zealand. **The role of soil and atmospheric moisture deficits in determining forest pattern in New Zealand.**

Regression analyses have been used with an extensive historic dataset of c. 15 000 plots to determine the relative correlation between the distributions of New Zealand's major forest tree species and a comprehensive range of environmental predictors. Initially, models incorporating temperature, solar radiation, soil water balance, and geological substrate failed to predict the distributions of many species adequately. Addition of data describing vapour pressure deficits substantially improved the predictions. Additional compositional data was then collected from lowland forest remnants east of New Zealand's main mountain ranges to test the relative importance of soil and atmospheric water deficits in determining forest pattern. Analyses of the extended data set show very strong correlations between December vapour pressure deficit and the distributions of many species. The physiological mechanisms by which atmospheric water deficits might influence tree distributions will be considered. Results will be used for a range of applications, including reconstruction of pre-human forest patterns, and prediction of potential impacts of changing environmental conditions on forest pattern.



✉ J. R. Leathwick, and J. McC., Overton. Landcare Research New Zealand, PB 3127, Hamilton, New Zealand. **Environmental domains for New Zealand**

With increasing recognition of the importance of ecosystems in conservation and environmental management comes the need for an ecosystem classification of New Zealand. One approach is to use current distributional data (e.g., vegetation cover), but data for many taxa is limited. In addition, the resulting classification is static – it indicates only current ecosystems and lacks any predictive capability. An alternative, widely used in other countries, is classification of relevant environmental predictors to form environmental domains, i.e., regions of similar environment. These can be expected to have similar ecosystem character because of the generally strong correlations between environment and the distributions of biota. We are using analyses of data describing the distributions of species drawn from various taxonomic groups to identify those environmental factors which are most important in determining species distributions. In a trial classification at a national scale we have used an automatic classification procedure with factors strongly correlated with the distributions of canopy tree species. This classification differs from the Ecological Regions and Districts classification in that areas may be placed together in domains, even though they are geographically separated.

William G. Lee. Landcare Research, Private Bag 1930, Dunedin, New Zealand. **Fifty years of takahe conservation research and management: what have we learnt?**

The rediscovery of the takahe in the Murchison Mountains, Fiordland, in 1948 is one of the major ornithological highlights of this century. The finding of a small population of takahe initiated probably the most extensive and long-term research and conservation efforts undertaken for any indigenous species, and could now be viewed as an early example of adaptive management. Research on the takahe has contributed to our understanding of some of the major themes in New Zealand avian ecology, namely herbivory, flightlessness, and size. Although restricted to a protected area, intensive manipulations of the threatened species have been required to conserve the Fiordland population, and establish founder populations on predator-free islands elsewhere. Conservation management efforts have involved control of mammalian competitors, limited predator control, egg manipulation, artificial incubation of eggs, captive-rearing and reintroduction of takahe to Fiordland, and transfers of birds to islands. Controversial issues in the history of takahe conservation include the causal mechanisms of prehuman and post-1948 population decline, the potential versus realized niche of the species, prioritization of management options, pragmatic versus empirical approaches to management, and the impacts of research. Nowadays, although the possible extinction of takahe as a species has been greatly reduced, there remain major challenges to ensure the conservation of viable populations on the mainland and on offshore islands.

✉ A. Lehmann, J. Leathwick and J. McC. Overton. Landcare NZ Ltd, Hamilton, New Zealand. **Environmental determinants of fern species distributions in New Zealand**

We analysed the distributions of a number of fern species with respect to climatic and substrate variables. Fern distributions were determined from NIVS and NFS survey data, including ca. 21000 plots in forests across New Zealand. Climatic variables were predicted from surfaces fitted to meteorological station data, and substrate information was obtained from the NZLRI database. Generalized additive and generalized linear regression models were used to establish the relationship between the presence/absence of fern species and the environmental variables. These models were then used to predict the potential spatial distribution of the species across New Zealand. The potential application of this method to other taxa and variables of interest will be discussed.

Michelle Leishman. School of Biological Sciences, Macquarie University NSW 2109, Australia. **How much variation in plant traits is captured by the LHS plant ecology strategy scheme?**

There is considerable interest in the development of plant ecology strategy schemes that permit any species worldwide to be placed in context with any other species in a quantifiable 'strategy space'. The development of a scheme that is generally accepted would have several practical benefits: it would enable species to be classified into 'functional types' that are required for modelling vegetation dynamics under global change; and it would allow meta-analysis and synthesis of the results of large numbers of experiments. Recently a leaf-height-seed (LHS) plant ecology strategy scheme has been developed. The scheme has three axes represented by the terms leaf, height and seed. These refer to (1) specific leaf area SLA, (2) height of the plant's canopy at maturity, and (3) seed mass. In this study we examined the predictive power of each of the three attributes SLA, height and seed mass, with respect to a broad range of other plant attributes. The consistency of the predictive power of the three attributes was assessed using four quite different floras: Sydney woodland, western New South Wales shrubland, the flora of Sheffield, and shrubland and woodland of central-western Argentina.

✉ James Lennon, Graham Hickling and Adrian Paterson; Ecology and Entomology Group; Soils, Plant and Ecological Sciences Division, Lincoln University, PO Box 84, Lincoln, New Zealand. (PatersoA@Lincoln.ac.nz) **Does moonlight intensity and phase affect feeding patterns of brushtail possums?**

Moonlight may have three affects on a nocturnal species; activity may decrease as a response to higher predation risk, activity may increase as visual conditions are improved, or there may be no affect. The relationship between phase and intensity of moonlight and feeding patterns of brushtail possums was examined over a three month period in forest/farmland habitat in Prices Valley, Banks Peninsula. Feeding behaviour on non-toxic bait was measured at two feeders on pasture-edge and in forest, using video and infrared trail monitors. Bait consumption was found to be unaffected by rainfall, temperature and within-night variation in moonlight intensity. Bait consumption decreased at both sites on full moon nights (by 33% at the forest site and 13% at the pasture-edge site) compared to new moon nights, and was significantly correlated with moon phase.



☺ ✉ M. Lettink<sup>1</sup>, Jamieson, I.<sup>1</sup>, and Lambert, D.M.<sup>2</sup> <sup>1</sup>Dept. of Zoology, University of Otago, PO Box 56, Dunedin, New Zealand. <sup>2</sup>Dept. of Ecology, Massey University, Palmerston North, New Zealand. **Are island takahe (genetically) monogamous? A DNA fingerprinting analysis**

The takahe (*Porphyrio mantelli*) is an endangered flightless rail endemic to New Zealand. At present, approximately two hundred takahe persist between the remnant wild population in the Murchison Mountains, four off-shore islands, and the captive rearing unit at Burwood Bush. Island populations are characterised by low fertility rates, poor hatching success, and high juvenile mortality. To date, no single cause has been pinpointed. A number of factors have been implicated, including habitat/nutritional deficits and potential effects of inbreeding. Island takahe are assumed to be genetically monogamous, i.e. do not engage in extra-pair fertilisation (EPF). In order to test this assumption, a DNA fingerprinting analysis was performed on eleven takahe families. EPFs among island takahe would result in reduced genetic variance of the resulting offspring. This could potentially exacerbate existing infertility problems through increased inbreeding. The results from this study are discussed and will aid future conservation management of island takahe.

Alan Lill, Margaret Stanley, Susan Giles and Elizabeth Smallwood. Department of Biological Sciences, Monash University, Clayton, Victoria 3168, Australia. **The basis of fruit choice by captive Silvereyes (*Zosterops lateralis*)**

Many plants produce sugar-rich, fleshy fruits which are thought to aid dispersal by attracting frugivores which transport the seeds to potential germination sites. Silvereyes are significant consumers of fleshy fruits in Australia and New Zealand and therefore potentially important seed dispersal agents for many native and exotic plant species. We conducted experiments on wild-caught, captive birds in which they were presented with choices between real or artificial fruits varying in a number of parameters that could potentially influence fruit selection. Captive silvereyes tended to prefer red to either white or yellow fruits and preference was enhanced by colour contrast with the background. Green artificial fruits, which may mimic the colour of many unripe fruits in nature, were not strongly rejected. Silvereyes also responded positively to the size, relative abundance, sugar concentration and accessibility of fruits. These results, in combination with field observations of fruit-eating by silvereyes and other coexisting birds, should help us to understand how the mutualism between fleshy-fruited plants and frugivorous birds operates.

☺ Wayne L. Linklater. Ecology Group, Institute of Natural Resources, Massey University, Private Bag 11-222, Palmerston North, New Zealand. **Publishing trends in the New Zealand and Australian Journals of Ecology compared.**

Publishing trends in the New Zealand and Australian Journals' of Ecology (NZJE and AJE) were compared (1953-97) and publishing by contemporary (1997) Australasian authors examined from mid-1995 to 1998. The AJE consistently contained a high proportion ( $\approx 80\%$ ) of papers in which the fundamental biology of native species was examined. In contrast, the NZJE gradually increased the proportion of papers in which the environmental impacts of exotic species and eradication technologies were examined (10%, 1953-57 to 52%, 1993-97) and reduced the proportion of manuscripts investigating the fundamental biology of native species (64%, 1953-57 to 30%, 1993-97). The number of manuscripts in these categories published in both journals was significantly different from the number of manuscripts contemporary authors from each country published but in opposite directions. Therefore, different trends in the journals were not due to differences between NZ and Australia in the numbers of manuscripts produced but rather to editorial preferences and/or journal submission bias by authors. The NZJE has gradually become more specialised but now under-represents manuscripts on the fundamental biology of native NZ species, 69% of which are now published internationally. Analyses comparing the source of manuscripts and international versus local publishing rates are also presented. Future implications are discussed.

B.D. Lloyd<sup>1</sup> and S.M. McQueen<sup>2</sup> <sup>1</sup>Science & Research, Dept. of Conservation, P.O. Box 10420, Wellington. <sup>2</sup>Otago Conservancy, Dept. of Conservation, P.O. Box 5244, Dunedin. **Evaluating the Impact of 1080 Operations on Short-tailed Bats**

The impact of an aerial 1080 operation on a population of short-tailed bats *Mystacina tuberculata* inhabiting Rangataua Forest, central North Island, was evaluated using several methods. High variability in bat activity levels during winter made it impossible to measure population changes at the time of the 1080 operation. Population levels were therefore monitored during the summers before and after the operation. Minimum population estimates were obtained by counting evening departures from colonial roosts. Activity levels were measured with automatic bat-detectors. There was no indication of a population decline. The impact of the 1080 operation was also monitored directly during the 10 days following the operation by catching 269 bats as they arrived at a roost after foraging, and holding them for 48 hours. None of the bats displayed any symptoms of 1080 intoxication, but the technique's sensitivity has not been resolved. Short-tailed bat's diet includes many arthropods which feed on pollard baits. The LD<sub>50</sub> can be ingested in  $<0.3$  g of arthropods containing the 1080 concentrations (58.43  $\mu\text{g/g}$ ) reported by McQueen & Lloyd (1998). It seems probable that, although there was no measurable impact on the bat population, the species may be vulnerable to secondary poisoning after 1080 operations.



© Lloyd, K.M.<sup>1</sup>, Wilson, J.B.<sup>1</sup> and Lee, W.G.<sup>2</sup> <sup>1</sup>Botany Department, University of Otago, PO Box 56, Dunedin. <sup>2</sup> Landcare Research, PO Box 1930, Dunedin. **How do rare plants differ? A study of the comparative ecology of rare and common *Acaena* and *Chionochloa* species.**

The causes and consequences of being rare may result in rare plant species possessing characteristics that are quite different from those associated with common species. Commonly the study of rarity takes a single-species approach, however this approach is poorly suited to recognising any such differences. A particular need has been identified for comparative studies involving larger numbers of both rare and common species. This paper reports on a comparative ecological study of several rare and common *Acaena* and *Chionochloa* species. The results of experiments examining these species for differences in reproductive and dispersal traits, and responses to competition and environmental stress factors, are presented.

© Mona A. Loofs. School of Geography and Environmental Studies, University of Tasmania, GPO Box 252-78, Hobart TAS 7001. **Effects of sewage irrigation in a Tasmanian heath**

Many areas of heathland in Tasmania are subject to land clearing, fragmentation and an increase in edge effects. Edge effects are defined as disturbances that are likely to occur at the boundaries between heath and human land use (urban or agricultural). One such disturbance is the application, by the local council, of nutrient-rich wastewater in heathy woodland on the east coast of Tasmania. Wastewater from the Stieglitz Sewage Treatment Ponds was spread by an irrigator over the period August-October 1996. Two species (one native tree and one exotic grass) were planted by the council to ameliorate the effect of the increased nutrients. The current study was designed to monitor the effect on the plant community of the irrigation and planted species. Ten 5 m x 5 m quadrats were placed in the irrigated area and 20 were placed outside the irrigation spray-drift zone. Irrigated and non-irrigated quadrats were matched to 70% similarity using species composition, resulting in 10 matched pairs. The quadrats were analysed for differences in species composition, and relative percentages of bare ground, live cover and dead cover. The results of the effect of irrigation on these variables is discussed.

Thomas E. Martin. Montana Cooperative Wildlife Research Unit, University of Montana, Missoula, MT, USA. **Alternative perspectives in life history evolution in birds: David Lack and north temperate biases led us astray.**

Inverse relationships between fecundity and survival, as well as between clutch sizes and numbers of broods, represent fundamental axes of evolved variation in life histories and species vary in their position along these trade-off functions. Food has long been thought to play the most important role in shaping this variation following the insights of David Lack. However, while food (energy) constraints may create these trade-off axes, position of species along these axes (e.g. high fecundity/low survival vs low fecundity/high survival) represent differing solutions to allocating limited energy. Past tests have tried to examine microevolution based on intraspecific experiments, but such approaches often may not test what investigators think they are testing; such tests may not reflect evolutionary pathways and I will suggest an alternative experimental approach. A simple graphical model illustrates why food is unlikely to explain the major axis of evolved variation among species in allocation decisions along trade-off functions. Comparative analyses provide support for this graphical model and argues against food as a major influence on evolution of life history differences among species. Instead predation may have played a more important role in creating variation in life history tactics among species than has been recognized. Each environmental factor, however, acts through mechanistic pathways (e.g. behavior, physiology), and future work needs to examine these pathways in more detail. Past theory has largely been derived from north temperate, especially European perspectives, when 80% of the birds derive from tropical and southern hemisphere origins where selective forces may differ. I will discuss why we have had this focus and how it has shaped much thinking and then briefly discuss alternative hypotheses and mechanistic pathways. Paternal care decisions represents a mechanistic pathway that underlies fundamental trade-offs and embodies many of the environmental and physiological constraints on life history evolution; parents face a trade-off between caring for themselves versus their young (survival vs reproduction) and allocation decisions can be strongly influenced by both food and predation constraints. A simple cost/benefit model based on Skutch's (1949) original argument linking predation risk to reproductive investment leads to simple predictions that can be tested in the field and that could increase our understanding of the evolution of life histories in both north temperate and south temperate/tropical systems. Both comparative and field data will be presented to demonstrate and test some of these ideas, including preliminary results of comparisons between phylogenetically and ecologically matched species in north temperate (North America) and south temperate (Argentina, South America) that may provide some insight into theories for Australia and New Zealand.



J.M. Maxwell. Te Anau Area Office, Department of Conservation, P.O. Box 29, Te Anau, New Zealand. **Fiordland Takahe Population -Trends, Dynamics and Problems**

In 1982 the takahe population was considered critically endangered, having dropped by 39% in nine years. Competition with red deer for food in the alpine grasslands was cited as an important factor influencing the population. A conservation management plan for the species (Mills et al. 1982) was followed by the current Takahe Recovery Plan (Crouchley 1994). Deer control was continued, along with introduction of direct management of breeding pairs. This included brood reduction, by cross fostering of viable eggs to pairs with non-viable eggs, also removal of eggs for captive rearing and reintroduction to the wild. Captive rearing was intended to boost recruitment, bypassing the risky first year of life in the wild. Some captive reared individuals have been translocated to predator free island reserves and there has been substantial growth in the total takahe population due to establishment of these populations. Sixteen years on, the Fiordland population decline has been halted. Since 1981 the adult population has fluctuated about a mean of 117. By the early 1980's culling had substantially reduced deer numbers. If red deer were the major cause of recent decline we might have expected increase in the takahe population since then. Possible reasons for lack of increase are that i) habitat recovery has not yet gone far enough, ii) severe environmental conditions during the 1990's have influenced the population, iii) other management actions have affected the population or some combination of the above. These factors and takahe population features are discussed.

✉ Matt McGlone and John Hunt, Landcare Research, PO Box 69, Lincoln. **Origin of unusual growth forms of *Metrosideros umbellata* on Auckland Island**

The interior of the rata (*Metrosideros umbellata*) forests of the Auckland Islands presents a chaotic spectacle of gnarled, leaning trunks and twisted branches. Massive branches twist, dip and wind for metres. Trunks may rise a short distance from the surface, bend at a right angle to extend parallel to the ground for 5-10 m, and then grow vertically to reach the canopy. Serpentine trunks loop along the ground. Some have stated that these unusual tree forms are caused by the strong gale force winds of the subantarctics; others have argued that the peat soils are incapable of supporting larger trees, which eventually fall or lean while continuing to grow. We show that virtually all irregular trunk formations result from incomplete stem or branch breakage, followed by epicormic regrowth which completely obscures the break. Toppling or leaning is rare, as the peat provides a firm hold for the wide-spreading roots. Contorted branch growth results from the highly phototrophic nature of the epicormic shoots which grow directly towards light gaps in the dense canopies. Similar growth forms have been reported for rata and a range of other trees on the mainland, especially in high altitude forests.

☺ Amelia McQueen and Bastow Wilson. Botany Department, University of Otago, P.O. Box 56, Dunedin, New Zealand. **Using peat accumulation to predict successional changes of a raised bog.**

Bogs are self-perpetuating ecosystems which accumulate large amounts of peat. These ecosystems are reliant on precipitation for both nutrients and water (i.e. ombrogenous). In contrast, fens are peat accumulating systems which are influenced by mineral substrates and thus are more nutrient-rich and higher in pH (pH ~5-7). Primary productivity within bogs is low (e.g. on Borland bog the primary productivity of a *Sphagnum* community ranged between 13-79.5g m<sup>-2</sup> yr<sup>-1</sup>). The acidic and waterlogged environment of bog inhibits the activities of microbes within the peat. Thus, peat accumulation occurs because of a lack of decomposition rather than high primary productivity. A peat core was taken from Borland bog, a raised bog in Southland, New Zealand. from the southern dome of Borland bog was taken. Radiocarbon dating indicated that the initiation of Borland bog occurred ~ 12600 years B.P.. From 12600 to 9300 years B.P. there was a high rate of peat accumulation (77.49g m<sup>-2</sup> yr<sup>-1</sup>) suggesting a nutrient-rich fen stage in the bog succession. Between 9300 and 1600 years B.P. the peat accumulation rate dropped to 10 g m<sup>-2</sup> yr<sup>-1</sup>, suggesting a change from nutrient-rich fen to a nutrient-poor fen. After 1600 years B.P. there was a small increase in the rate of peat accumulation to 27g m<sup>-2</sup> yr<sup>-1</sup> as the nutrient poor fen became bog.

S.M. McQueen<sup>1</sup> and B.D. Lloyd<sup>2</sup> <sup>1</sup>Otago Conservancy, Dept. of Conservation, P.O. Box 5244, Dunedin. <sup>2</sup>Dept. of Conservation, P.O. Box 10420, Wellington. **Invertebrate Consumption of 1080 Baits in Rangataua Forest, Central North Island.**

Consumption of 1080 baits by nocturnal invertebrates was assessed in the winter range of short-tailed bats (*Mystacina tuberculata*) in Rangataua Forest by routine inspection and video surveillance. Hand placed non-toxic carrot and pollard baits containing pyranine (a fluorescent dye) were inspected on six nights every month during May to October 1997. Pollard baits with a toxic loading of 0.15% were monitored for eight days following aerial 1080 pest control at the end of August 1997. A bait application rate of 5 kg/ha was used throughout the study. The number and diversity of invertebrates feeding on baits on different nights was extremely variable. Feeding was confirmed both by video surveillance and the presence of pyranine on mouth-parts. Relatively large (>4 mm) invertebrates feeding on baits included weta (6spp.), harvestmen (4 spp.), beetles (3 spp.), millipedes (2 spp.), and amphipods. The duration of feeding bouts ranged from a few seconds to two hours. Invertebrates found on toxic baits were assayed for 1080 content. There were seven pooled samples with a total weight of 27 g. The range of 1080 concentrations was 22 -130 ug/g, (mean = 58.43 ug/g) which is considerably higher than those reported previously.



☺ Rachel A. Meissner & John E.D. Fox School of Environmental Biology, Curtin University of Technology, GPO Box U1987, Perth, Western Australia, 6845. **Establishment of *Triodia* spp. in response to seed depth and microtopography**

The location and position of a seed in relation to the soil surface are important for it to germinate and establish. Availability of suitable microsites may ultimately affect population dynamics and distribution of that species. Two experiments were designed to study the effect of seed burial and microtopography on establishment of four species of spinifex, a xerophytic grass endemic to Australia. The main objective was to explain the distribution of the species when grown in the field, under natural conditions. The selected species were *Triodia longiceps*, *T. pungens*, *T. wiseana* and *T. molesta*. Establishment was at least twice as high when seed was sown at 0 cm than at 1, 2 or 3 cm depths. Furthermore, a rocky topography was the most favourable microsite for establishment accounting for at least 75 % of total establishment obtained for the experiment. These results were consistent for all four species. Light, seed size and soil moisture will be discussed as likely factors explaining these results.

✉ M.F. Merrett, and B.D. Clarkson, Landcare Research, Pt. Bag 3127, Hamilton, New Zealand. **Taxonomy and ecology of *Alseuosmia quercifolia***

The results of an investigation of the taxonomic status, ecology and conservation, and some aspects of the reproductive biology of an apparently unnamed *Alseuosmia* species (*A. sp.* 'Hakarimata') will be discussed. *Alseuosmia sp.* 'Hakarimata' shares a reasonably faithful set of morphological characters throughout its distribution and is not an intermediate between putative parents *A. banksii* and *A. macrophylla*. *Alseuosmia quercifolia* and *A. sp.* 'Hakarimata' are considered synonyms, specific status is warranted, and the original epithet *A. quercifolia* should be re-instated. *Alseuosmia quercifolia* occurs most commonly in lowland native forests of the Waikato region but also as far north as North Cape. It prefers well drained, shaded habitats on the less steep, cooler, south or south-east facing lower slopes of hills and ranges. Flowering occurs over a relatively short period in September when highly fragrant hermaphrodite flowers are produced. A lack of diurnal insect visitation and floral morphology suggest moths are the pollination vector. Some self-pollination is possible with manual manipulation but cross-pollination is significantly more successful. Rain during peak flowering seriously reduces reproductive success. Like all *Alseuosmia* species it is readily propagated from cuttings but seed germination is only successful when specific temperature and light requirements are met.

☺ ✉ Aaron P. Miller. Dept. of Zoology, University of Otago, P.O. Box 56, Dunedin, New Zealand. **Dietary Habits Of Mice Inhabiting Coastal Sand Dunes**

The diet of feral house mice (*Mus musculus* L.) in New Zealand is poorly known. Although mice are predominantly omnivorous, invertebrates usually make up a large component of the diet irrespective of habitat. New Zealand has over 300,000 ha of sand dunes which harbour a diversity of endemic invertebrate species. The aim of this study was to describe the general diet of mice inhabiting dune habitat. This was achieved by examining stomach contents of mice trapped in coastal sand dunes, 15 km south of Dunedin. Quantitative analysis of the individual and/or combined effects of season, gender, and reproductive status was performed using the logistic procedure PROC LOGISTIC. Mice were omnivorous although diet was biased towards invertebrates. Lepidopteran and Coleopteran larvae were important dietary constituents but this importance varied significantly with season. The occurrence of Araneae (spiders) within stomachs was significantly greater in reproductive females than non reproductive females during summer. Results emphasise the importance of native invertebrate species in the diet of feral house mice in coastal sand dunes in New Zealand. Furthermore, they highlight the need for detailed research into the largely ignored potential impact of mice on endemic invertebrate populations in New Zealand.

Henrik Moller. Zoology Department, University of Otago, P.O.Box 56, Dunedin, New Zealand. **Australasian Nature Conservation: challenges, scientific ethics, and the burden of uncertainty.**

A brief review will contrast the history of nature conservation in Australia and New Zealand; the challenges confronting our respective cases of the global extinction crisis; and responses of Conservation NGOs and professional ecologists. Case studies will focus on the burden of ecological uncertainty and the environmental precautionary principle, as applied in some recent controversies in New Zealand. I plea for a stronger code of ethics amongst conservation biologists in their role as opinion makers and supporters of conservation.

Henrik Moller<sup>1</sup>, Christine Hunter<sup>1</sup> and David Fletcher<sup>2</sup>. <sup>1</sup>Zoology Department and <sup>2</sup>Department of Maths and Statistics, University of Otago, PO Box 56, Dunedin, New Zealand. **A comparative approach to estimating survival and reproductive rates of Procellariiformes**

Rakiura Maori require estimates of survival and breeding rates to predict impacts of harvest, fishery bycatch and climate change on abundance of Titi (sooty shearwaters, muttonbirds). We reviewed survival, breeding success, probability of skipping breeding, and age at first reproduction amongst petrels and albatrosses. Energetics and behavioural ecology models are used to predict likely demographic parameters for *Puffinus griseus* based on patterns observed in other species. This comparative demography approach is potentially particularly valuable for seabirds like Procellariiformes where the bird's can outlive field biologists (there are few long-term data bases), and where several species are threatened by fishery bycatch (the need for parameter estimates is urgent).



© ✉ Huw Morgan, Glenda Wardle, Murray Henwood. Plant Ecology (A08), School of Biological Sciences, The University of Sydney, NSW 2006, AUSTRALIA. **Heteroblasty: a study of the rainforest species *Capparis arborea*.**

The processes influencing the evolution and maintenance of heteroblasty are not yet well understood. To address these processes, we must first characterise the nature of heteroblasty. *Capparis arborea* is a small tree inhabiting riverine, littoral and dry rainforests of eastern Australia. It displays two extreme, apparently age-related morphologies. Smaller individuals are characterised by small, sessile leaves with spinescent midribs, whereas larger individuals possess larger, petiolate, non-spinescent leaves. Each form is further distinguished by the presence or absence of stipular spines, different phyllotaxy and stem morphology. Forty-five morphological variables were measured and analysed using non-metric MDS. Heteroblastic variation in this species is continuous rather than abrupt. Two age-related morphological phases were identified (a “juvenile” phase and an “adult” phase), and each were linked by a transitional period. An orthotropic growth form was also identified and appears to occur independent of the age-related growth phases. Foliar characters of the juvenile phase show less plasticity than those of the adult phase. Transition from juvenile to adult phase did not appear to be coincidental with a shift towards reproductive maturity. Differences between these phases of development might be best explained by understanding variation in light regimes and herbivory pressures experienced by *Capparis arborea* populations.

© ✉ Maria Morlin, Zoology Department, University of British Columbia, Canada. **A comparison of historical land use change and coho salmon (*Oncorhynchus kisutch*) abundance in the Strait of Georgia, British Columbia.**

My Masters thesis research focuses on the contribution of habitat loss to coho salmon (*Oncorhynchus kisutch*) stock decline since the 1970's in the Strait of Georgia. Habitat loss is often blamed for this decline, but it may be a minor contribution compared with alternative hypotheses, such as marine survival, climate change, or over-exploitation. The objective of this research is to determine the relationship between the temporal trend of coho salmon abundance and land use changes that are indicators of loss (or degradation) of coho habitat in selected Georgia Basin watersheds. This approach for detecting trends in land use related to habitat loss and coho productivity may be applied by fisheries managers to other fish species. It will also identify areas of heavy land use or rapid change that require habitat conservation measures.

Steve Morton, CSIRO Wildlife and Ecology, GPO Box 284, Canberra, ACT 2601, Australia.  
**Ten things that fascinate me about ecology and land management in Australia and New Zealand**

Australia and New Zealand have much in common biologically and culturally, yet offer so many fascinating points of contrast. I am an ecologist intrigued with the interactions between environment, ecology and land management. Despite my lack of experience with New Zealand, I set out here to explore both some striking similarities and some marked contrasts in the ways in which key features of the two environments are being reflected by application of ecological understanding to management. I will try to encompass waterways, forests, rangelands, agriculture, indigenous knowledge, fire, and use of wildlife, among several other things. Because of some of the principles that emerge, I will conclude that ecologists in both countries are particularly vital to the task of lifting land management to the necessary levels.

☺Kirsten Moss. Zoology Department, University of Canterbury, Private Bag, Chnstchurch.  
Email: k.moss @ zool. canterbury.ac.nz. **Hedgehog diet and home range in braided riverbeds of the Mackenzie Basin**

Recent infra-red video footage suggests hedgehogs (*Erinaceus europaeus*) may be a more significant predator on endangered wildlife than has been previously recognised. Effective control of hedgehogs requires an understanding of their population density and movements. Using radio telemetry I measured the home range of hedgehogs in braided river habitat on the eastern side of the South Island during summer and autumn. There were an average of 0.16 hedgehogs per hectare in the study area. Average range span of males was double that of females. Home ranges varied from 4.34ha to 143.7ha in size (depending on method of analysis), with the average home range size of 24.7ha (convex polygons) for both sexes combined. Consistently males occupied home ranges 2-3 times that of adult females. However, core areas were only 7% of the total home range size which suggests that hedgehog control programs should use trap densities of at least 1 trap/ha to ensure complete coverage.



Christa Mulder<sup>1</sup> and Julia Koricheva<sup>2</sup>. <sup>1</sup>School of Biological Sciences, Victoria University of Wellington, P.O. Box 600, Wellington, New Zealand. <sup>2</sup>Dept. of Entomology, Swedish University of Agricultural Sciences, Uppsala, Sweden. **Effects of Invertebrates on Diversity - Ecosystem Function Relationships.**

Relationships between plant species diversity and ecosystem function are likely affected by the presence of invertebrates, since they can both affect and be affected by species richness. We tested this hypothesis by comparing plots which had been sprayed with insecticide with plots which had not, using two species mixtures at each of four levels of diversity (2,4,8 and 12 species). We also examined biomass removal by herbivores across five levels of diversity and 29 species mixtures. Levels of herbivory were lower in monocultures and two-species mixtures than in higher-diversity plots. Sprayed plots had higher biomass which was more evenly distributed across species than unsprayed plots. Biomass increased more rapidly with increased species richness in sprayed than in unsprayed plots, and other variables (decomposition rate, soil moisture) also showed different patterns with diversity in sprayed than in unsprayed plots. We conclude that invertebrates must be included in the determination of mechanisms relating species diversity and ecosystem processes, as their presence changes these relationships.

☺ David Murphy and Dave Kelly, Zoology Dept and Plant and Microbial Sciences, University of Canterbury, Christchurch 8001, New Zealand. Email [d.murphy@zool.canterbury.ac.nz](mailto:d.murphy@zool.canterbury.ac.nz). **What is limiting pollination by bellbirds at Craigieburn?**

Two species of native mistletoes, *Peraxilla tetrapetala* and *Alepis flavida*, may be pollinator and disperser limited at Craigieburn, where bellbirds (*Anthornis melanura*) are the major pollinators and dispersers. Mistletoes may be limited because either bellbirds forage preferentially on non-mistletoe foods during the mistletoe flowering and fruiting seasons, or because bellbird numbers are too low to allow sufficient pollination and dispersal. To test these hypotheses we observed bellbird diets over 12 months, examined the energy value of available food sources, and used 5 minute counts as an index of bird density. Although bellbirds were annual generalists, they did concentrate on mistletoe nectar and fruit when available. There was no indication of food limitation as bellbirds spent a low (c 20%) and constant percent of their time feeding from July to February. Bellbird densities were relatively low compared to other New Zealand sites. Therefore limited pollination and dispersal services to mistletoes are most likely to be due to low bellbird densities, and bird densities are probably limited by predation rather than food supply.

✉ Elaine Murphy<sup>1</sup>, Kerry Brown<sup>2</sup> and Rachel Keedwell<sup>2</sup> <sup>1</sup>Science and Research Unit, Department of Conservation, PB 68-908, Newton, Auckland, NZ. <sup>2</sup>Department of Conservation, Twizel Area Office, Private Bag, Twizel, NZ. **Predator diet in the Mackenzie Basin after the release of rabbit hemorrhagic disease**

A major concern to the Department of Conservation (DoC) from the introduction of rabbit hemorrhagic disease (RHD) was that if rabbit numbers were reduced dramatically, then rabbit predators in these areas would eat more of native species. The impact this would have on threatened species is unknown. Last spring and summer, over 600 cats, ferrets and stoats were removed from braided riverbed areas in the Mackenzie Basin, as part of DoC's response to the release of RHD. Bird remains were found in 61% of cats so far analysed (86/142), 36% of ferrets (44/123) and 62% of stoats (23/37). Detailed results by site, and other prey eaten, will be presented. The high occurrence of bird remains in cats (cf. to other studies in a similar area), indicates that prey switching by cats did occur. It is not known whether this was a one-off effect. Predator diet and breeding success of braided riverbed birds will be monitored again this year, to help determine whether predator-prey switching is an on-going problem.

☺ Kerry Neil. Marine Biology Department, James Cook University, TownsvilleQLD 4811, Australia. **The influences of chronic and catastrophic disturbances on a tropical rocky shore invertebrate assemblage.**

The relative significance of chronic and catastrophic disturbances in regulating tropical rocky shore communities has rarely been quantified. I examined the composition and abundance of intertidal invertebrates on an sheltered tropical rocky shore (Townsville, Australia) from June 1996 to July 1998. Under natural levels of disturbance the community exhibited unpredictable seasonal variations in the abundance and diversity of species. Under experimental conditions, chronic disturbances produced a temporary shift in the abundance of dominant space competitors with the barnacle *Balanus amphitrite* outcompeting and encrusting turf algae. The assemblage returned to the predetermined state rapidly (with turf algae dominant) and overall there was no change in the community composition. Immediately following a catastrophic disturbance (ex tropical cyclone Sid, January 1998) there was a marked decline in abundance of herbivorous gastropods and in the occurrence of turf algae. However, there was a 5-fold increase in the abundance of *B. amphitrite* accompanied by a shift in the composition of the community due to an increase in species richness low on the shore. The different responses of the community to catastrophic and chronic disturbance suggest that only extreme disturbances, like unpredictable cyclonic events, shift competitive hierarchies in this system thus affecting patterns of dominance, diversity and abundance of invertebrates on Queensland's tropical rocky shores.



John Neldner, Queensland Herbarium, Brisbane Botanic Gardens, Mt Coot-tha Road Toowong, QLD 4066. **Remnant vegetation of south-eastern Queensland biogeographic region. An analysis of 200 years of change.**

Comprehensive vegetation survey and mapping was conducted across the South-eastern Queensland biogeographic region, which covers 63 000 km<sup>2</sup>. Three digital coverages were produced, (1) remnant vegetation in 1997, (2) remnant vegetation in 1995, and (3) pre-clearing vegetation. For the heavily populated coastal area near Brisbane, remnant vegetation in 1974 is available. Pre-clearing vegetation equates to what is generally mapped as 'pre 1750' or 'pre European' vegetation. Remnant vegetation was defined as vegetation where the structure of the woody vegetation was still intact. The vegetation mapping is underpinned by 2500 sites and thousands of ground observations. The sites and traverses are distributed so as to sample the environmental variability across the landscape. A total of 170 vegetation communities are defined and mapped, comprising 32 open-forest, 71 woodland and 10 open-woodland ecosystems, 37 rainforest and vine thicket and 20 non-forest ecosystems. Remnant vegetation remains for only 44% of the bioregion. The communities of the coastal and alluvial plains have been most heavily impacted. 40.8% of *Melaleuca* communities, 42.5% of rainforests, 45.5% of wet eucalypt forests, and 70.8% of coastal heaths remain. While a high proportion of dry eucalypt forest remains, specific communities are under threat, through rapid urban development, or agricultural clearing.

Claire L. Newell and Robert B. Allen. Landcare Research NZ Ltd, PO Box 69, Lincoln, Canterbury, New Zealand. **Changes in plant species diversity patterns along an elevation gradient at Camp Creek, Westland**

We examined the influence of mass effect and beta-diversity on plant species richness patterns along an elevation gradient in a watershed where vegetation composition is strongly correlated with elevation. Many studies have described how species richness (species per site) change with elevation, but few have quantified which factors might account for these patterns. Theoreticians suggest the species pool from the area adjacent to a site (mass effect) and site-to-site variation in composition (beta-diversity) influence richness, but their contribution is unclear. Stevens (1992) suggests beta-diversity decreases with elevation due to a positive correlation between species elevation breadth and mean elevation position. This predicts a rise in richness with increasing elevation, contradicting most empirical studies. We found elevation breadth was positively correlated with mean elevation position. Beta-diversity decreased from low- to upper-elevations and increased at high-elevations. Despite these changes, richness remained constant. Gradient studies often identify a strong environmental gradient running perpendicular (orthogonal) to elevation. We suggest orthogonal gradient strength may affect elevation beta-diversity rates. Orthogonal beta-diversity decreased following a low-elevation increase. Richness was weakly associated with mass effect and strongly correlated with orthogonal beta-diversity, indicating a strong association between species richness and compositional change on the orthogonal environmental gradient.

✉ Glen Newton<sup>1</sup>, V. Behan-Pelletier<sup>2</sup> and J. Klironomos<sup>3</sup>. <sup>1</sup>Institution: Nexus Ecological Research Institute Mailing Address: NERI, 64 Eastern, Chelsea, QC, Canada J0X 1N0; E-mail: [glen@kimana.com](mailto:glen@kimana.com) <sup>2</sup>Agriculture Canada, Ottawa, ON, Canada K1A 0C6; <sup>3</sup>University of Guelph, Guelph, ON, N1G 2W1. **DERP: An Ecological Metadatabase for the Management, Indexing, and Searching of Ecological Projects**

The Database of Ecological Research Projects (DERP) is a meta-research database, recording information about ecology research projects. Using the ubiquitous infrastructure of the Internet and the Web, DERP allows investigators to record a range of information about proposed, ongoing and completed georeferenced, ecological research projects. This information can be accessed by other researchers and decision-makers through Web-based interfaces searching for information about ecology. DERP will also enable development of profile Agents, which can be instructed to search for specific items as the database is updated, to periodically perform these searches on new or modified entries and email search results to the researcher. DERP has an extensive set of fields, in an attempt to create a rich and useful information base, including: project name, project URL, project timeframe, keywords, abstract, contact information, data availability, data URL, site description(s), site URL, taxa studied, functional group, research topic, methodology, FAO soil type(s), georeferencing of location, world ecosystem designation of site, etc. DERP has been developed with extensive interaction and feedback from the international ecological research community, and includes multilingual interfaces in various languages (version 1 in English and French).

✉ James C. Noble and Paul Walker. CSIRO Wildlife and Ecology, PO Box 84, Lyneham, ACT 2602, Australia. **An active adaptive management approach to the problem of shrub proliferation in western New South Wales.**

The cumulative effects of woody weed proliferation over the past century have led to a progressive decline in pastoral productivity, with aggregate income opportunity loss estimated as high as A\$80 million per annum for Queensland and New South Wales combined. Several management options are currently available for controlling shrubs although their use over extensive paddocks is heavily constrained by cost factors. This paper outlines preliminary results emanating from a series of workshops involving principal stakeholders aimed at: defining the spatial and temporal resolution required for effective woody weed management; systematically describing and quantifying the relationships between various factors so as to obtain an holistic view of the system, i.e. at paddock, property and regional scales; incorporating biological, ecological and economic data from past research, as well as similar knowledge acquired by local landholders over time, into a woody weed assessment and management system. The research uses an 'adaptive management' approach and concepts from 'systems thinking' and 'learning organisations' to create an environment which will encourage property owners and land administrators to experiment with alternative control options. An adaptive management approach, whereby such management tools are refined over time will, in turn, encourage the development of sustainable pastoral enterprises in the semi-arid woodlands of eastern Australia.



Grant Norbury<sup>1</sup> and Nigel Barlow<sup>2</sup> <sup>1</sup>Landcare Research, PO Box 282, Alexandra.

<sup>2</sup>AgResearch, PO Box 60, Lincoln. **Effects of RHD-induced rabbit declines and predator trapping on predation of banded dotterels**

Rabbits are the main food of three predator species (ferrets, cats, and harriers). Increased consumption of native prey of secondary importance in predator diet is commonly observed after declines in rabbit abundance. This is corroborated by studies of predation on banded dotterel nests in braided riverbeds. We found  $56 \pm 10\%$  ( $n = 4$  study sites,  $\pm 95\%$  CLs) of nests in the Mackenzie Basin were lost to predators where RHD significantly reduced high density rabbit populations. This is similar predation to that reported immediately after 1080 rabbit poisoning when  $52 \pm 7\%$  of nests were lost to predators ( $n = 4$  sites, calculated from studies reported in Rebergen *et al.* 1998, *New Zealand Journal of Ecology* 22: 33–41). These predation rates are higher than those normally found during breeding seasons without rabbit control (i.e.,  $23 \pm 4\%$ ,  $n = 12$  samples). During the RHD epidemic, the Department of Conservation undertook an intensive predator kill-trapping programme on other sites in the same study area to protect riverbirds from increased predation. Predator trapping reduced predation to normal levels. We found  $22 \pm 12\%$  nest loss in trapped sites ( $n = 3$ ), compared with  $49 \pm 7\%$  nest loss in untrapped sites ( $n = 7$ ). Continued monitoring during subsequent breeding seasons will provide longer-term effects of RHD on banded dotterel populations. We also conducted a preliminary analysis of historic Department of Conservation data on banded dotterel population surveys, and Canterbury Regional Council spotlight counts of rabbits and predators on neighbouring properties. The data suggest that predator numbers over 5 years relate directly to rabbit numbers, and that rates of change in dotterel numbers are negatively related to the ratio of predators to rabbits (and would therefore be unaffected if the ratio of predators to prey stays constant in the long term). The data also suggest that dotterel rates of change are density-dependent such that the population may be able to compensate for increased predation pressure. Continued monitoring during future breeding seasons will provide more closely targeted data on the long-term effects of RHD on native bird populations, each species of which is unique in terms of its vulnerability and compensatory ability.

G.L. Norbury, J.P. Parkes, R.P. Heyward. Landcare Research, P.O. Box 282, Alexandra, New Zealand. **Rabbit Haemorrhagic Disease after one year in New Zealand**

We compared the behaviour of RHD where it was released by biociding and where it arrived naturally. Rabbit densities declined by 67% on both sites during the spring 1997 epidemic. Rabbit abundance has since declined at rates greater than expected. Sera from shot rabbits were tested for antibodies to RHD. No rabbits (out of 60) had antibodies on the natural site before the epidemic but this increased to 31% ( $n=62$ ) immediately after the epidemic. Eight percent of rabbits ( $n=60$ ) were immune on the biocide site before the epidemic (presumably because the farmer did some spot baiting before mass biociding) and this increased to 43% ( $n=60$ ) immediately after. There were no differences in immunity between sites. The proportion of antibody-positive rabbits has since declined on both sites. This is due mainly to individuals losing antibodies, but also recruitment of susceptible young rabbits born during the epidemic. Challenge trials indicate that loss of antibodies does not mean loss of immunity to further challenge.

Colin O'Donnell, Department of Conservation, Private Bag 4715, Christchurch, New Zealand. **Yellowheads and Wiseheads. Single Species Management Results in Ecosystem Restoration**

The yellowhead (*Mohoua ochrocephala*), a cavity nesting forest bird, has vanished from 75% of its former range. Monitoring and research showed that sudden population crashes coincided with years in which predator numbers were high. Experimental control during a predator population irruption increased breeding success of yellowheads to c.80%, whereas success was only 36% (and half the breeding females were preyed upon) in a similar, but untreated, area. Predator populations in southern beech (*Nothofagus*) forest go through cycles. Indices of beech seedfall and rodent numbers were used to predict successfully years when control was needed. Research then focused on the ecology of stoats (*Mustela erminea*) and effective techniques for their control. Although the incentive for management arose from the Yellowhead Recovery Programme, research findings are widely applicable to predator control programmes. Integrated management programmes have since arisen that involve experimental control of pests and monitoring of the performance of indicator species. In the Eglinton Valley, possum and predator control spans c. 8000 ha. Beech tree seeding, forest structure, rodents, mustelids, forest bird numbers, bats, parrots, mistletoes, and riverbed bird communities are monitored. For the next predator irruption we plan to test cost- and control-efficiency of one-off (pulsed) 1080 poison and Fenn trapping operations over c. 6000-8000 ha valleys compared to low intensity annual poisoning and trapping over similar sized areas. Yellowheads are one threatened species still accessible to the public in mainland forests and an important indicator for monitoring biodiversity. Developing the ability to manage their pests will assist in the conservation of forests generally.

Colin Ogle<sup>1</sup>, Graeme La Cock<sup>1</sup>, and Neil Mickleson<sup>2</sup> <sup>1</sup> Department of Conservation, Private Bag 3016, Wanganui; <sup>2</sup> Manawatu Wanganui Regional Council, Ohutu, RD3, Taihape. **Impacts of old man's beard (*Clematis vitalba*) on plant biodiversity in indigenous forest, Taihape, New Zealand.**

The exotic vine, *Clematis vitalba*, has been in forest reserves around Taihape in the Rangitikei Ecological Region of the central North Island for about 70 years. Before this weed was abundant, the Taihape forests were species-rich in indigenous vascular plants, especially woody species. Evidence is produced to show that the spread of *C. vitalba* has led to a loss of biodiversity among the indigenous vascular flora. Furthermore, those species which have been lost tend to be either those on the national lists of threatened, rare and local plants, or those whose past presence around Taihape was of considerable biogeographic significance. Current control of *C. vitalba* in the Taihape forests is based upon mechanical and chemical methods, followed by grazing with sheep to prevent regeneration of *C.vitalba*. These methods have resulted in renegeration of a narrow range of indigenous forest species. Comparisons are made with similar forest in the nearby Paengaroa Scenic Reserve which has never had *C. vitalba*.



✉ John D. Orbell, Ee K. Tan, Merryn Coutts, Stephen W. Bigger and Lawrence N. Ngeh. School of Life Sciences & Technology, Victoria University of Technology, P.O. Box 14428, Melbourne City MC, Victoria, 8001, Australia. **Cleansing Oiled Feathers - Magnetically**

An oil-adsorbing magnetic powder, which is non-toxic and a non-irritant, has been tested in the laboratory as a novel cleansing agent for oiled feathers. For contamination by three different crude oils, an engine oil and a crude oil/sea water emulsion, up to 97% of the contaminant, and effectively all of the cleansing agent itself, can be rapidly removed from the feathers by magnetically harvesting the oil-laden powder. After a number of treatments, the cleansed feathers are visually and texturally indistinguishable from the originals, and their hydrophobic microstructure is restored. An added advantage of this method is the easy disposal of both the contaminant and the cleansing agent.

✉ John D. Orbell, Manfred J. Zabinkas, Ee K. Tan, Merryn Coutts, Stephen W. Bigger and Lawrence N. Ngeh. School of Life Sciences & Technology, Victoria University of Technology, P.O. Box 14428, Melbourne City MC, Victoria, 8001, Australia. **Towards a Quantitative Indicator of Damage in Cleansed Feathers**

Depending on the method used to remove oil contamination from feathers, varying damage to the hydrophobic microstructure may occur. This ranges from a disruption of the coherence of the vane, which may be qualitatively assessed under a light microscope, to the shredding of hooklets away from the barbules; this requires a higher magnification to observe in detail. The extent of the latter damage appears to be related to severity of the cleansing treatment. We have explored this feature with a view to developing a rapid method for quantifying feather damage after cleansing. Such a method would be useful in the development of new and improved cleansing agents.

✉ Jérôme Orgeas and Alan N. Andersen. CSIRO Wildlife and Ecology, Tropical Ecosystems Research Centre, PMB 44 Winnellie, Darwin NT 0822, Australia. **Responses of Beetles to Experimental Fire Regimes in an Australian Tropical Savanna.**

This study was part of a landscape-scale fire experiment at Kapalga in Kakadu National Park. Beetles were sampled from the grass-layer by sweep netting in woodland and open forest habitats, during February (mid-wet season) and May (end of wet season) from 1989 to 1995. Three fire treatments (exclusion of fire, burning early (May/June) in the dry season, and burning late (Sept/Oct) in the dry season) were tested, each replicated three times. Experimental units were 15-20 km<sup>2</sup> landscapes. A total of 233 beetle species were collected, with diversity and abundance being greatest during February and in open forest. Fire had little effect on overall beetle abundance. However, compared with unburnt sites, the two burning treatments caused similar significant decreases in species and family richness early (1991-1993) in the experiment, followed by marked increases later (1994-1995), but only in open forest. The effects of fire were therefore patchy both in time and in space, with the two burning treatments producing similar results despite their marked differences in intensity. Overall, fire appears to be a relatively minor factor influencing savanna beetle assemblages compared with rainfall and habitat effects.

Bertram Ostendorf, David W. Hilbert, Brett Buckley, Jeroen van den Muyzenberg, and Mike S. Hopkins. Co-operative Research Centre for Rainforest Ecology and Management, CSIRO Tropical Forest Research Centre, Atherton, Queensland. **Modelling the spatio-temporal response of vegetation to climate change: linking a cellular automata approach with artificial neural network modelling**

Our ability to predict vegetation changes under future climatic conditions is complicated by the spatially and temporally dynamic nature of the problem. For example, the present spatial pattern of a vegetation mosaic may constrain the future spread of vegetation under climate change. To evaluate these constraints, we have combined artificial neural network modeling (ANN) with a cellular automata approach. The ANN-model is used to predict how the local environmental suitability for 15 forest types in the wet tropics region of Northern Queensland will change under an altered climate (+1 deg. C and -10% precipitation), whereas the cellular automata model is used to examine the spatial constraints on the spread of these vegetation types. Estimating the extent of future vegetation types with the combined method resulted in different predictions for about 7% of the area compared to using the ANN alone, indicating that the spatial arrangement of vegetation in a landscape can constrain the possible response to climate change. Including cleared areas as man-made barriers to vegetation change had little additional effect (only 0.5% of the area would be different). Thus, considering the small temperature and precipitation changes expected within the next decades, the current amount and spatial arrangement of clearing in the wet tropics may not impose significant barriers for vegetation shifts in the study area. Further examination of more precise climate change predictions over longer time-scale remains necessary.

✉ Keely Ough and Anna Murphy. Arthur Rylah Institute, Dept of Natural Resources and Environment, PO Box 137, Heidelberg, Victoria, Australia 3084. **Understorey islands: a method of protecting understorey flora during clearfelling operations.**

Research in Wet Forests of Victoria indicates many understorey plants are sensitive to the soil disturbance associated with clearfelling. Many of the species declining in abundance have a common regeneration strategy: they resprout from vegetative propagules soon after disturbance. Such regeneration is typical in Wet Forests after natural disturbances such as wildfire. Vegetative resprouters are also abundant in areas designated for timber production. However, the resprouting organs of some such species are damaged during the mechanical processes associated with clearfelling, resulting in substantial declines in some understorey plant populations after harvesting. Our study investigates the viability of a modification to clearfelling operations designed to improve the survival of these species. Small areas of vegetation within a coupe are designated machinery free zones, or Understorey Islands. Trees are still able to be felled from within Understorey Islands, but mechanical disturbance, particularly disturbance to the soil, is minimised. Survival of resprouting species within Understorey Islands one year after the completion of logging was generally much higher than in areas subjected to normal clearfelling procedures. This was particularly evident for the two most common species, *Dicksonia antarctica* and *Olearia argophylla*. These species are often very long-lived under a natural disturbance regime, and are otherwise poorly represented within post-clearfelling regeneration. Understorey Islands is a simple, low cost means of retaining in-coupe biodiversity.



J. McC. Overton<sup>1</sup>, C.R. Fonseca, M. Westoby<sup>2</sup>, and B. Lee<sup>3</sup>. <sup>1</sup> Lancare Research NZ, Hamilton. <sup>2</sup> School of Biological Sciences, Macquarie University, NSW 2109, Australia. <sup>3</sup> Landacre Research NZ, Dunedin **Responses of vegetation attributes to soil and climatic gradients: comparison of Australia and New Zealand**

We compared the responses of three attributes to changes in climate and soil nutrients in both New South Wales, Australia (42 sites), and the South Island of New Zealand (38 sites). The attributes considered were Specific Leaf Area, leaf width, and canopy height. Sites were chosen to sample a range of rainfall and soil nutrient levels, and were constrained to be below 500m elevation. In both surveys, total Phosphorus was the most important of the measured soil characteristics in determining mean community vegetation attributes, and total rainfall the most important climatic character. Overall, NZ sites had higher values of both of these variables, with some overlap between the surveys. In NSW, the climatic and soil characteristics were of roughly equal importance, resulting in similar, concomitant shifts in vegetation attributes between communities along the gradients, with differences between the gradients becoming apparent at their lower ends. Conversely in NZ, while the attributes showed similar concomitant shifts, the shifts were much larger along the total Phosphorus gradient than the rainfall gradient.

☺ Paula J. Peeters. Department of Biological Sciences, Monash University, Clayton, 3168, Australia. **Are herbivorous insects influenced by the leaf anatomy of their host plants ?**

Leaves are composed of tissues that vary widely in nutritional and chemical composition, and physical properties, and thus are potentially heterogeneous food resources to small insect herbivores. The arrangement of hard tissues and softer, more nutritionally rich tissues within a leaf may influence the distribution and morphology of small insect herbivores. To investigate the influence of leaf anatomy on herbivorous insects, the insect assemblages associated with a range of leaf structures and ages were compared, as part of a larger study assessing the influence of leaf structure on herbivorous insects. Patterns of leaf anatomy and insect morphology were examined using conventional clearing, sectioning and staining methods, as well as innovative image analysis and confocal microscope techniques. Some preliminary results will be presented and their implications discussed.

☺ George Perry and Neal Enright. Department of Geography and Environmental Studies University of Melbourne Parkville, VIC 3052, Australia. **A Frame-Based Model of Vegetation Dynamics for Mont Do, New Caledonia**

A non-spatial frame-based model of long-term vegetation dynamics in a botanical reserve on Mont Do, New Caledonia is presented. A simple five-frame 'state-and-transition' type model was built to represent vegetation dynamics. Successional changes occur at critical densities of the conifer species *Araucaria laubenfelsii*. These densities are based on data from concurrent field studies. Fire, cyclones and climatic variation (abnormally wet, normal, or abnormally dry decades) are also included in the model, as are changes in soil type. The model operates at a decadal time-step, with the results taken from replicate simulations of 1000 years. The model indicates that the landscape may be very sensitive to changes in the disturbance regime especially changes in fire frequency. The model indicates that it may be easy to maintain the system in either a degraded state, through repeated disturbance, or in a 'late' successional state, through low disturbance frequencies. It appears more difficult to maintain the system in intermediate states and this is reliant on the interaction(s) between fire and other disturbance and climatic events. At present the model is non-spatial. Development of the model such that it is spatially explicit would be simple and would allow contagious processes such as fire spread and seed dispersal to be more realistically modelled.

Pharo, E.J. and Vitt, D.H. Sustainable Forest Management Network, G-208 Biological Sciences, University of Alberta, Edmonton, AB T6G 2E9 CANADA. **Lichen response to selective logging: managing a woodland caribou (*Rangifer tarandus caribou*) food source**

In North America, woodland caribou (*Rangifer tarandus caribou*) numbers have been declining for the past few decades, especially in areas conflicting with other forest uses. Forestry practices like clear-cut harvesting in the caribou winter range has been suggested to be part of the reason for this decline. Selective logging may be one of the options available for forestry operations to sustain some level of wood supply and at the same time maintain caribou habitat. In collaboration with three timber companies, we are conducting a pre- and post-selective logging study in caribou winter range focusing on the response of terrestrial lichen diversity and abundance. Nine stands averaging between 30 and 40 hectares each were divided into four; one area serving as a control and the other three have been thinned to 20, 40 and 60 % of the original canopy density. Pre-harvest data were collected over the summer of 1997 and the plots were cut over the summer of 1998. Understanding the pre-harvest distribution and abundance of terrestrial lichens is an important step in their management, and it is these data that are being presented here.



✉Pharo, E.J., Naidoo, R. and Vitt, D.H. Sustainable Forest Management Network, G-208 Biological Sciences, University of Alberta, Edmonton, AB T6G 2E9 CANADA. **Sustainable Forest Management in Canada**

As the world's leading exporter of wood pulp, newsprint and softwood lumber, Canada's forest trade is affected by global concern for sustainable forest management. In 1995, a network of sustainable forest management research was established to provide the public with environmentally sound products, industry with the critical necessary techniques, and policy-makers with the informed approaches necessary to achieve sustainable forest management. This poster focuses on one of the four network themes: the Ecological Basis of Sustainability. Research projects in this theme aim to provide the sound ecological basis to sustainable forest management based on the natural disturbance paradigm. Four projects from this theme are discussed. 1) A land-aquatic interface project is examining the impacts of harvesting and fire on the water quality and biodiversity in boreal lakes. 2) A natural disturbance project is exploring how intensity, frequency, and size of natural disturbances shape forest structure and landscape pattern. 3) A large experimental project is comparing the before/after response of biotic communities to selectively-cut versus burned stands. 4) A fourth project is investigating the relative contributions of stand versus landscape structure to the biodiversity of several vertebrate and invertebrate taxa.

✉J.P. Pigott, N.G. Marchant, A.R. Chapman and N.S. Lander. Western Australian Herbarium, CALM Science Division, Department of Conservation and Land Management Locked Bag 104 Bentley Delivery Centre Western Australia 6983. **Communicating information about environmental weeds: utilizing corporate data and Internet technologies.**

Field staff and members of the public generally ask three questions in relation to environmental weeds. What is the weed's name, its distribution and what the management options for it? These questions are usually answered from general knowledge or by looking up relevant books. Often more accurate information is available in corporate data sets. At the Western Australian Herbarium CALM Science manages several, including the database of more than 435,000 vouchered specimens, the Census of WA plants and a comprehensive descriptive catalogue at species level. A related CALM database contains ecological information on environmental weeds in WA. Intranet technology can make this information available over a corporate WAN using standard web browsers. This provides current nomenclature and information on distribution, morphology and habitat. The development of such systems and their application is discussed, as is the presentation of subsets of this information on the Internet. The Internet can also be used to provide links to sites weed around the world. Examples of species information available at web sites in Australia and New Zealand are given as well the relevance of regular maintenance and crosschecking of such information. In this way it is hoped that valuable information is made available to departmental staff, scientists, community groups and practitioners (eg farmers, bush regenerators and conservationists), who can maintain currency of their knowledge, apply it in the field and subsequently contribute new data.

© Alistair Poore and Peter Steinberg. School of Biological Science, University of New South Wales, Sydney, NSW 2052. **Consequences of host plant use in a herbivorous marine amphipod**

One model for the evolution of host range in herbivorous insects predicts that herbivore preference among different host plants correlates with performance on those resources. If herbivore growth, survival and fecundity differ across hosts, then herbivores should be selected for the ability as adults to discriminate between hosts of different quality for their larvae. I tested this model with an analogous system, the herbivorous marine amphipod, *Peramphithoe parmerong*. After leaving the female's brood pouch, juveniles of this species develop in close proximity to their mother and thus, habitat selection by females dictates juvenile performance in a similar way to many ovipositing insects. Two measures of adult behaviour - habitat selection (nest building preference) and consumption - and two measures of juvenile performance - growth and survival - for several algal species were compared. *Peramphithoe* displayed strong behavioural preferences across different algal species. Only nest building preference, however, and not consumption, corresponded to amphipod growth and survival. Field densities across algal hosts also correspond with nest building preferences, growth and survival, but not consumption rates. Intrinsic qualities of the host algae, particularly the presence of non-polar secondary metabolites, explained much of the variation in amphipod behaviour. These data support the model that host range is determined by variable performance across different hosts.

✉ Hugh Pringle<sup>1,2,3</sup>, Emma Raaff<sup>1</sup> and Jill Landsberg<sup>2</sup>. <sup>1</sup>Agriculture Western Australia. <sup>2</sup>CSIRO Division of Wildlife and Ecology, PO Box 84 Lyneham ACT 2602. <sup>3</sup>Research School of Biological Sciences, ANU, Canberra. **Modeling historical grazing activity along grazing gradients in the Western Australian arid zone**

In the vast sheep station country of the arid interior of Western Australia, the wells and bores that have been developed to water sheep become the focus of their grazing activity. In general, grazing intensity declines with increasing distance from watering points in these large, arid zone paddocks and distance from water is a reasonable surrogate for accumulated grazing activity within a paddock. However, because paddocks vary in grazing history and environment, distance from water is a less reliable surrogate for comparing accumulated grazing activity between paddocks. We have developed a two-step approach to modeling grazing intensity for grazing gradients in a number of paddocks. The first step integrates functions of distance from water, proportional use of all available sources of water, vegetation preference, and water quality (salinity). The aim is to model relative grazing activity within each paddock in which the gradients occur. The second step incorporates temporal management information: age of watering points, stock numbers and seasons. A third step comparing modeled activity with recommended 'safe' levels has potential for predicting grazing impacts. Accumulated 'overstocking' may be a better predictor of impact than approximations of grazing activity per se.



Graham H. Pyke and Arthur W. White. Australian Museum. **The green and golden bell frog (*Litoria aurea*) in Australia and New Zealand: Biology and Management**

The conservation status of the green and golden bell frog (GGBF) varies from one region to another. It is endangered in NSW, vulnerable in Victoria and a locally common feral species in New Zealand. Across these three areas, the sites where this species occurs and breeds generally share the following features. Ponds usually contain still or slowly moving water, are usually shallow, unshaded and free of predator fish (such as the introduced Plague Minnow - *Gambusia holbrooki*), and usually fluctuate markedly in water level. Emergent aquatic plants (e.g. *Typha* sp., *Eleocharis* sp.) are usually present and vegetation adjacent to the water generally includes areas of low herbs and/or grass. There are usually rocks, timber or other material, under which frogs may either overwinter or seek shelter during the day. Most present sites are highly disturbed by human activities, some with some sites, such as those in New Zealand, being largely or completely human-made. The few sites that are not disturbed by human activities would none-the-less experience disturbance through natural flooding. This apparent importance of disturbance and other aspects of the biology of the GGBF indicate that this species is essentially an "endangered weed". The consequences of this for management of this species are discussed.

✉ Lyn.Raffan<sup>1</sup> and Dieter Hochuli<sup>2</sup> <sup>1</sup>School of Biological Sciences, The University of Sydney, N.S.W. 2006, Australia. <sup>2</sup>Institute of Wildlife Research, School of Biological Sciences, The University of Sydney, N.S.W. 2006, Australia. **An assessment of surrogates used in conservation biology and planning in the Sydney Region**

Faced with limited data and financial and temporal constraints, conservation biologists have to make decisions regarding appropriate and justifiable shortcuts for the evaluation of biological diversity. These shortcuts include the use of surrogates for, and indicators of, biodiversity. Surrogates used include imposed groupings based on patterns such as habitat or ecosystem, abiotic environmental variables, and 'hotspots'. Hotspots are those areas that are rich in biodiversity, endemism or numbers of rare or threatened species. It is assumed that patterns of diversity among well defined and studied groups of animals will reflect patterns of diversity amongst those groups that are not well understood. This coarse filter approach has been applied in many conservation decisions, seemingly without proper testing. The uncritical use of these surrogates and indicators may result in flawed interpretations of patterns in biodiversity and, ultimately, poor conservation decisions. In this study, we describe patterns of avian diversity in the Sydney region. Using field data, the associations of birds with coarse habitat features such as soil fertility, temperature, rainfall and slope, as well as several finer characteristics, are used to test the effectiveness of some proposed surrogates. The testing of these patterns may then lead to the formation of true surrogates for and indicators of biodiversity which will aid in conservation processes.

☺ ✉ Tanya A. Rankin. Institute of Wildlife Research, School of Biological Sciences, University of Sydney, NSW 2006. **Diet of platypuses (*Ornithorhynchus anatinus*: Monotremata) in the Kangaroo River, NSW: selective feeding on stream macroinvertebrates**

Platypuses (*Ornithorhynchus anatinus*) are semi-aquatic mammals, unique to eastern Australian waterways. They feed on a diverse variety of aquatic macroinvertebrates, including worms, crustaceans, molluscs, and insects. Platypuses consume an enormous volume of macroinvertebrates for their size — estimates of up to half their own bodyweight in macroinvertebrates each night have been made. Though generally opportunistic in their feeding, recent work in Tasmania suggests that platypuses may feed selectively on particular macroinvertebrate taxa. Differential predation has the potential to have profound impacts on macroinvertebrate community structure, which can lead to changes in river food webs, altering litter processing rates and algal community composition. In the present study, the diet of platypuses is being compared with availability of macroinvertebrate prey collected seasonally from three instream habitats (riffles, pools and edges) in the Kangaroo River in the Southern Highlands of NSW. Dietary preferences are being examined on the basis of macroinvertebrate taxon selected, size selected, and habitat foraged. Sex, age and individual preferences exhibited by platypuses will also be examined. This study forms a basis for wider investigations into the functional significance of platypus to river food webs.

✉ Ratz, H., N. Alterio, B. McKinlay, H. Moller. Author for correspondence: Hiltrun Ratz, Box 31, Portobello, Dunedin, New Zealand. Email: [penguin@deepsouth.co.nz](mailto:penguin@deepsouth.co.nz) **How much is a species worth? An evaluation of alternative methods of introduced predator control to protect the Yellow-eyed Penguin (*Megadyptes antipodes*)**

A limited budget makes it desirable to use the most cost-effective control methods available to protect indigenous wildlife from introduced small mammals such as stoats (*Mustela erminea*), ferrets (*M. furo*), and house cats (*Felis catus*). The cost of trapping these predators was estimated at NZ\$297 and NZ\$1,105 per extra Yellow-eyed Penguin (*Megadyptes antipodes*) recruited to the population from one large colony and five small scattered colonies respectively on South Island, New Zealand. Secondary poisoning of predators using brodifacoum would cost \$93 and \$250 per recruit from the same respective colonies, a 69% and 77% improvement respectively in cost effectiveness compared to trapping. Secondary poisoning methods therefore hold promise to improve protection of native species, especially for highly fragmented populations on the mainland, but further research to reduce risks to non-target species and further improve efficacy is urgently needed. Decline of Yellow-eyed Penguins on South Island can be avoided if 44% of breeding attempts are protected from predation. This can be achieved by secondary poisoning from the interest from a dedicated trust fund of \$125,000. A strategy of applying predator controls to a mixture of relatively large and very small breeding colonies brings a compromise in cost effectiveness, but minimises probabilities of localised extinction.



Aalbert Rebergen, Department of Conservation, Private Bag, Twizel (present address Department of Conservation, P O Box 191, Masterton) **Early brood desertion, double brooding and female productivity in a population of banded dotterel (*Charadrius bicinctus*)**.

The breeding behaviour of banded dotterel *Charadrius bicinctus* was studied during 4 seasons from 1992 to 1995 on the Ahuriri river, North Otago. Individually marked females were observed to renest after successfully fledging their first brood (double brooding) in all 4 years, and this behaviour varied in extent among years (4-40%). Double brooding in the banded dotterel has only been recorded in the literature on one previous occasion (Pierce 1989). Some females deserted their first brood prior to fledging, leaving the males in sole charge of the chicks. Females renested after losing eggs or chicks, and up to 5 clutches were laid in a season. The average productivity of resident females was 1.68 and 0.93 young/year in 1994/95 and 1995/96 respectively. The average annual adult survival over the study was 84.7%.

© Ben Reddiex, Graham Hickling and Richard Duncan. Ecology and Entomology Group; Soil, Plant and Ecological Sciences Division, PO Box 84, Lincoln University, Canterbury. **Diet selection of a generalist herbivore: European rabbits (*Oryctolagus cuniculus*) in the semi-arid grasslands of the Mackenzie Basin**

There have been no previous quantitative studies of European rabbit (*Oryctolagus cuniculus*) diet in New Zealand, despite the prolonged and significant impact these introduced pests have had upon both pastoral and conservation values of this country's semi-arid grasslands. Rabbit diet selection was assessed on three replicate sites in the Mackenzie Basin, South Island, over the period December 1996 to March 1997. Rabbits were generalists, feeding on a mean of 11 plant species per stomach sample (n=90) and 33 plant species per site. The single largest dietary component was introduced *Hieracium* species; these comprised 32 to 39 % of the diet at the three sites, which was proportional to their availability. Over all sites combined, six plant species were positively selected, there was no selection for 17 species, and 24 species were negatively selected; these results were consistent across the sites. Sex and age of rabbits had no significant influence on their diet selection. The nutritional composition of rabbit diet was very similar to that of the available vegetation. Of a range of nutrients measured in the vegetation, magnesium was the only one found to be significantly correlated with diet selection. The determinants of rabbit diet selection in this habitat require further research.

Christine E. M. Reed<sup>1\*</sup>, Shirley Calder<sup>2</sup>, Raewyn Empson<sup>1</sup>, Wayne S. Boardman<sup>3</sup> and Colin Miskelly<sup>1</sup>. <sup>1</sup>Department of Conservation, Wellington Conservancy, PO Box 5086, Wellington. <sup>2</sup>Parasitology Department, Institute of Veterinary, Animal and Biomedical Sciences, Private Bag 11-222 Palmerston North. <sup>3</sup>Pathobiology, Institute of Veterinary, Animal and Biomedical Sciences, Private Bag 11-222 Palmerston North. \*Present address: Taronga Zoo, PO Box 20, Mosman, NSW Australia. **Minimising health risks to newly translocated populations: baseline disease sampling of Wellington green geckos (*Naultinus elegans punctatus*), Duvaucel's gecko (*Hoplodactylus duvaucelii*) and goldstripe geckos (*Hoplodactylus chrysosireticus*)**

Translocations of threatened species to establish new, or augment existing populations, have increased markedly in the past 15 years. While these transfers generally assess quality of habitat at the release site, and any risks from potential competitors or predators, few assess the risks of disease transfer between sites. As part of an ecological restoration strategy for Mana Island near Wellington, individuals of three species of gecko - Wellington green gecko (*Naultinus elegans punctatus*), Duvaucel's gecko (*Hoplodactylus duvaucelii*) and goldstripe geckos (*Hoplodactylus chrysosireticus*) - were sampled to establish baseline intestinal parasite and gut flora before transfer to Mana Island in February 1998. Cloacal swabs, cloacal washes and faecal samples were collected from a total of 29 individuals. Four green geckos contained intestinal parasites identified to group type, including the first identification of *Cryptosporidium* cysts in a New Zealand lizard. Eight of the ten Duvaucel's geckos, and six of the ten goldstripe geckos possessed adult or egg stages of intestinal parasites. No potentially pathogenic bacteria were isolated from cloacal swabs or washes of the three species. The usefulness of collecting baseline disease information is discussed in the context of disease risk assessment for lizard translocations.

✉ Virginia Reid and Susan Timmins Science and Research Unit, Science Technology and Information Services, Department of Conservation, PO Box 10-420, Wellington. Email: v Reid@doc.govt.nz; stimmins@doc.govt.nz. **Bone-seed, a yellow-flowered shrub invading coastal communities**

The South African shrub bone-seed *Chrysanthemoides monilifera* has been recorded invading parts of New Zealand coast, particularly in the northern half of the North Island on disturbed cliffs. Here the native vegetation is usually short-stature and the taller, faster growing bone-seed is readily outcompeting native species. Bone-seed flowers and seeds profusely. The hard seeds remain viable for at least 10 years in the soil. Abundant new bone-seed seedlings were observed in the Spring following bone-seed control work. Thus, once established, bone-seed tends to dominate the site and reduces the chances for protecting natural coastal communities. It is likely that bone-seed is nearing the end of a lag phase and will soon dramatically increase its distribution in New Zealand, both in coastal areas and further inland as predicted by climate modelling. In Australia, bone-seed is expected to occupy 90% of New South Wales coast by 2010 if left unchecked.



Virginia Reid, and Susan Timmins, Science and Research Unit, Science Technology and Information Services, Department of Conservation, PO Box 10-420, Wellington. Email: [stimmins@doc.govt.nz](mailto:stimmins@doc.govt.nz). **Climbing asparagus, a South African in your forest patch**

Climbing asparagus *Asparagus scandens* has been observed invading disturbed regenerating forest and scrub as well as intact forest. It is introduced either by dumping of garden refuse or bird dispersal. It currently has a patchy distribution throughout much of the North Island of New Zealand. Climate modelling suggests that the distribution of this vine in New Zealand is likely to greatly increase with time. Climbing asparagus significantly modifies native understorey where it can carpet the forest floor and smother shrubs and saplings. It has been observed growing as high as

3m. Growth experiments show it grows slowly, but nevertheless control may be difficult because it has a large root biomass and is bird dispersed. A related species, smilax *Asparagus asparagoides* has a major ecological impact in forest remnants it has invaded in Australia where it is extremely difficult to control.

✉ Virginia Reid and Susan Timmins. Science and Research Unit, Science Technology and Information Services. Department of Conservation, PO Box 10-420, Wellington. Email: [vreid@doc.govt.nz](mailto:vreid@doc.govt.nz); [stimmins@doc.govt.nz](mailto:stimmins@doc.govt.nz) **The effects of weeds on threatened plants**

Half of the threatened plant species of concern to New Zealand Department of Conservation are threatened by one or more weed species. In many cases, the weed involved is a grass species. Grasses hinder regeneration and also compete directly with adult individuals of threatened plant species. Weeds have a greater impact on threatened plant species in coastal habitats, seral plant communities and damp habitats, i.e. wetlands, dune slacks, alpine seepage's and lakes. The threat from weeds can be direct or synergistic, i.e. exacerbating the effects of other risk factors.

Ralph Riley<sup>1</sup>, Colin Townsend<sup>1</sup>, Dave Raffaelli<sup>2</sup> and Alex Flecker<sup>3</sup>. <sup>1</sup>Department of Zoology, University of Otago, Dunedin, New Zealand. <sup>2</sup>Culterty Field Station, University of Aberdeen, Scotland. <sup>3</sup>Section of Ecology and Systematics, Cornell University, Ithaca , USA. **Sources and effects of subsidies along the stream-estuary continuum**

Much has been made recently of the potential importance of allochthonous materials (subsidies) for the organisation of food webs. The realisation that most ecological systems are open to some degree is not new; however, the focus of research has moved away from mainly descriptive statements about the magnitude of subsidies to addressing issues about their effects on food-web dynamics, especially indirect effects. We describe a series of investigations on streams and rivers in New Zealand and on a single estuary in Scotland, the food webs of which have been intensively studied by the authors over many years. We discuss evidence for direct and indirect effects of subsidies (from terrestrial, upstream and marine sources) of nutrients, animal biomass and dead organic matter along the continuum from headwater streams to estuary. Key findings include: a nutrient subsidy used by basal species in a stream food web (bottom-up) can alter the outcome of a top-down cascade mediated by fish; the terrestrial contribution to river invertebrate diet is consistently higher in floodplain reaches than in constrained river reaches; there are bottom-up effects of enhanced densities of estuarine primary consumers (resulting from nutrient and organic subsidies) on shorebird populations.

✉ Alistar Robertson. School of Science and Technology, Charles Sturt University, PO Box 588, Wagga Wagga, NSW 2678, Australia. **Floods and the biological productivity of floodplain wetlands: a field experimental study.**

Variation in the timing, frequency and duration of flood pulses is a major factor controlling the patchiness of floodplain ecosystems at most temporal and spatial scales. Damming of rivers, and water extraction for irrigation have altered the natural pattern of flooding in dryland rivers of the Murray-Darling Basin of SE Australia. This project is using experimental floods of replicate sections of floodplain on the Murray River to determine how the seasonal timing and the frequency of flooding impacts on the biological productivity of temporary floodplain wetlands. Mean daily rates of production of aquatic macrophytes are greater in spring floods than summer floods, and greatest in sites receiving two floods per year. Rates of benthic oxygen demand are generally high and extremely variable, and net benthic algal production is rare during any flood. Gross phytoplankton production is low, but greatest in winter floods. The biomass of autotrophic biofilm is greatest in summer. Decomposition of coarse particulate organic matter is more rapid in areas flooded in summer. Taken together, the data indicate that changes to flood patterns have altered the balance of primary production between macrophytes and algae in these floodplain wetlands.



Alastair Robertson<sup>1</sup>, Dave Kelly<sup>2</sup>, Jenny Ladley<sup>2</sup>, and Kate McNutt<sup>1</sup> <sup>1</sup>Ecology, Institute of Natural Resources, Massey University, Private Bag 11222, Palmerston North. <sup>2</sup>Department of Plant and Microbial Sciences, University of Canterbury, Private Bag 8011, Christchurch. **Native bird declines and the reproduction of New Zealand's flora: have mutualisms been disrupted?**

The extinction of a large minority of the New Zealand land birds and the extreme rarity of other species has been well documented. Less well discussed are the declines in so-called "common" birds of the mainland. A review of historical observations made by Buller and colleagues suggests that the endemic honeyeaters (bellbird and tui) suffered major declines initially in the North Island from about 1860 and around 30 years later in the South Island. These declines coincided with the colonisation of each island by ship rats and, in the case of the South Island, the liberation of stoats. A third honeyeater, the stitchbird, became extinct everywhere except Little Barrier Island while the other two species later staged a partial recovery on the mainland. Recent bird counts suggest that high densities of these species normally only occur in areas where they are protected from predators. These birds are important partners in mutualisms involving the pollination and dispersal of much of the New Zealand flora. Our work shows that some of these mutualisms are no longer operating well and that as a result regeneration may be suffering. We will present as examples two recent case studies involving the pollination of New Zealand mistletoes and the dispersal of tree fuchsia.

☺ D. A. Roshier<sup>1</sup>, A.I. Robertson<sup>1</sup> and R.T. Kingsford<sup>2</sup> <sup>1</sup>School of Science and Technology, Charles Sturt University, PO Box 588, Wagga Wagga, 2678, Australia. <sup>2</sup>NSW National Parks and Wildlife Service, PO Box 1967, Hurstville, 2220, Australia. **Variation in wetland availability and the responses of waterbirds in arid Australia.**

Many Australian waterbird species are dependent on the occurrence of temporary or semi-permanent waterbodies in inland Australia for feeding and breeding. These waterbodies are dispersed widely in space and time. Conservation and management of resources utilised by waterbirds requires knowledge of the spatial and temporal scales over which birds utilise habitat. For instance, birds may move backwards and forwards between patches of wetland on timeframes of days or weeks or birds may confine themselves to individual waterbodies until the resource is depleted. In the former, the scale of interest for management is that at which weather events interact with catchments to form mosaics of surface waters. In the latter, ecological interactions are defined by the physiognomy of particular wetlands and their capacities to hold water. The possibility also exists that the scale of interaction alters as a function of season or climatic conditions. In this paper we present some early results on the variation in wetland availability in arid Australia and the response of waterbird populations.

☺ Karen A. Ross, Barry J. Fox and Jennifer E. Taylor. School of Biological Science, University of New South Wales, Sydney, NSW 2052, Australia. **Multiple disturbance effects of sand mining followed by fire on vegetation.**

Natural systems are increasingly subject to complex disturbance regimes. Community responses to individual disturbance types have been well studied, but the impacts of multiple disturbance types have not. We studied the response of a forest plant community in eastern Australia to the multiple disturbance of sand mining followed by fire. Compared to adjacent unburned mined sites, burning after short disturbance intervals (0.6-2.4 y between mining and fire) reduced native species richness and increased weed densities; medium disturbance intervals (10 y between mining and fire) increased native species richness but did not alter weed species richness or weed densities; and longer disturbance intervals (12 - 13 y) did not show significant differences for native or weed species richness, or weed densities. Therefore burning regenerating vegetation within two years of mining is detrimental for this community, while burning at a later stage may be beneficial. When we compared the compound effect of mining followed by fire to the addition of the separate mining and fire effects, there were synergistic responses for native species richness: results from short disturbance intervals were negatively synergistic, medium disturbance intervals were positively synergistic, while long disturbance intervals were slightly negatively synergistic. Our data suggest that the effect of multiple disturbance may be markedly different to that expected from the addition of the individual disturbance effects.

☺ ✉ Jason Ross. Centre for Integrated Catchment Management, University of Western Sydney, Richmond 2753. **Impact of water quality on turtles of the Upper Parramatta River Catchment.**

The presentation will outline progress on a study within the Upper Parramatta River Catchment area, assessing the impact of water quality on two species of turtle : Eastern snake-necked tortoise - *Chelodina longicollis*; Murray short-neck tortoise - *Emydura macquarii*. The role of long-term water quality factors, eg. ammonia and organic nitrate levels, water temperature, turbidity and pH, on local turtle species and their dynamics. The study aims to identify methods for effective ecosystem management to better preserve local species in their native habitat.



Stephen Roxburgh<sup>1</sup>, Katriona Shea<sup>2</sup> and J. Bastow Wilson<sup>3</sup> <sup>1</sup>Ecosystem Dynamics Group, Research School of Biological Sciences, Institute of Advanced Studies, Australian National University, Canberra ACT 0200, Australia. <sup>2</sup>CRC for Weed Management Systems, CSIRO Entomology, Black Mountain, GPO Box 1700, Canberra, ACT 2601, Australia. <sup>3</sup>Botany Department, University of Otago, P.O. Box 56, Dunedin, New Zealand. **The Intermediate Disturbance Hypothesis: Spatial aspects and mechanisms of species coexistence.**

The Intermediate Disturbance Hypothesis (IDH) is one of the most popular non-equilibrium explanations for the maintenance of species diversity in ecological communities, however a recent series of articles in the forum section of the New Zealand Journal of Ecology has shown that there still exists considerable confusion over how the IDH actually operates. Here we clarify two aspects of the IDH using the results from simple simulation models. Firstly, we show that the IDH is not a simple 'mechanism' of coexistence in its own right, but rather, the term IDH covers a range of mechanisms capable of promoting coexistence under intermediate disturbance regimes. A common requirement for coexistence in these mechanisms is that the competitors differ in appropriate ways in their response to disturbance-induced spatial and temporal variability in resources and environmental conditions. Secondly, we address the issue of whether the IDH requires disturbances to be spatially patchy in order for coexistence to be promoted.

☺ ✉ Alexa R. Ryhorchuk Department of Zoology, University of Melbourne, Parkville, Vic 3052, Australia. **Observations on three sympatric browsing mammals in rocky habitat**

The Brush-tailed Rock Wallaby (*Petrogale penicillata*) has suffered severe range restriction since the arrival of Europeans in Australia. In Victoria, it is now found in only two areas: Red Rock in the Grampians National Park, and around the tributaries of the upper Snowy River in East Gippsland. At one site in Little River Gorge, Snowy River National Park, Common Brushtail (*Trichosurus vulpecula*) and Mountain Brushtail Possums or Bobucks (*T. caninus*) occur in sympatry with the Brush-tailed Rock Wallaby. This site is located in a steep, rocky gorge, with the dominant vegetation community being dry *Acacia* woodland. As such, there are few tree hollows for use by possums, but abundant crevices and hollows in the rock piles and cliffs. This study investigated the potential for shelter competition between the two possum species and rock wallabies. I trapped these three species using collapsible aluminium-framed cagetraps, for a total of 353 trap nights over nine months. I captured 120 Common Brushtails, 35 Bobucks and four rock wallabies. I also made diurnal observations on the rock wallabies, including radiotracking two individuals. Rock wallabies were strongly faithful to their diurnal resting sites in rock crevices, whereas the possums ranged over much of the study area and used diurnal resting sites near (often <20 m) where they were captured. The larger body size of adult rock wallabies, and the lesser ability of the possums to scale rocks, suggest that rock wallabies of all age classes are unlikely to be at a competitive disadvantage for shelter.

Alan Saunders. Department of Conservation, PO Box 10-420, Wellington. **The emergence of ecosystem-focused restoration projects in New Zealand**

New Zealand conservation practitioners have considerable experience in successfully recovering threatened species. A growing number of programmes aimed at recovering plants and animals threatened with extinction have been initiated and important progress towards planned recovery objectives has been made. Many species recovery programmes continue to be focused on offshore islands which are generally less modified than sites on the mainland, and where populations with high national biodiversity value persist. Offshore islands present conservation management opportunities which are not available at mainland sites.

Community and ecosystem restoration goals have recently been proposed for some islands. Because it is neither appropriate nor feasible to manage what remains of New Zealand's biodiversity entirely on offshore islands, recent initiatives have aimed at capitalising on the lessons learned from islands to restore damaged ecosystems at sites on the main islands of New Zealand. Important progress has already been made, although the complexity and intensity of management required, our limited understanding of ecological responses to management, and the lack of precedents in ecosystem focused programmes are major challenges. A co-ordinated experimental management approach is likely to be the most effective in meeting these challenges.

M. J. Schreider. Centre for Research on Ecological Impacts of Coastal Cities, Marine Ecology Laboratories, A11, University of Sydney, Australia. **Epifauna and epiphytes on intertidal algae: is there a general relationship?**

Hypotheses about relationships between epifaunal crustaceans and epiphytic algae were tested on a rocky shore near Sydney, Australia. Abundances of amphipods and tanaids were strongly correlated with the total amount of epiphytic algae, whereas abundances of isopods and harpacticoid copepods did not exhibit such correlation. The analysis of relationships between different epifaunal taxa and particular groups of epiphytes showed that the two most common intertidal amphipods exhibited different responses. *Hyale maroubrae*, responded to the total amount of epiphytes, whereas abundances of *Gondogeneia* sp. only correlated with amounts of two species of epiphytic algae - *Ulva lactuca* and *Petalonia fascia*. The best predictor of densities of harpacticoids was the amount of filamentous epiphytes.

Experimental techniques developed in this study allowed testing of hypotheses about factors determining distribution of epifaunal crustaceans on their host algae. The results of this study are important in view of the common assumption that epiphytes are generally important for epifaunal crustaceans. No such generality could be reached from this study, and the results suggested that plant - animal interactions in epifaunal assemblages should be studied at finer taxonomic resolution than has been done previously.



Scott, N.A.<sup>1</sup>, White, J.D.<sup>2</sup>, Coops, N.<sup>3</sup>, Whitehead, D.<sup>4</sup> <sup>1</sup>Landcare Research, Private Bag 11052, Palmerston North. <sup>2</sup>Department of Biology, Baylor University, Baylor, Texas, USA. <sup>3</sup>CSIRO Forestry and Forest Products, Private Bag 10 Rosebank MDC, Clayton South 3168, Victoria, Australia. <sup>4</sup>Landcare Research, PO Box 69, Lincoln, Canterbury. **Predicting productivity patterns in New Zealand forest ecosystems**

Factors controlling forest productivity may vary at different spatial scales. We used a simplified physiological model linked to remotely sensed data to quantify forest productivity and biomass accumulation for a wide range of New Zealand forest types. The 3-PG model uses a simple radiation absorption model to calculate photosynthetically active radiation absorbed by a stand (APAR). APAR is then reduced by the effects of drought, vapor pressure deficit and stand age to estimate gross primary production (GPP). The 3-PGS model incorporates a satellite-derived vegetation index reflecting current canopy condition. Both models utilise national-scale climate, vegetation, and soil data layers to quantify spatial patterns of forest productivity. 3-PG explained a significant portion of the variation in national-scale forest biomass based on plot measurements ( $r^2=0.83$ ) using one set of physiological parameters. Errors in forest biomass for different classes were often lower than those obtained from plot measurements. Our results suggest that climate and soil properties are important factors controlling productivity and biomass accumulation in New Zealand forest ecosystems at the national scale across all forest types. This approach provides a mechanism for national-scale assessments of carbon fluxes in forest ecosystems, potentially an important component of future greenhouse gas emissions reporting.

☺ ✉ Laura Sessions and Dave Kelly. Department of Plant and Microbial Sciences, University of Canterbury, Private Bag 4800, Christchurch, New Zealand. E-mail: l.sessions@botn.canterbury.ac.nz. **Estimating the impact of herbivory on endemic New Zealand mistletoes**

Herbivory may limit plant populations by destroying biomass and reducing flowering and seed set. Damage may either accumulate gradually over time on a majority of plants or herbivory may be extremely patchy. This study assessed how these different types of herbivory affect endemic New Zealand mistletoe species (*Peraxilla colensoi*, *Peraxilla tetrapetala*, and *Alepisfiavida*). Mistletoes are becoming increasingly rare throughout the country, and circumstantial evidence suggests herbivory by the Australian brushtail possum (*Trichosurus vulpecula*) poses the greatest threat. We monitored seasonal leaf loss on mistletoes in four South Island beech forests and found that insects on average removed more leaf area than possums. However, possum damage was concentrated on a few plants at certain times, while insect damage occurred on all plants in every season. Possum browse may thus cause more plant mortality for any mean leaf loss at the population level, because the few damaged plants lose significant leaf area. In trials using captive possums, we also found that the animals prefer *Alepis flavidus* over *Peraxilla* spp. foliage and new leaves over old ones. *Peraxilla tetrapetala* was not markedly more palatable than *Nothofagus solandri*. Given these trends, we suggest how mistletoe monitoring should be designed to most effectively and accurately assess mistletoe population health.

Katriona Shea, Tim Woodburn and Andrew Sheppard. CRC for Weed Management Systems, CSIRO Entomology, GPO Box 1700, Canberra, ACT 2601, Australia. **Models for the management of *Carduus nutans* (nodding thistle) in Australia**

Nodding thistle, *Carduus nutans*, is a noxious weed in Australia and is of key economic importance. Our main question is: 'What is the best management strategy for this weed?'. The list of management options includes biological control, herbicides, and grazing management. Given that the results of management are strongly affected by Australia's variable climate, this means that testing all the possibilities, including integrated weed management combinations, in the field would be a mammoth task. However, there are excellent long-term data on the dynamics of *C. nutans*, which we are currently using to develop a model that will take account of all the factors affecting the success of *C. nutans* as a weed. The model is a single species, discrete time, stage-structured, stochastic, seasonal model, the exact structure of which is determined by the field data. Using this model, we hope to find a weak link or "Achilles heel" in the weed life cycle which we can target for most effective control, with the aim of developing an optimal integrated weed management strategy.

☺ ✉ Erica Shedley<sup>1</sup>, Mark Adams<sup>1</sup>, John Pate<sup>1</sup> and Stuart Halse<sup>2</sup>. <sup>1</sup>Botany Department, University of Western Australia. <sup>2</sup>Department of Conservation and Land Management, W.A. **Parrot damage in Tasmanian Bluegum plantations in the south-west of Western Australia.**

Port Lincon ringnecks (*Barnardius zonarius*), locally known as Twenty-eightparrots, are causing severe damage to young plantations of Tasmanian Bluegums (*Eucalyptus globulus*) in the south-west of WA. The parrots strip the bark and scrape the cambium from lead shoots, resulting in deformed and multi-stemmed trees which can be difficult to harvest. A survey of twelve 2 year-old plantations showed that within some plantations, damage was positively correlated with diameter at breast height (DBH) of the trees. Analysis of phloem sap, sampled from small incisions in the bark of *E. globulus* stems, showed that sucrose + raffinose concentration varied across sites from 20 - 31% (w/v) in autumn, being highest in the most water stressed trees, whereas concentration of total amino acids was higher in unstressed trees with high foliar nitrogen. Trees predisposed to parrot damage maintained high concentrations of amino acids and a low C:N ratio in the phloem sap throughout the season. The C:N ratio within stems decreased with stem height and was lowest in the uppermost branches where parrot damage occurred. The apparent preference for faster growing trees may be related to the concentration of protein or amino acids in the sap and cambium material.



Andy Sheppard, Peter Hodge, and Quentin Paynter. \*CSIRO Entomology, GPO Box 1700 Canberra ACT 2601 Australia. \*CSIRO Entomology, Tropical Ecosystems Research Centre, Private Bag 44, Winnellie NT 0821 Australia. **Factors affecting recruitment and survival of Scotch broom, *Cytisus scoparius*, in Australian invaded ecosystems**

*Cytisus scoparius* is a highly invasive temperate leguminous shrub in Australia and New Zealand. A comparative study of factors affecting recruitment replicated at 2+ sites in England and France in the native range, as well as in Australia and New Zealand was set up in 1992/93. The generic experimental design consisted of replicated  $\pm$  grazing,  $\pm$  cultivation,  $\pm$  mature broom and  $\pm$  natural enemy treatments in a series of 5 x 5 m plots at each site. Australian sites also included the state of stand development (immature, mature and senescent) as a factor. Here we present results from Australian sites in the Shoalhaven river system (southern NSW) and compare them to the results already in press from the native range. These Australian sites suffered the highest rates of drought induced seedling mortality. Seedling emergence was highest in mature broom stand than in either immature or senescent stands. Seedling emergence was also higher with grazing but not in either cultivated or broom-removed plots, where seedling densities correlated to the size of the seedbank. Seedling survival was higher in grazed plots and in cultivated and broom-removed plots. Seedling growth was highest with cultivation in mature broom, and with broom-removal in the immature broom stands.

✉ Katherine Short World Wide Fund for Nature New Zealand - Anglian Water Waitangi Fellow. kath.short@wwf.org.nz PO Box 6237, Wellington, New Zealand. **Wetland Management in the United Kingdom: Lessons for New Zealand**

During a recent study tour of wetland management in the United Kingdom the following conclusions were reached: *Legally* the United Kingdom is subject to the European Habitats Directive ensuring wetland protection. New Zealand is subject to the Convention on Biodiversity (CBD) and Ramsar. In the UK, Ramsar is used to protect wetland sites for migrating birds. New Zealand, at the end of the Pacific flyway could provide more, suitable sites for overwintering birds. The UK enforces *financial* penalties for environmental mismanagement whilst encouraging good practice. Financial support for wetland conservation in NZ is limited and competed for. Developing financial penalties for environmental degradation and funding restoration in NZ needs further discussion. *Public awareness* of the place of wetlands as functioning ecosystems in the UK is not high however the Royal Society for the Protection of Birds has 1 million members and support for wetlands as places for migratory birds is high. There is not a high awareness of the functions of wetlands in New Zealand and much could be done. Opinion over the need for a *national policy* is mixed as protection is already gained through Biodiversity Action Planning, and EU Directives. The Department of Conservation is developing a Wetland Action Plan (1998/99). With high local application and support it could ensure enhanced wetland protection.

☺ ☒ Brent J. Sinclair. Department of Zoology, University of Otago, Dunedin, New Zealand.  
**Cloche experiments at high latitudes: Investigating microarthropod response to elevated temperatures at Cape Bird, Ross Island, Antarctica.**

Five cloches have been installed at Keble Valley (Caughley Beach SSSI No 10, Cape Bird, Ross Island, Antarctica 77°14'S, 166°28'E) to assess the potential response of terrestrial microarthropods to anthropogenic climate change. Cloche experiments have been criticised by Kennedy (1995), based upon studies in the maritime Antarctic which found decreased temperatures during periods of early snow cover, and increased relative humidity. Cloches were designed to minimise the side effects described by Kennedy (1995), and plots installed to control for potential shading and migration effects. The cloches increased the surface temperature at least 2.1 °C over control plots, giving an average of 6.4 more hours above 0°C per day. In comparison to the maritime Antarctic, where cloches increased relative humidity, cloches in drier, higher latitude situations may decrease moisture availability by preventing light, rapidly melting snowfalls. A regular sampling regime incorporating surface collection of microarthropods and extraction of soil invertebrates has been instigated, although the extreme patchiness of microhabitat types and invertebrate distribution may reduce the power of the experiment. Kennedy A.D. 1995. *Global Change Biology* 1, 29-42.

☺ ☒ Angus Small and Ian Jamieson. Department of Zoology, University of Otago, Dunedin.  
**Investigating causes of low reproductive success of takahe on offshore islands of New Zealand**

The takahe (*Porphyrio manotelli*) is a large, flightless bird endemic to New Zealand. They were thought to be extinct until their rediscovery in the tussock grasslands of Fiordland in 1948, and are still among the most highly endangered bird species in the world. Although they have been officially protected from direct human disturbance for half a century, takahe numbers have continued to fall and their range in Fiordland has diminished over this time from 4000 km<sup>2</sup> in the late 1960's, to the present 650 km<sup>2</sup> in the Murchison Mountains. Due to this decline, small numbers of takahe were transferred onto four predator-free offshore islands during the mid 1980's. However pairs of takahe breeding in these habitats of the offshore islands have had significantly lower hatching success of eggs than pairs breeding in alpine grasslands of the Murchison Mountains of Fiordland. As part of my Zoology MSc I am investigating possible causes for this low hatching success of takahe eggs by comparing nest site and reproductive parameters of birds breeding on islands (Mana, Maud, Kapiti and Tiritiri Matangi) to those breeding in Fiordland.



J. Smallridge and C. M. Bull. School of Biological Sciences, Flinders University, GPO Box 2100, Adelaide, South Australia. **Ecological interactions at three levels: geographical patterns in lizards, ticks and protozoan parasites.**

Sleepy lizards near Mt Mary, a semi arid study site in the mid-north of South Australia, are the hosts of two ecto-parasitic ticks, *Aponomma hydrosauri* and *Amblyomma limbatum*, and of the endoparasitic haemogregarine protozoan *Hemolivia mariae*. *Hemolivia* develops inside lizard erythrocytes. After these are ingested by ticks, *Hemolivia* develops in the tick gut and epithelial cells, into infective meronts. New lizards become infected with *Hemolivia* when they ingest infected ticks. At the study site the two tick species have an abrupt parapatric boundary. The northern tick species, *Amblyomma limbatum* is very much more susceptible to infection by *Hemolivia*. This is a possible explanation for why *Hemolivia* shows a sharp distributional boundary, coinciding with the tick boundary. It may also contribute to explaining the tick boundary if *Aponomma hydrosauri* is adversely influenced by feeding on infected lizard hosts, or if *Hemolivia* enhances the competitive ability of *Amblyomma limbatum*.

Anita Smyth<sup>1</sup>, David Lamb<sup>1</sup>, Les Hall<sup>2</sup>, Hamish McCallum<sup>3</sup>, Geoff Smith<sup>4</sup> and Damien Moloney<sup>5</sup>. <sup>1</sup>Department of Botany, <sup>2</sup>Department of Veterinary Pathology, <sup>3</sup>Department of Zoology, The University of Queensland, Qld. 4072. <sup>4</sup>Department of Natural Resources, Brisbane. Qld. <sup>5</sup>Department of Environment and Heritage, Brisbane, Qld. **Species as models for studying biodiversity of hollow-dependent bird fauna in commercial native forests**

The significance of hollow-bearing trees for vertebrate fauna dependent on hollows for survival in production forests is being studied in the dry sclerophyll forests of South-East Queensland. Results of this research will be used to assess strategies for species diversity management in commercial native forests. In the region, there are 32 mammal species, 39 bird species and one reptile that use hollows for breeding, roosting or denning. Differences in the ecology of hollow-dependent species predict that hollows will be used in different ways to satisfy their habitat requirements. In this study, available resources make it impossible to study the habitat use of hollows by all species. Ecologists have recognized that use of indicator/surrogate species in some cases misrepresents the complexity of habitat use by different species. One solution is to initially derive guilds, which represent the extremes of the spatial extent of different species to satisfy their biological requires, then choose species as a model of its spatial guild. Hollow-dependent birds are used as a case study to present this approach. Differences in home ranges territoriality and body-hollow size ratio was used as criteria to derive spatial guilds at the forest stand, tree and hollow spatial scales.

☺ ✉ Rachel J. Standish and Alastair W. Robertson. Ecology, Institute of Natural Resources, Massey University, Private Bag 11 222, Palmerston North, New Zealand **Experimental restoration of a weed-affected forest remnant**

*Tradescantia* is a ground smothering weed common to many forest remnants of eastern Australian and New Zealand. Like other invasive creepers, it has the potential to alter vegetation species richness and abundance, as well as ecosystem function (eg. forest regeneration). Also in common with other invasive creepers *Tradescantia* is difficult to eradicate chemically or mechanically. We are trialing an alternative 'green' solution within a *Tradescantia*-affected forest remnant in the Manawatu, New Zealand. The aim of the project is to establish a canopy of natives that suppresses *Tradescantia* through shading, and allows native seedlings to come through. The success of the restoration program depends on answering four sequential questions, only the first of which we can answer at this stage: 1. Can native saplings planted into swards of *Tradescantia* survive and grow? 2. Will planted saplings fill canopy gaps and so overshadow *Tradescantia*? 3. Will *Tradescantia* reduce in biomass in response to reduced light? 4. Will native regeneration occur? This approach, if successful, is less harmful to the environment, more user-friendly and requires less follow-up treatment than chemical and mechanical weed control methods. Lastly, the technique may be applicable to forest remnants with other ground smothering weeds.

☺ Rachel J. Standish<sup>1</sup>, Alastair W. Robertson<sup>1</sup> and Peter A. Williams<sup>2</sup> <sup>1</sup>Ecology, Institute of Natural Resources, Massey University, PB 11 222, Palmerston North. <sup>2</sup>Landcare Research, PB 6, Nelson. **Predicting the *Tradescantia* biomass threshold for forest remnant restoration.**

*Tradescantia* is an environmental weed in New Zealand and eastern Australia, where it carpets the ground in canopy-depleted forest remnants and prevents seedling emergence. We related *Tradescantia* biomass to light levels and native seedling abundance and richness in two forest remnants of the Manawatu Plains, New Zealand. We found that in shaded situations (< 4 % full light), *Tradescantia* does not form a carpet and native seedling emergence occurs (maximum emergence at ~3% full light). Using these data we have been able to predict the *Tradescantia* biomass threshold level for 6 commonly occurring native species. Kohekohe (*Dysoxylum spectabile*) appears to be the most tolerant, occurring in areas where high *Tradescantia* biomass has reduced available forest floor light to 1.8% full light. However, preliminary data suggest that these seedlings don't grow as well as those in reduced *Tradescantia* biomass and increased light. To explore the management implications of these findings we have planted saplings of four native canopy forming species into swards of *Tradescantia*, in an attempt to shade out the weed. The strength of this approach is that it directly addresses the problem (forest degradation) rather than the effect (weed infestation) and avoids the use of chemical spray.



✉ R.J. Stanley<sup>1</sup>, K.J.M. Dickinson<sup>1,2</sup> and A.F. Mark<sup>2</sup> <sup>1</sup>School of Biological Sciences, Victoria University, P O Box 600, Wellington, Present address: Department of Conservation, Private Bag 8, Newton, Auckland, <sup>2</sup>Botany Department, Otago University, P O Box 56, Dunedin, (present address: KJMD). **Demography of a Rare Endemic *Myosotis*: Boom and Bust in the High-alpine Zone of The Dunstan Mountains, Central Otago, New Zealand**

A five-year ongoing demographic study of the extremely localised (ca. 0.5 ha), high-alpine endemic *Myosotis oreophila* and the widespread *M. pulvinaris*, where their ranges overlap has revealed widely fluctuating populations in both species. Three representative permanent plots (290 m<sup>2</sup> or 6.4% of the total population area) were located near the centre and margins of the *M. oreophila* population. High turnover is confirmed by the loss of 1476 *M. oreophila* plants and recruitment of 1600 in the sample population over five years. Three years of good recruitment and one of high mortality indicate that the total population has varied by ca. 40% (max. 21,800; min. 13,000) over five years. It can be assumed that the whole population has essentially turned over in this time but verification needs more detailed analyses. The partially overlapping, but inversely related, distributions and density patterns of the leafy *M. oreophila* and cushion *M. pulvinaris* have revealed similar demographic patterns and no indication that either is changing its status along their respective margins. We tentatively endorse the rare status currently assigned *M. oreophila* since the population, although extremely local, appears capable of maintaining itself despite a surprisingly rapid turnover of individuals and perhaps the total population in a habitat where longevity of the flora previously has been assumed.

Harald Steen<sup>1</sup> and Kjell E. Erikstad<sup>2</sup>. <sup>1</sup>Zoology Department, University of Otago, PO Box 56, Dunedin. <sup>2</sup>NINA, Department of Arctic Ecology, Storgaten 25, N-9005 Tromsø, Norway. **Sensitivity of willow grouse population dynamics to variations in demographic parameters.**

In order to estimate the potential importance of each of the demographic traits (egg-, chick-, and apparent winter survival) on willow grouse population dynamics we performed a sensitivity/elasticity analysis on a general model for rate of growth of numbers of breeding willow grouse hens. The demographic parameters used were taken from a 21 year study of willow grouse population dynamics on a Norwegian island. Growth rate of the number of breeding hens might be sensitive to changes in a parameter either because of the model structure or because there is substantial between year variation in the parameter. We therefore used three measures of parameter importance: sensitivity, elasticity and an actual elasticity coefficient (AE-coefficient). Considering elasticity coefficients alone, apparent winter survival compared to survival from egg laying to 4 weeks had 2.3 times the impact on  $\lambda$ . Both, Elasticity coefficients and AE-coefficients indicate that apparent winter survival was the most important parameter in determining changes in  $\lambda$ . Thus, management efforts on willow grouse should be devoted towards improving winter survival rather than increasing chick production.

Josh Stern, School of Biological Science, University of New South Wales, Sydney, Australia, 2052. j.stern@unsw.edu.au. **The varying effects of brown algal phlorotannins: animal physiology or phlorotannin structure?**

Temperate marine brown algae commonly produce polyphenolic secondary metabolites (phlorotannins) that deter some (not all) marine herbivores. Phlorotannins may be deterrent because they bind strongly to proteins, and may thus inhibit herbivore digestion. A comparison of Australian and Californian marine invertebrate herbivores indicated that they differ in their willingness to consume high phlorotannin diets (Steinberg et al. 1995). I therefore examined Australian and Californian herbivore assimilation efficiency (AE) of phlorotannin-rich seaweeds. I found that Californian, but not Australian herbivore assimilation efficiency was affected by seaweed phlorotannins. To determine if this difference was explained by differences in gut conditions, I compared herbivore gut pH, redox state, and detergency. Surprisingly, gut conditions in Australian herbivores appeared to be more favourable to phlorotannin-protein binding, despite their better AE of phlorotannin-rich seaweeds. However, subsequent tests suggested that the intrinsic protein-binding ability of Australian phlorotannins was comparatively lower, perhaps explaining the limited effect of Australian phlorotannin on AE in these herbivores. This intrinsic difference in protein-binding ability between phlorotannins may result from an observed difference among phlorotannin structures (based on <sup>13</sup>C NMR data). Finally, these data also suggest that Australian phlorotannins may function as toxins under certain conditions, raising the question of how these herbivores cope with this potential deleterious effect.

Jacqui Stol and Jill Landsberg. CSIRO Wildlife and Ecology, PO Box 84, Lyneham, ACT 2602, Australia. **Regional variation in composition of arid rangeland seedbanks**

After rain, large areas of Australia's usually dry rangelands bloom with ephemeral vegetation emerging from rich soil seed stores. We investigated these seed stores in five different plant communities in the arid rangelands: two were subtropical mulga woodlands with summer-dominated rainfall, and three were temperate chenopod shrublands with winter rainfall. Seedbanks were assessed by glasshouse germination of moistened soil samples, maintained under warm and cool season temperatures. All the communities were rich in species (total numbers 104-181), but with major differences in composition between the seed bank and standing vegetation. Differences were most pronounced in the mulga woodlands, where only 10-16% of species occurred in both the seedbank and the standing vegetation, and 46-56% of all species were found only in the seedbank. The overlap was a higher in chenopod communities (17-23% of species in both seedbank and standing vegetation), and fewer species (23-32%) were detected only in the seedbank. In all the communities, the seedbanks were dominated by grasses and forbs, nearly half of which were annuals. Many species germinated successfully under both cool and warm season conditions, regardless of the climate zone from which they came.



☺ Wendy J. Stubbs and J. Bastow Wilson. Botany Department, University of Otago, PO Box 56, Dunedin, N.Z. **Niche limitation in an Otago salt marsh**

The degree of niche separation between species co-occurring in an Otago salt marsh was calculated to seek evidence for constraints on the ability of species to coexist when similar in resource use. Species niche was measured using 20 morphological variables generally believed to affect plant resource acquisition. The variance in niche separation observed within the salt marsh was then compared with the variance estimated from a null model. Significantly lower variance in the observed community indicates niche differentiation.

☺ ☒ Liz Sutherland, School of Biological Sciences A08, University of Sydney, NSW 2006, and Forest Conservation Unit, NSW National Parks and Wildlife Service, PO Box 1967, Hurstville NSW 2220, Australia. [liz.sutherland@npws.nsw.gov.au](mailto:liz.sutherland@npws.nsw.gov.au) **Fire, Resource Limitation and Small Mammal Populations in Coastal Eucalypt Forest**

This study aimed to quantify the responses of *Rattus fuscipes* and *Antechinus stuartii* populations to resource availability after fire, by experimentally manipulating levels of food and nest site availability in burnt eucalypt forest. Results indicated an initial increase in *R. fuscipes* abundance in response to food addition, concomitant with improved body condition at the same sites during the first winter. The response was not sustained, however, and neither food nor nest addition had a significant effect on the abundance of *R. fuscipes* populations over the two year duration of the study. Similarly, *A. stuartii* initially responded to food supplementation, although the effects appeared to diminish over time. There was some evidence that as *A. stuartii* populations increased in response to food, nest availability became a limiting factor. Food supplementation also affected the social structure of *A. stuartii* populations by reducing dispersal and increasing longevity of males within food supplementation sites. Overall, this study indicates that patterns of small mammal population recovery after fire are not driven solely by resource availability. I suggest that the different population responses to fire, reported between this and other studies, are likely to be a result of interspecific competition within a species pool unique to each study site.

Roy Swain<sup>1</sup> and Corinna Kik<sup>1,2</sup> <sup>1</sup>School of Zoology, University of Tasmania, Australia.

<sup>2</sup>Department of Animal Ecology and Morphology. University of Ulm, Germany. **Eco-Behavioural Trade-offs Associated with Pregnancy in the Southern Snow Skink, *Niveoscincus microlepidotus*, from Tasmania**

*Niveoscincus microlepidotus* is a small, viviparous skink (3-5 g) restricted to high altitudes in southern Tasmania. Females reproduce biennially, and the embryos, although fully developed by the end of summer, are carried overwinter and born during the following spring and early summer. Consequently, pregnant and non-pregnant adults may be studied contemporaneously. Trade-offs associated with pregnancy were investigated over a six-month period, from November 1997 to March 1998. Pregnant females ran just as fast and jumped just as far as non-pregnant females but their stamina was reduced. They selected basking sites that were closer to the ground and closer to a retreat. There were no differences in wariness, as measured by recognition distance or response distance to an approaching observer. Similarly, no differences in basking frequency were observed, although in the laboratory both pregnant and non-pregnant females spent more than twice as much time basking as males. Body temperature (T<sub>b</sub>) was monitored in the laboratory using free-ranging animals with thermocouples attached. Pregnant females maintained significantly lower average daily T<sub>b</sub>s and experienced significantly lower maximum T<sub>b</sub>s; much shorter periods were spent at high temperatures by pregnant animals.

☺Marita Sydes and Rod Peakall. Division of Botany and Zoology, The Australian National University, Canberra, ACT 0200, AUSTRALIA (marita.sydes@anu.edu.au). **Male sterility as a factor contributing to the lack of sexual reproduction in the endangered shrub *Haloragodendron lucasii*.**

An understanding of factors limiting a species reproductive biology should a priority area of research in threatened species. This is especially true for species existing in small populations where seed production is thought to be limited. For the endangered shrub *Haloragodendron lucasii* the finding of extensive clonality and only seven genetic individuals suggested that the species was not be capable of sexual reproduction. Further support for the lack of sexual reproduction in *H. lucasii* comes from the observation of no fruit set in the field since its rediscovery in 1986. Observations suggested that *H. lucasii* may have low male fertility. This study confirmed that *H. lucasii* was effectively male sterile by comparing the level of male fertility in *H. lucasii* to that of three sexual congeners. Characters measured included pollen grain numbers, anther dehiscence and pollen viability. The confirmation that *H. lucasii* is male sterile has already had a role in setting the current conservation management priorities for this endangered shrub. Current management options will be outlined, along with a possible origin of male sterility and the future prospects for this endangered species.



©Elizabeth Tasker<sup>1</sup>, Christopher Dickman<sup>1</sup>, and Ross Bradstock<sup>2</sup> <sup>1</sup>School of Biological Sciences A08, University of Sydney, NSW 2006, Australia <sup>2</sup>Biodiversity Survey and Research Division, NSW National Parks & Wildlife Service, PO Box 1967, Hurstville 2220, Australia. **Small Mammal Diversity and Abundance in Relation to Understorey Structure in the Managed Eucalypt Forests of Northern New South Wales, Australia**

We tested the hypothesis that the diversity and composition of small mammal communities is correlated with understorey complexity. This was undertaken as part of an ongoing project on the impacts of cattle grazing and associated frequent burning by farmers, on the biodiversity in eucalypt forests in NSW. Twelve sites in wet sclerophyll forest, distributed over 50 km, had a management history either of cattle grazing and associated frequent burning (6 sites), or of minimal cattle grazing and infrequent fire (6 sites). The sites were chosen using a GIS database to be otherwise very similar in terms of forest type, elevation, topographic position, geology, and logging history. Grazed/burnt sites had an open, grassy understorey with relatively few shrubs, whereas ungrazed/infrequently burnt sites had a dense and structurally complex shrub understorey. Fourteen months of trapping at these sites revealed that the ungrazed/complex sites have significantly more abundant, but less diverse, small mammal communities. The abundances of both Brown Antechinus *Antechinus stuartii* and Bush Rat *Rattus fuscipes* at the ungrazed/complex sites are amongst the highest ever recorded in Australia. The grazed/burnt sites also had a different species composition compared to the ungrazed/complex sites.

Charlotte E. Taylor. School of Biological Sciences F07, The University of Sydney, NSW 2006, Australia. **The pollination biology of pioneer rainforest trees: studies from the Euphorbiaceae**

Plants described as pioneers frequently demonstrate a breeding system characterised by frequent or continuous flowering periods resulting in a high level of seed production and subsequent dispersal by a variety of biotic agents. There has been considerable debate about the relative importance, for such species, of maintaining genetic variability through outcrossing. Such discussions of effective breeding systems require detailed knowledge of the potential for, and success of, pollination, particularly for trees in which mature male and female flowers are separated temporally or spatially. Possible limitations in effecting pollen movement may be further compounded for species where there are few, if any, apparent lures or rewards for biotic pollinators. The current study presents data on floral morphology, timing of floral events, and movement of pollen between male and female flowers for rainforest species in the Euphorbiaceae. Flowers of *Macaranga* and *Glochidion* are characteristically small, green and much reduced or modified, generally with little fragrance or nectar. Thus they appear to provide few of the lures or rewards usually associated with potential pollinators. The outcome of floral events in these genera is discussed.

✉Charlotte E. Taylor School of Biological Sciences F07, The University of Sydney, NSW 2006, Australia. **Isolation and fragmentation in rainforests: preliminary studies on the breeding system of *Glochidion* (Euphorbiaceae).**

Rainforest plants in Australia have experienced a variety of disturbances or isolation events associated with the phenomenon of fragmentation. While such fragmentation is usually assumed to be due to anthropogenic processes, this may not always be the case. Tropical taxa, which are restricted to rainforest areas, may inevitably be subject to relatively increased isolation, in more southerly latitudes of Eastern Australia, due to the naturally fragmented distribution of rainforest. The current study proposes to determine the degree to which the breeding system of species of the tropical genus *Glochidion* (Euphorbiaceae) may be affected by isolation. It is speculated that the breeding system, and hence genetic variation within and between individuals and populations will vary across a latitudinal gradient as pollinator guilds change. The possible compounding effects of natural isolation and anthropogenic disturbance will be discussed.

😊 Jennifer E. Taylor<sup>1</sup> and Peter S. Harlow<sup>2 1</sup> School of Biological Science, University of NSW, NSW 2052. <sup>2</sup> School of Biological Sciences, Macquarie University, NSW 2109. **Consequences of temperature-dependent sex determination in a field population of agamid lizards**

Temperature-dependent sex determination (TSD) occurs in all crocodiles, some turtles and a few lizards. In Australian agamid (dragon) lizards, TSD and genetic sex determination occur in closely related species. We present the first field data on reproduction and growth rates in a TSD lizard, the Australian jacky lizard (*Amphibolurus muricatus*). High and low incubation temperatures produce only females, while intermediate temperatures hatch males in varying proportions. Eggs are laid from October to February and early hatching lizards attain a greater body size in their first year than late hatchers. Both sexes may increase future reproductive fitness by early hatching: females via the fecundity advantage of larger body size, and males due to the body-size advantage in male-male combat for territories containing females. However, a large male with a harem of several females will have a disproportionate fitness benefit from early hatching compared to a large female. Thus, as nest temperatures increase in a predictable manner from spring through summer, if TSD has an adaptive significance, we would expect relatively more males to be allocated to early hatching clutches than females. We investigated the possible significance of TSD by comparing sex differences in emergence time and growth of hatchlings in the field.



✉ Wendy Telfer and José M. Facelli. Department of Botany, The University of Adelaide, Adelaide, SA. **The effect of shrubs on *Eucalyptus incrassata* recruitment in an abandoned pasture in the Murray Mallee.**

The main aim of this project was to investigate how the establishment of tree seedling in abandoned pastures in mallee areas is affected by the presence of shrubs. We examined the effects of *Acacia calamifolia* and *Baeckea behrii* shrubs on recruitment of *Eucalyptus incrassata* from Spring to Autumn. Because herbaceous abundance is lower under shrubs we expected reduced competition under canopies. We placed seeds, and planted seedlings of *E. incrassata* in plots beneath shrubs and in open spaces. Half of the plots had herbaceous vegetation removed. Field germination rates were low, and only occurred beneath shrubs, but all seedlings died within two weeks. Shrubs strongly inhibited seedling establishment. Seedling biomass, height, leaf area, and leaf number were greater in the open than beneath the shrub canopies after seven month. The presence of herbaceous vegetation had no effect on seedling growth or survival, and thus no indirect facilitation occurred. We found little evidence that facilitation is a more dominant mechanism in these more arid regions than in the more mesic regions where most oldfield studies have been previously conducted.

Alan Tennyson, Collection Manager Birds, Museum of New Zealand Te Papa Tongarewa, WELLINGTON, PO Box 467, New Zealand. **The history of bird extinctions on Pitt Island, Chatham Islands**

More than 10,000 fossil bird bones of about 50 species were collected on Pitt Island (6,190 ha) in the Chatham group (east of New Zealand) between c1920 and 1997. More than half of these species no longer occur on Pitt Island and 11 are totally extinct. Some of these deposits are up to 4,500 years old. Apparently the most common birds used to be small burrow nesting seabirds - a prion (*Pachyptila* sp.) and diving petrel (*Pelecanoides urinatrix*) - which are now extinct on the island. Other species commonly found in deposits include the extinct Dieffenbach's rail (*Gallirallus dieffenbachii*) and a crested penguin (*Eudyptes* ?n. sp.) and the threatened Chatham Island pigeon (*Hemiphaga chathamensis*) and Chatham Island petrel (*Pterodroma axillaris*). Albatrosses (*Diomedea* sp.) once used to nest on the island. The reasons for the demise of the avifauna are due to the introduction of pigs, cats, wekas (*Gallirallus australis*), land clearance for farming and probably human hunting during the last 500 years.

☺ ☒ R.M. Thompson and C.R. Townsend. Department of Zoology, University of Otago, PO Box 56, Dunedin, New Zealand. **The effects of land use on stream community attributes.**

The effects on stream communities of riparian conversion from tussock to intensive agriculture were assessed through a study of six streams in two sub-catchments of the Taieri River. Food-web attributes of the invertebrate and fish communities were compared between the agricultural (Lee Stream) and the tussock sub-catchments (Healy Creek). Despite increased amounts of nitrates and organic matter in agricultural streams there was no evidence of these physicochemical changes affecting community attributes. Algal production and biomass were broadly comparable between the two land uses, and there was no evidence of differences in invertebrate biomass. More detailed analysis of the food webs also indicated no differences in community structure: number of species, connectance, number of links per species and mean chain length were unaffected by land use. Other measures of community structure such as predator-prey ratios and the number of species at different trophic levels and in different functional feeding groups also revealed little evidence of differences between land uses. The only exception were significantly higher densities of shredder and omnivorous species in agricultural streams. The absence of changes in food-web structure despite clear evidence of physicochemical changes may indicate a high degree of resilience in these communities.

Fleur Tiver School of Environmental Management, University of South Australia, Mawson Lakes, SA 5095, Australia. **Regeneration patterns in mulga (*Acacia aneura*) in southern and central South Australia**

Trunk girth measurements and stage-structure descriptions were used to compare the regeneration status of populations of mulga (*Acacia aneura*) in the southern chenopod shrublands and north-western grasslands of South Australia. Mulga is failing to regenerate in the chenopod shrublands, except where protected from sheep grazing. In the far north west of South Australia, past overgrazing by cattle is associated with increased regeneration in mulga. Rabbits appear to have nil or minor effects compared to the ungulate herbivores in either case.



☺✉ Matt Todd and Hazel Chapman. Plant and Microbial Sciences, University of Canterbury, Christchurch, New Zealand. **Isozyme variation and gene flow within and between populations of an ecologically restricted species, *Heliohebe lavaudiana* (Scrophulariaceae).**

While genetic variation in populations of species with widespread and/or continuous distributions is often studied, little is known of the population mechanics of species restricted both geographically and ecologically. *Heliohebe lavaudiana* is such a species, found only on the scattered basalt rock outcrops of Banks Peninsula. We wish to know the degree of variation within and between populations of *H lavaudiana*, the effect of gene flow upon this figure with respect to the geographical distance between populations, and any implications that this may have on the long term fitness of the species. Four main population 'clusters' are identified, each containing between four and ten populations in reasonably close proximity. Cuttings from sixteen populations have been propagated for use both as a source of fresh material for isozyme analysis and for future pollination experiments. Ten isozyme loci are currently being examined using starch gel electrophoresis. Future experiments include the examination of known inter-population hybrids, and the effects of stress upon the expression of the phenotype. Current data suggests that variation between population is low for several loci, but that, for other loci, the Akaroa cluster is showing marked differences to the remainder of the populations.

David Towns<sup>1</sup>, Charles Daugherty<sup>2</sup> and Alison Cree<sup>3</sup>. <sup>1</sup>Department of Conservation, PO Box 68908, Newton, Auckland. <sup>2</sup>Victoria University of Wellington, Private Bag Wellington. <sup>3</sup>University of Otago, PO Box 56, Dunedin. **Raising the Lid from a Forgotten Fauna: a Review of Ten Years of Conservation Effort for New Zealand Reptiles**

The native terrestrial reptile fauna of New Zealand comprises the last representatives of the Sphenodontida - two species of tuatara (*Sphenodon*) - and about 60 species of lizards in four endemic genera: *Hoplodactylus* and *Naultinus* (*Gekkonidae*), *Cyclodina* and *Oligosoma* (*Scincidae*). The entire fauna is strictly protected by legislation, but both species of tuatara, one quarter of the geckos and half of the skinks are now regarded as requiring urgent conservation action. The most widespread problem appears to have been predation by introduced mammals. Tuatara and many resident species of lizards on islands now have improved prospects following successful campaigns to eradicate introduced predatory mammals, especially rodents. In addition, 12 species of lizards and both species of tuatara have been reintroduced to islands within their former range once predators were eradicated. Habitat destruction and introduced predators remain as particular problems in the mainland North and South Islands. Solutions may come from targeted predator control and innovative new approaches to ecosystem management.

Colin Townsend<sup>1</sup>, Todd Crowl<sup>2</sup>, Alex Flecker<sup>3</sup>, Angus McIntosh<sup>4</sup> and Alex Hury<sup>5</sup>.

<sup>1</sup>Department of Zoology, University of Otago, Dunedin, New Zealand. <sup>2</sup>Ecology Center and Department of Wildlife, Utah State University, USA. <sup>3</sup>Department of Entomology, Cornell University, USA. <sup>4</sup>Department of Zoology, University of Canterbury, New Zealand.

<sup>5</sup>Department of Biological Sciences, University of Maine, USA. **Individual, population, community and ecosystem consequences of a trophic cascade in some New Zealand streams**

A challenge confronting ecologists is the integration of processes at various levels in the ecological hierarchy. We review a series of coordinated studies in some New Zealand streams that address this problem. Our approach has ranged from extensive descriptive studies of distributions, through experimental studies in artificial channels, to comparative studies in contrasting streams. Brown trout (*Salmo trutta*) have replaced non-migratory galaxiid fishes in some streams but not others. At the level of individuals, both galaxiids and invertebrates show changes in behaviour as a result of the arrival of trout. These changes influence populations by altering their interactions with their prey. At the community level, when trout are present populations of grazing invertebrates are suppressed and algal biomass is enhanced. Finally, at the ecosystem level, essentially all invertebrate production is consumed by trout (but not by galaxiids) and algal primary productivity is six times higher in a trout stream. The introduction of trout to these small streams has resulted in strong top-down control of community structure and ecosystem functioning via its effects on individual behaviour and population distribution and abundance.

S. A. Trewick<sup>1</sup> and T. H. Worthy<sup>2</sup>. <sup>1</sup>Department of Zoology, University of Otago, PO Box 56, Dunedin. <sup>2</sup>Palaeofaunal Surveys, 43 The Ridgeway, Nelson. **Origins and prehistoric ecology of takahe: flightless *Porphyrio* (Aves: Rallidae).**

Despite twice being considered extinct and now certainly rare and therefore difficult to study, much is known about takahe ecology. Considerable information about the prehuman distributions and ecologies of takahe have been recovered from fossil material deposits. The takahe, *Porphyrio mantelli* was described from fossil material collected at Waingongoro in the North Island. A second species (*P. hochstetteri*) was later described from an individual collected near Te Anau, South Island. Recent morphological and molecular studies using fossil bones have confirmed the distinct specific status of the birds. This work indicates two independent evolutionary origins from similar flying ancestors akin to the Pukeko. *P. mantelli* (extinct) was restricted to the North Island and is known from 79 sites. Most are lowland and range in age from Pleistocene to Late Holocene. The distribution of fossil sites and composition of associated avifaunas suggest that NI takahe preferred forest edges at dunes and wetlands, or where areas of shrubland might be expected. *P. hochstetteri* was restricted to the South Island and survives as a relict population in subalpine Fiordland. This species is known from 49 sites, mostly in lowlands. During the Pleistocene SI takahe lived in grassland/shrubland mosaics in northwest Nelson. In the Holocene, it frequented lowland, mainly eastern regions where forest – shrubland - grassland mosaics existed. It is evident that the surviving takahe are a relict population living in a marginal habitat. This is presumably the result of the combined effects of extirpation from more hospitable habitat and the plastic autecology of the species.



☺ Stephen C. Ulrich, Glenn H. Stewart, Richard P. Duncan and Peter. C. Almond. Ecology and Entomology Group; Soil, Plant and Ecological Sciences Division; PO Box 84; Lincoln University; Canterbury. **Species coexistence following periodic disturbances in a mixed conifer/ beech/ hardwood forest, Mt. Harata, north Westland.**

We examined patterns of disturbance and stand development in a poorly drained 0.3 hectare plot in mixed conifer/ beech/ hardwood forest, in north Westland. Three major periods of disturbance occurred about 275 yrs, 190-200 yrs and between 160 and 170 yrs ago, based on evidence from tree population structures, annual growth-ring releases and the spatial distribution of trees in the plot. Different suites of species were recruited at different times, with the most extensive disturbance c. 275 yrs ago resulting in stand wide recruitment of almost exclusively conifer species (*Dacrydium cupressinum*, *Dacrycarpus dacrydioides*, *Libocedrus bidwillii* and *Podocarpus hallii*). Subsequent and less extensive disturbances resulted in the recruitment of *Nothofagus menziesii* and an upsurge in recruitment of *D. dacrydioides* about 200 yrs go, and *N. fusca* and *Elaeocarpus hookerianus* 160-170 yrs ago.

After the same disturbance, species partitioned establishment sites according to substrate characteristics (eg, logs and mounds versus forest floor, and within forest floor microsites along a gradient of peat texture). Our results, therefore, suggest that species coexist by (1) differential response to disturbances of varying extent and (2) fine-scale differences in the regeneration niche following disturbance.

☺ Rodney van der Ree and Andrew Bennett. School of Ecology and Environment, Deakin University, 662 Blackburn Rd, Clayton 3168, Victoria. **The spatial arrangement of the Squirrel Glider, *Petaurus norfolcensis*, in a network of linear habitats.**

The capacity of fauna to survive within fragmented ecosystems is a critical issue in conservation today. This is particularly pertinent in the northern plains region of Victoria where approximately 6.2% of remnant tree cover remains. Within the study area near Euroa, remnant vegetation cover is less than 2%, and the majority of this is located along roads and streams, forming an almost continuous network of linear habitats ranging in width from 20 to 40m. Within this landscape of highly connected linear habitats, a diverse and abundant arboreal marsupial fauna exists. At least 11 species of mammal utilise the linear habitats, with a number of woodland-dependent species primarily restricted to the linear remnants. The spatial organisation of the 'vulnerable' Squirrel Glider was determined by radiotracking 20 individuals between January and March 1998. Home range length along the linear remnants varied between 500 and 1400m, and home range area was between 1.5 and 4 ha. Home ranges were largely linear in shape, however all gliders also incorporated isolated trees or clumps of trees in paddocks into their range when such habitat features were present. This study highlights the importance of linear remnants for habitat and connectivity in highly fragmented landscapes.

✉ C. Vanderwoude<sup>1,2</sup>, L. A. de Bruyn<sup>2</sup> and A. P. N. House<sup>1</sup>. <sup>1</sup>Queensland Forestry Research Institute. M.s. 483 Fraser Rd Gympie, Qld. 4570, Australia. <sup>2</sup>University of New England, Armidale N.S.W. 2351, Australia. **Invasion by *Pheidole megacephala*: a threat to biodiversity of undisturbed forests in south-east Queensland**

The tramp ant *Pheidole megacephala* (Fabricus) is a well-known household pest of urban areas of coastal Australia. Establishment and spread of *P. megacephala* colonies has been regarded as only possible at disturbed sites. However, an established colony of *P. megacephala* has been found in an apparently undisturbed open forest near Maryborough in south-east Queensland. Typical open-forest ant communities in this region are characterised by species-rich assemblages dominated by species of *Iridomyrmex*, *Rhytidoponera* and other *Pheidole*. However where *P. megacephala* were recorded, these species were virtually absent. Most notably, *P. megacephala* has completely displaced Dominant Dolichoderines (species of *Iridomyrmex*) and Subordinate Camponotini (species of *Camponotus Opisthopsis* and *Polyrhachis*) as well as all other species of *Pheidole*, which are also common in forest areas. Baiting with tuna revealed three distinct zones: (i) totally dominated by *P. megacephala*, where few other species were detected, (ii) an intermediate zone where Opportunists (species of *Ochetellus* and *Paratrechina*) competed with *P. megacephala* at baits; and (iii) *P. megacephala* were absent and many other species were recorded. Further monitoring is required to detect other infestations in forest areas. Machinery-treatment programmes are also needed to prevent future introductions of this species to other forests.

☺ Karl Vernes<sup>1</sup> and Daniel T. Haydon<sup>2</sup>. <sup>1</sup>Department of Zoology and Tropical Ecology, and the Cooperative Centre for Tropical Rainforest Ecology and Management, James Cook University, Townsville, Qld, 4811, Australia. <sup>2</sup>Department of Zoology, University of British Columbia, Vancouver, BC, V6T 1Z4, Canada. **The effects of fire on the foraging patterns and habitat use of a mycophagous marsupial.**

A study of movement paths of the northern bettong (*Bettongia tropica*) was undertaken to examine the foraging patterns and habitat use of a mycophagous marsupial within burnt and unburnt habitats in Australian fire-prone forest. Analysis of step lengths and turning angles of movement paths revealed that bettongs exhibited area-restricted search behaviour by taking significantly shorter steps and more acute turns following successful foraging. Prior to a foraging event where truffles were recovered, bettongs took shorter steps and more acute turns indicating that truffles were detected one step prior to being recovered. After the experimentally induced fire, bettongs had equal access to burnt and unburnt habitat, but significantly more bettongs chose to forage in the burnt habitat during this time. In burnt habitat bettongs experienced higher probabilities of truffle recovery, were less likely to investigate previously existing diggings and undertook more acute turns when traversing the landscape. The greater foraging success experienced on recently burnt habitat combined with a tendency to exhibit area restricted search behaviour probably explains the significantly higher turning angles observed on burnt versus unburnt habitat.



J. A. Vranjic and R. H. Groves. Co-operative Research Centre for Weed Management Systems, c/- CSIRO Plant Industry, GPO Box 1600, Canberra ACT 2601 Australia.

**Restoration of coastal Australian vegetation invaded by the South African weed *Chrysanthemoides monilifera* subsp. *rotundata*.**

The shrub *Chrysanthemoides monilifera* subsp. *rotundata* (Bitou bush; Asteraceae), was introduced to Australia from South Africa at the turn of the century. To date, it has invaded a large proportion of the southeastern Australian coast, and, although it naturally inhabits coastal dune systems, *C. m. rotundata* in Australia has invaded adjoining heath, woodland and forest communities. Its impact has been to reduce native plant diversity and alter the habitat for animal species. *Chrysanthemoides* presently can be controlled in several ways: by spraying with low levels of glyphosate; by hand-pulling of seedlings; and by the introduction and release of South African herbivores shown to be specific to *C. monilifera*. In a coastal conservation reserve, a field experiment is determining the effects of prescribed fire accompanied by augmentation of seed of native species in an area previously sprayed with herbicide to control *C. m. rotundata*; an introduced biocontrol agent, the tip moth (*Comostolopsis germana*), also has established at the site. We are monitoring the establishment of introduced and native plant species as well as changes in the soil seed bank. In addition, glasshouse experiments are evaluating the competitive and allelopathic effects of bitou bush. When completed, the results from these experiments will aid the development of an integrated management strategy for coastal vegetation invaded by *C. m. rotundata*, in which the establishment and growth of a range of dominant native species are promoted and the growth and fecundity of invasive species progressively weakened. A management strategy for weed invaded natural vegetation which ignores the deliberate promotion of competitive native species as part of a restoration program will be ineffective in the long-term; it may result in the replacement of the weedy species *C. monilifera* by other equally undesirable invasive species (e.g. *Polygala myrtifolia*).

Steve Wagstaff and Peter Wardle. Landcare Research, Lincoln; Carlos Ramirez, Universidad, Austral de Chile, Valdivia; Cecilia Ezcurra, Universidad del Comahue, Bariloche, Argentina. **Phylogenetic relationships of Southern Andean and New Zealand plants**

Phylogenetic analysis of *rbcL* sequences from related species found in the Southern Andes and New Zealand yield low genetic distance values. Progressively greater values are observed in comparisons among taxa at higher taxonomic ranks. The inferred branching order in our phylogenetic trees corresponds to the fossil record; the basal lineages in our phylogeny are comprised of taxa that appear early in the fossil record. There is significant rate variation across lineages which makes it difficult to apply a molecular clock to these data, however even the most conservative estimates suggest that only a fraction of the shared lineages appeared before the initial break-up of Gondwana 80 mya. Long-distance dispersal probably accounts for much of the floristic similarity between New Zealand and South America. Antarctica was probably an important corridor for dispersal between these two regions, as there is fossil evidence that the Trans-Antarctic Mountains supported woody vegetation as late as the Pliocene.

C-H. A. Wahren<sup>1</sup>, R. J. Williams<sup>2</sup> and W. A. Papst<sup>3</sup> <sup>1</sup>School of Agricultural Science, LaTrobe University, Bundoora, Victoria 3083, Australia. <sup>2</sup>CSIRO Division of Wildlife and Ecology, PMB 44 Winnellie, NT, 0821, Australia. <sup>3</sup>Center for Land Protection Research, Bendigo Victoria, Australia. Current Address: School of Agriculture Science, LaTrobe University, Bundoora, Victoria 3083, Australia. **The ecology of alpine and subalpine wetland vegetation of the Bogong High Plains, south-eastern Australia.**

Wetlands are among the most sensitive plant communities in the Australian Alps. Their total area is relatively small, they are vulnerable to disturbance and have high conservation value. In 1996, the identification and spatial arrangement of vegetation units within wetlands was determined for a range of sites across the Bogong High Plains. Manipulative experiments investigating ecological processes in several key species were carried out between 1991 and 1995. These studies showed that most wetlands comprised a closed wet heath that included the peat forming moss *Sphagnum cristatum*, low open heath, and open herbfield that occurred on a stony substratum dominated by hygrophylous herbs. The condition of surveyed sites suggested that wetland vegetation was degraded. Experiments using fragments of *Sphagnum* and two open herbfield species showed that detached pieces of these plants will colonise stony pavements. *Sphagnum* established best on or among other plants, but failed to survive on gravel or sand. Survival of *Sphagnum* fragments was significantly higher in areas of low-energy water flow than in areas of high-energy water flow. Cattle activity clearly reduced survival and establishment of both *Sphagnum* and the two open herbfield species by direct trampling of fragments and by reducing the abundance of suitable microsites.

✉ Susan Walker. Landcare Research NZ Ltd, **Vegetation dynamics in semi-arid vegetation, Central Otago, New Zealand.**

Several phenomena which have been suggested to be characteristic of semi-arid vegetation worldwide, are investigated in semi-arid short tussock grassland in Central Otago, New Zealand, using perturbation experiments. This vegetation is not at equilibrium, as has been suggested for areas of semi-arid vegetation elsewhere, and environmental control of vegetation changes appears complex. A formal test gave no evidence for stability, but suggests that stabilising processes exist. Continuous changes in response to release from grazing conform with the Range Succession Model, although barriers to succession are probably present. No discontinuous, event-driven changes became apparent within the study period to suggest State-and Transition dynamics. Quantitative vegetation changes brought about by perturbation are rapidly reversed under heavy rabbit-grazing, but not where rabbit grazing is low or absent. It remains to be determined whether changes in species composition are persistent, indicating the existence of alternative stable states, and whether trajectories of vegetation change depend on environmental conditions at the time of perturbation. Although elements of the range succession model, the ball-and-cup analogy of alternative stable states, and of annuation and pulse phenomena, may be seen in the vegetation of Central Otago, the vegetation does not strictly conform with any of these models.



© David Ward. Australian Flora and Fauna Research Centre, University of Wollongong, Wollongong, **Recruitment and growth of the subtidal gastropod, *Turbo torquatus*, in New South Wales, Australia.**

In southern New South Wales, adults of the large subtidal gastropod, *Turbo torquatus* are generally associated with kelp and turf habitats. The aim of this work was to establish how recruitment of this gastropod varied with habitat. Recruitment estimates of *Turbo torquatus* were made at the three main subtidal habitats (kelp, turf and urchin-dominated barrens) found at depths of 3-5m along the coast of New South Wales. Estimates were made at two sites near Wollongong (34°30'S., 150°55'E.), North Big Island and South Big Island, using a suction sampling device. Sites were separated by approximately 1km and were sampled in January and February 1997. Recruitment was evident in the kelp and turf habitats with densities as high as 500/m<sup>2</sup> recorded. No recruits were recorded in the barrens habitat. At both sites there were positive correlations between recruit density and cover of coralline turfing algae. Sampling was continued in the turf habitat every 4 months at both sites until January 1998. This allowed me to calculate growth rates for the 0+ cohort from modal progression of the length-frequency distributions. Recruitment occurred twice a year supporting gono-somatic index data which indicates two spawnings per year. In summary recruitment in *Turbo torquatus* was strongly linked to habitat. This will be the focus of further research.

Peter Wardle and Steve Wagstaff. Landcare Research, Lincoln; Cecilia Ezcurra, Universidad del Comahue, Bariloche; Carlos Ramirez. Universidad Austral de Chile, Valdivia. **Floristic Comparison of Southern Andean and New Zealand Plant Communities.**

Southern Andean and New Zealand vegetation types share striking visual similarities. We have ranked component species, genera and families of Southern Andean communities along a photogeographic series, with one end comprising taxa restricted to the Southern Andes and New Zealand, and the other end comprising Southern Andean taxa that are mainly northern hemisphere in distribution and do not occur in New Zealand. The relatively few Southern Andean species that are shared with or have close relatives in New Zealand grow mainly in open habitats. In coastal salt marsh, shared species contribute strongly to physiognomic similarity with the equivalent New Zealand vegetation. Shared southern hemisphere genera largely account for the visual similarity of cushion bogs in the two regions, and in lesser degree, for the similarity of evergreen forests. In tussock grasslands and alpine fell-fields, physiognomic similarities depend mainly on nearly cosmopolitan genera and families, and on convergent evolution. Andean deciduous, subalpine *Nothofagus* forests and New Zealand tall *Chionochloa* grasslands occupy similar environments, but are dissimilar physiognomically and floristically.

T.E. Ward-Smith and M.A. Potter. Institute of Natural Resources (Ecology Group), Massey University, Private Bag 11222, Palmerston North, New Zealand. **The response of captive and wild kiwi to a range of non-toxic baits used for pest control in New Zealand**

A range of non-toxic plain baits (carrot, two types of cereal-based baits (No.7 and RS5), apple paste, and a starter paste) used in poisoning operations for control of brushtail possum (*Trichosurus vulpecula*) were offered to captive and wild North Island brown kiwi (*Apteryx australis mantelli*). The response of captive kiwi to the five bait types differed dramatically to that of wild kiwi. All captive kiwi fed at least once on at least one bait type. Some kiwi showed preferences for particular bait types which were not consistent between individuals. Kiwi did not prefer any bait type to their usual artificial diet. According to the proportion of captive kiwi which fed on baits at least once, baits were placed in decreasing order as: pulp/paste > carrot > No.7 > RS5, although the differences between each bait type were not significant. A similar order was obtained when baits were ranked according to the number of times kiwi fed on each bait type. Wild kiwi did not actively feed on any bait type placed outside their nest entrances but they still may have ingested apple or starter paste as they probed these types. The results of the captive trials indicate that cereal-based baits may be the safest bait to sow aerially in kiwi habitat. Both captive and wild trials suggest that apple paste baits may be highly acceptable to wild kiwi.

Glenda M. Wardle. Plant Ecology (A08), School of Biological Sciences, The University of Sydney, NSW 2006, Australia. **Fire and rain: the demography of *Trachymene incisa* and *T. glaucifolia*.**

This research contrasts the demography of an annual species *Trachymene glaucifolia* which germinates following rain with a perennial species *T. incisa*. that resprouts from a root stock after fire. Individuals and populations experience complex patterns of environmental variability, but we do not fully understand how the patterns of survivorship, growth, and reproduction (life histories) are altered by unpredictable environments. Three populations of *T. glaucifolia* in the Simpson desert were monitored following heavy rainfall. There was significant small scale spatial variation in the germination, density and sizes of individuals. The demography of two populations of *T. incisa*, one of which had recently been burnt, were monitored. The existence of a soil seed bank for both *Trachymene* species and the consequences of the seed bank for population persistence are presented.



© David Warton and Glenda Wardle. School of Biological Sciences, The University of Sydney, NSW. 2061, Australia. **Spatial variation in the demography of *Acacia suaveolens***

It is fundamental to any demographic study to quantify the extent of spatial variation. However, studies of species found in even-aged stands typically lack replicated sampling at a given age. This study extended previous work on the demography of a fire-affected species, *Acacia suaveolens*, by comparing several northern Sydney populations most recently burnt in January 1994. Variation in size and fecundity of *A. suaveolens* individuals was observed at a number of spatial scales - among study areas, between sampling units at study areas, and within transects. Size-structured population projection matrices were constructed at each study area, with seed data extracted from previous work. Projected dispersed seed densities varied substantially across study areas and within a study area, and these projections were quite sensitive to seed fate. Continued field research and modelling is recommended, to better understand observed spatial variation in the context of the whole life-cycle.

© N. W. Was and Wilson, K. J. Ecology and Entomology Group; Soil, Plant and Ecological Sciences Division, P. O. Box 84, Lincoln University, Canterbury, New Zealand. (wasn@Lincoln.ac.nz). **Burrow occupancy of broad-billed prions (*Pachyptila vittata*) on South East (Rangatira) Island, Chatham Islands, New Zealand.**

Broad-billed prions (*Pachyptila vittata*) compete for burrows with other small burrowing seabirds on South East (Rangatira) Island, Chatham Islands, New Zealand. This competition is having a severe impact on the endangered Chatham petrel (*Pterodroma axillaris*) population. Seventy-seven broad-billed prion burrows were monitored nightly during the 1996 and 1997 breeding seasons and the 1997 and 1998 non-breeding seasons to determine their burrow use patterns. From a total 401 broad-billed prions recorded, the majority (between 47% and 76%) were not resighted in a subsequent season. The greatest number of prions recaptured were found in their breeding burrow in the non-breeding season (43%). From 1 - 10 broad-billed prions were found in each available study burrow over the non-breeding season, with some individuals recorded in multiple burrows. The majority (57%) of these multiple-burrow visitors were found in burrows less than 5 m away from the one they were banded in, but 24% were found in burrows up to 60 m away from the original banding point. Artificial blockading of burrows appeared effective in discouraging use at 64% of broad-billed prion burrows tested. Results between the two years differed, possibly because broad-billed prion numbers on the island were lower in the 1997 breeding and 1998 non-breeding seasons.

☺ John Morgan and Lynise Wearne School of Botany, La Trobe University, Bundoora, Victoria 3083, Australia. **Predicting richness in subalpine grasslands: effects of environmental and disturbance factors**

Describing variation in species richness within a single vegetation type provides opportunities to uncouple the factors affecting richness in that vegetation. Species richness in Australian temperate grasslands have been documented and related to site productivity and disturbance intensity. It is unknown whether these factors also influence richness in subalpine grasslands. We investigated how environmental and disturbance factors affect species richness in *Poa*-dominated subalpine grasslands in north-east Victoria, Australia. Total species richness was generally negatively associated with increasingly natural fertility of parent material as well as under conditions of increasing biomass of the dominant grass. No simple trends in total species richness with environment (altitude, soil depth and pH) or disturbance (grazing intensity), however, were detected. Environmental variation appears to result in mostly species substitution in subalpine grasslands with little directional change in total species richness. Reasons for this are suggested.

Lynise Weame & John Morgan, School of Botany, La Trobe University, Bundoora, Victoria 3083, Australia. **Is the subalpine grassland - forest boundary stable in snowplains of the Mt Hotham area, Victoria?**

Treeless snowplains are a notable feature of the Mt Hotham subalpine area. They occur at a wide range of altitudes (1200 - 1650 m) and topographic positions (cold air drainage valleys, ridge lines, hillsides). Climatic factors (e.g. temperature) and ground layer competition are thought to maintain the grassland/forest boundary in many sites. In many analogous subalpine forest/meadow boundaries in North America and New Zealand, tree invasion has been a notable and conspicuous process over the last century. We assessed the stability of the forest boundary at several snowplain sites by examining the size class of eucalypts across the boundary and by determining the age of seedling invaders. Large trees fringe many snowplains. Tree seedling invasion is common in *Poa hiemata* dominated grasslands, but not *P. costiniana* swards. Invasion began ca. 25 yrs ago and has been on-going since. Seedlings are restricted to within 15 m of forest boundaries and are most common on west-facing boundaries. Potential causes for recent tree invasion will be proposed.



© Wells, Andrew, Richard P. Duncan and Glenn H. Stewart. Ecology and Entomology Group, Plant and Ecological Sciences Division. PO Box 84, Lincoln University, Canterbury. **The importance of rare, earthquake-induced disturbance to landscape and forest history in Westland, New Zealand.**

Recent geological studies have identified three earthquakes on the Alpine fault, Westland, since 1400 AD, and these would probably have had a major impact on regional forest and landscape history. To investigate this, we examined the history of erosion and forest disturbance in a 1412 ha portion of the Karangarua catchment, south Westland. We aged stands of trees on all surfaces from increment cores, and identified erosion-initiated cohorts. The ages of the oldest tree in each of 59 cohorts were combined to give a picture of the history of major disturbance in the catchment. The spatial extent of individual erosion events was determined from geomorphological and forest evidence. Four episodes of major erosion and forest re-establishment have affected the valley since 1300 AD, indicated by clusters of cohorts that established c. 1850, 1740, 1660 and 1470 AD  $\pm$  20 years. The three earliest episodes had the greatest impact, and coincide with date-ranges for the last three Alpine fault earthquakes. The three episodes of disturbance related to Alpine fault earthquakes also dominated in a sample of 55 forest cohorts scattered across 300 km of Westland. This combined information suggests that landscape and forest history in Westland over the past 650 years has been overwhelmingly controlled by infrequent but severe Alpine fault earthquakes.

Mark Westoby<sup>1</sup>, David Warton<sup>1</sup> and Peter Reich<sup>2</sup> <sup>1</sup>School of Biological Sciences, Macquarie University, NSW 2109, Australia. <sup>2</sup>Dept of Forest Resources, University of Minnesota, St. Paul, MN 55108, USA. **The Time Value of Leaf Area**

When a plant invests in construction of a leaf, the revenue-stream that accrues is shaped by three variables: (1) the light-capture area or photosynthetic potential per gram dry mass invested (2) the longevity of the leaf, and (3) a time-discount rate, quantifying the fact that light-capture area deployed in the immediate future is more valuable to the plant than the same area deployed at some later time. Greater leaf longevity (2) apparently comes at the expense of light-capture area per gram (1), and recent comparative data make it possible to quantify this cross-species trade-off. Through an options-set approach, the consequences of (3), the time-discount rate, can be related to the trade-off between (1) and (2). It is an observed fact that a wide spread of strategies or options for leaf longevity and light-capture area per gram do actually coexist in vegetation, suggesting that the different observed strategies do not have a clear-cut advantage over each other. We investigate how time-discounting influences the relative advantage of strategies with high leaf longevity versus strategies with high light-capture area per gram.

R.J. Whelan, D.J. Ayre, F. Beynon and M. Richardson. Australian Flora and Fauna Research Centre, University of Wollongong, NSW, 2522, AUSTRALIA. **Frauds or Friends? Birds and Bees as Pollinators of *Grevillea*.**

The honeybee (*Apis mellifera*) is a frequent visitor to most species of *Grevillea* in south-eastern Australia. What effects might visits from this introduced species have? We quantified visit frequencies of flower visitors to several *Grevillea* species and confirmed that bees were indeed frequent visitors, both to species with bird-pollinated characteristics as well as to species with small flowers more suited for insect pollination. They were, however, likely to be effective pollinators only in the small-flowered species. Bees rarely came in contact with pollen presenters of *G. mucronulata* (only 18.5% of 257 visits; honeyeaters contacted pollen presenters in 98% of 252 visits) whereas they made almost obligate contact with the pollen presenters of *G. sphacelata* (99.5% of 964 observed visits). Honeybee activity varied among sites. In *G. macleayana*, pollination effectiveness was examined by comparing open-pollinated inflorescences (uncaged) and inflorescences from which vertebrates were excluded (caged). The rate of pollen removal from pollen presenters was equivalent in caged and uncaged inflorescences but pollen deposition on stigmas was about six times greater in uncaged inflorescences. These results lead to the prediction that, for some species of *Grevillea*, honeybees will alter levels of fruit set and/or realised mating systems.

☺ ☒ Sardha Wijesuriya and Colin Hocking School of Life Sciences and Technology, Victoria University of Technology, St. Albans campus, P. O. Box 14428, MMC 14428, Australia. **Soil nutrient status and weed invasion in physically disturbed native grasslands.**

This study investigated the levels of available soil nutrients in artificially disturbed small plots and how available soil nutrient levels affect the growth of weeds. Soil was removed from small round plots (1m diameter) in two steps: 1cm- 7cm and 7cm- 15cm. Each layer was kept separate. Each was homogenised and returned to the hole in appropriate order. Soil was initially analysed for available nutrients ( $\text{NO}_3^- - \text{N}$ ;  $\text{NH}_4^+ - \text{N}$ ;  $\text{H}_2\text{PO}_4^- - \text{P}$  and  $\text{K}^+$ ) 14 days after digging and at 34 days and 70 days thereafter. After 70 days total available N was 10 times greater in dug plots than in control plots and mineralizable N (in-situ) in dug plots was about 5 times greater than in control (undug) plots. The levels of available P in dug plots was 1.5 times higher than in control plots. Interestingly, the rate of mineralization of P was not significantly different between treatments. The available K was significantly higher in dug plots than in controls. The analysis of above ground biomass of plants growing on disturbed plots showed higher biomass of thistles and annual grasses in dug plots than undug (ie. control) plots. These were the dominant plant types on all disturbed plots. The addition of nutrients (N and P) to dug plots, increased above ground vegetative biomass. Conversely the addition of organic C (as sugar) decreased above ground vegetative biomass, compared to controls. Differences in overall biomass of weeds on the plots was paralleled by differences in biomass of annual grasses and thistles. We suggest that on disturbed soils in native grasslands the release of nutrients following plant death contributes substantially to the massive increase in weediness following disturbance.



☺ ✉ A. S. Wild. School of Geography and Environmental Studies, University of Tasmania, GPO Box 252-78, Hobart Tasmania 7001. **Patterns and processes of recovery following disturbance in high altitude treeless plant communities in Tasmania**

There is an abundance of data worldwide on the deleterious effects of trampling, horse riding and vehicle use on high altitude environments. In Tasmania's high altitude areas, previous research has shown that such activities can quickly lead to vegetation degradation and accelerated erosion. As a result, in many protected areas, numerous tracks have been re-routed or closed to protect vulnerable sites. However, there are no data on the rates or patterns and processes of vegetation recovery on these tracks. This information, particularly in relation to differing rates of recovery over environmental gradients, is essential to guide the selection of areas that may require artificial rehabilitation works. This study aims to investigate the rate and dynamics of natural revegetation of high altitude treeless plant communities on such tracks, thus contributing to this information base. Variations in rates of recovery will be determined for a variety of environments and vegetation types using both latitudinal and longitudinal approaches. Variables to be examined include the size, scale and intensity of disturbance, time since disturbance, and the location of disturbance with respect to altitude, soil, climate and plant community effected. These methods and a review of the environmental factors believed to affect natural revegetation in high altitude areas will be presented.

☺ Nancy Willems, Glenn H Stewart and Richard P Duncan. Ecology and Entomology Group, Soil Plant and Ecological Sciences Division, PO Box 84, Lincoln University, Canterbury. **The structure and dynamics of podocarps in isolated forest fragments.**

New Zealand's podocarp species rely on large disturbance openings operating across a vegetated landscape to stimulate regeneration. Clearance of vegetation that results in small remnants of forest may exclude disturbances of the scale necessary for podocarp regeneration. We surveyed the four remaining lowland podocarp stands on Banks Peninsula to determine the structure and regeneration patterns of podocarps and to assess their long term viability. Density, basal area, and size and age class distributions were used to examine current composition, and in conjunction with spatial analysis, to identify past regeneration patterns and infer likely future changes in composition and population structure. Podocarp size and age class structures for three of the four reserves were characterised by large, old matai and kahikatea trees (matai c. 350 to 600 years) with little or no regeneration for approximately the last 200 years. One of the four reserves showed much more recent regeneration with matai, totara and kahikatea mostly 80-160 years old, and substantial populations of seedlings and saplings. For three of the four forest fragments it appears that podocarps will be replaced by hardwood tree species over the next few centuries in the absence of appropriate disturbances that might facilitate podocarp regeneration.

✉ David G. Williams<sup>1</sup>, Paul Wallace<sup>1</sup>, Mutjinde Katjiua<sup>2</sup>, Nick Abel.<sup>3</sup> <sup>1</sup>Applied Ecology Research Group, University of Canberra, 2601, Australia. <sup>2</sup>Faculty of Agriculture and Natural Resources, Univ. of Namibia. <sup>3</sup>CSIRO Wildlife and Ecology, Canberra. **Effects of established trees on native temperate pasture growth.**

The planting or retention of trees in temperate pasture systems has been advocated to address the broad environmental effects of forest clearance and pasture improvement. These effects are now seen to threaten the sustainability of pasture systems through modification of water and nutrient cycles. Native tree cover is still present in many pasture lands of Australia, especially on steeper slopes and poorer soils. The pasture in these situations is commonly rich in native grass and forb species, whose agronomic potential and response to tree cover has been poorly studied. This study aimed to determine the effects of established tree cover on native pasture production under grazing on the Southern Tablelands of New South Wales. We made comparisons between treed (basal area 10-20 m<sup>2</sup> ha<sup>-1</sup>) and open fixed plots, and also between survey plots which covered the range (0-30 m<sup>2</sup> ha<sup>-1</sup>) of tree basal area within a paddock. Pasture biomass, production and offtake were measured seasonally, as well as pasture digestibility, protein content, soil nutrient status and microclimate. Overall we found that the treed pasture had higher seasonal productivity, mainly seen in relatively greater winter growth, and consumption was also higher under the trees. Pasture standing crop in the presence of stock tended to be higher in the open, mainly arising from spring growth flushes which are enhanced by short-lived species. The results suggest that trees in these pastures provide additional environmental heterogeneity that operates on the available species to influence their biomass contributions. Given the desirability of having deep-rooted perennial components in pasture lands, this study suggests that, in some places at least, tree cover can provide wider environmental services without compromising current levels of pasture production.



Jann Williams<sup>1</sup>, and Carol West<sup>2</sup>. <sup>1</sup>School of Botany, The University of Melbourne, Parkville, Victoria, 3052, Australia. <sup>2</sup>Department of Conservation, PO Box 743, Invercargill, New Zealand. **Environmental weeds in Australia and New Zealand issues and approaches to management.**

Environmental weeds are plants that invade natural ecosystems and are considered a serious threat to nature conservation worldwide. Australia and New Zealand, which have both evolved biota with a high degree of endemism, are particularly susceptible to introduced plants. Environmental weeds have been implicated in the extinction of several indigenous species and also threaten ecosystem stability and functional complexity. Historically, emphasis has been placed on the chemical or manual 'control' of weed infestations, often with little consideration of the long term effectiveness of such an approach or the ecological consequences. As the threat from invasive species has been more fully recognised, an integrated, strategic and ecological approach to weed management is being recommended. In both countries, systems for screening new plants before allowing entry for cultivation are being developed. For already established plants, management is conducted within a legislative and policy framework such as the Regional Pest Plant Management Strategies that operate through the Biosecurity Act in New Zealand. Noxious weed legislation in Australia has principally focused on agricultural weeds, but some Acts have recently or are currently undergoing revision to give greater emphasis to environmental weeds and the involvement of the community in weed management. Quarantine, legislation and on-ground management are complimented by education programs about the impact and control of environmental weeds. This paper will review the status of environmental weed management in Australia and New Zealand, focusing on the ecology of environmental weeds and the ecosystems they threaten.

Peter A. Williams<sup>1</sup>, Brain J. Karl<sup>1</sup>, Peter Bannister<sup>2</sup> and William G. Lee<sup>3</sup>. <sup>1</sup>Landcare Research, Private Bag 6, Nelson, New Zealand. <sup>2</sup>Botany Department, University of Otago, Dunedin, New Zealand. <sup>3</sup>Landcare Research, Private Bag 1930, Dunedin, New Zealand.  
**Introduced small mammals as potential dispersers of weeds in New Zealand.**

The invasion success of weeds is strongly influenced by the seed dispersal system and the availability of vectors, including animals. We examined the potential of mice, kiore, ship rats and possums to disperse germinable seeds. We fed them fleshy fruit of weeds (*Berberis glaucocarpa*, *Cotoneaster glaucophyllus*, *C. simonsii*, *Crataegus monogyna*, *Ilex aquifolium*, *Leycesteria formosa*, *Ligustrum sinense*, *Lonicera japonica*, *Passiflora mollissima*, *Pyracantha*, *Sorbus aucuparia*) and native species (*Coprosma robusta*, *Prumnopitys ferruginea*, *Solanum aviculare*) and measured the percentage of fruit consumed, seed ingested, and gut passage time of the faeces. These were collected and the seeds extracted and tested for germination potential both in a glasshouse (2 weed species) and under controlled conditions (11 species). Mice and kiore destroyed all seeds eaten but large numbers of viable seeds of *Leycesteria formosa* and *Solanum aviculare* passed through ship rats. Possums accepted a wide range of adventive fruit (11 species) and the proportion of seeds egested that were ingested ranged from 6% to 83%. An average time of 7.5 days for all seeds to be passed was required and it was unrelated to simple fruit parameters such as percentage pulp and moisture content. For seeds where germination also occurred in the controls, the germination from possums ranged from 3% to 78% (mean 24.7%) and was generally lower than in the controls (mean 42.2%), with the exception of *Passiflora mollissima* where the percentage for possums was 60% and 45% for the controls. Ship rats, therefore, have some potential, and possums a major potential, to disperse the seeds of many fleshy fruited woody weeds and native species.



Peter A. Williams<sup>1</sup>, Euan Nicol<sup>2</sup>, Melanie Newfield<sup>2</sup>. <sup>1</sup>Landcare Research, Private Bag 6, Nelson. <sup>2</sup>Landcare Research, P.O.Box 69, Lincoln. **The risk of invasive weeds entering New Zealand has been reduced by screening proposed plant imports.**

The risk to conservation land posed by the importation of plants new to New Zealand was assessed. We summarised the taxonomy, life form, region of origin, period of naturalisation, history of weediness elsewhere in the world, and other attributes of environmental weeds in New Zealand. Data were compared with similar attributes for environmental weeds of the world and with proposed imports into New Zealand that had been screened for weed potential in recent years. Compared with the rest of the world, weeds of New Zealand have a similar proportion herbs, less trees and shrubs, and more grasses, rushes, and vines. Of the new species screened, almost half were herbs. Vines and grasses were virtually eliminated by the screening process, so that the overall potential weediness of those recommended for acceptance was considerably lowered. Pathways by which seeds and nursery stock reach New Zealand was assessed from seizure data supplied by MAF and these were compared with the number of passenger arrivals into New Zealand. The risk of seeds arriving, either declared or undeclared, differs for different regions of the world and with method of transport to the boarder. The greatest risk of undeclared material in terms of number of items is via baggage from Asia and Australia, and from Europe via packages and letters. We do not know the risk from all sources of illegal imports, particularly seeds arriving by letter from Europe where the seeds could originate from anywhere in the world, and because both the volume of mail and the proportion of mail containing undeclared plant material is high. These data on seizures and arrivals were compared with the country region of origin of the most recently established weeds. The shift to an increasing importance of Asia as a source of weeds is paralleled by the increasing importance of contact with that region. Despite the volumes of both legal and possibly illegal new species arriving in New Zealand, the threat to conservation land in the medium term is probabaly greater from recently established adventives and the 18000 species presently in cultivation and not yet recorded in the wild.

Stephen E. Williams. Cooperative Research Centre for Tropical Rainforest Ecology and Management, Department of Zoology & Tropical Ecology, James Cook University, Townsville, Qld 4811, Australia. Email: [stephen.williams@jcu.edu.au](mailto:stephen.williams@jcu.edu.au). **Multiple determinants of biodiversity patterns: the necessity of examining ecologically meaningful groups**

The patterns and processes associated with biodiversity have been the subject of extensive research over recent years. The most commonly used measure of biodiversity is species richness and it is usually applied to a particular taxonomic group. I use patterns of vertebrate species richness in the Australian Wet Tropics rainforests to demonstrate that the species richness of a taxonomic group does not provide adequate ecological resolution to understand the processes behind the patterns of biodiversity. Distribution data on rainforest vertebrates within 22 subregions of the Wet Tropics were used to analyse biogeographic patterns in assemblage composition, structure and diversity, and to relate these patterns to environmental factors. The ecological correlates of species richness and spatial patterns of assemblage structure suggest that patterns of species richness are complex and fall into a variety of categories, each being influenced by different processes. These results stress the necessity of using meaningful and objective groups, chosen on the basis of their functional ecology in order to understand the determinants of biodiversity: it is insufficient to examine patterns based purely on species richness within broad taxonomic groups.

✕ ☒ A.J. Willis, R. McKay, J. Vranjic and R.H. Groves. CRC for Weed Management Systems, CSIRO Plant Industry GPO Box 1600, Canberra, ACT 2601, Australia. **The germination ecology of an endangered shrub and a threatening environmental weed.**

Environmental weeds are widely perceived as a key threat to the continued survival of numerous endangered plant species. Relatively few studies, however, rigorously quantify their environmental impacts. Bridal Creeper (*Asparagus asparagoides*), among other weeds, is a primary threat to *Pimelea spicata*, a rare shrub threatened with extinction unless adequate management strategies are initiated. As the ecology of *P. spicata* is believed to be fire-adapted, a possible management tool is to burn weed-infested populations to stimulate the growth and recruitment of *Pimelea*, while simultaneously managing the above-ground weed population. The relative impacts of such fires on the seed bank dynamics of both the endangered shrub and its threatening weeds are, however, unknown. We present data from a series of experiments comparing the effect of smoke, heat, ash and light on the germination ecology of *P. spicata* and Bridal Creeper. The experiments highlight potential outcomes of a management burn for the germination and recruitment of both *P. spicata* and its threatening weed.



✉ Raymond T. Wills. Kings Park and Botanic Garden, Perth, Western Australia. **Weed invasions in Kings Park bushland, Perth, Western Australia.**

Environmental weeds compete with native plants for light, nutrients, water, and often displace them, especially in disturbed sites. Owing to the long history of disturbance and alienation of bushland, Kings Park bushland has a severe weed problem. Of the 465 species of plants recorded from the bushland, 175 species are not native to the area. Some of these weeds are non-local, Australian native species, but most are from overseas. The most common point of origin for the Park's weed species, including the most serious weeds, is South Africa. The fynbos is very rich in geophytes (bulbous plants) and many species from the family Iridaceae have become weed species in the south-west of Western Australia, including the Kings Park bushland.

Janet Wilmshurst and Matt McGlone. Landcare Research, PO Box 69, Lincoln 8152. **Recent South Island Sphagnum bogs: anthropogenic or climatic origins?**

Sphagnum moss is widespread in the cooler and wetter parts of the South Island of New Zealand, often forming a prominent cover on peat bogs. Live Sphagnum and a thin layer of decomposing Sphagnum remains generally overlie sedge-dominated peat deposits which are several metres thick and up to 12 000 years old. Sphagnum remains are scarce in these underlying peat deposits compared to the surface layers. There appears to be a strong link between the spread of Sphagnum and anthropogenic modification of the landscape. In several sites where detailed pollen and macrofossil analyses have been carried out, the rise of Sphagnum dominance coincides with European settlement last century. However, some Sphagnum capped bogs also occur in unmodified or weakly modified habitats, but still date from the time of human settlement. It is therefore unclear if the ultimate cause of Sphagnum spread is a response to human land use or to cooler, wetter climates – unparalleled in the previous record – or both.

☺ Jenny Wilson and Andrew F. Bennett. School of Ecology and Environment, Deakin University, 662 Blackburn Rd, Clayton, Victoria. **The loss of large eucalypt trees from a box and ironbark forest: implications for floral resources for nectar-feeding animals.**

The importance of large old trees for hollow-dependent fauna is well known. However, the importance of large trees in terms of floral resources has received little attention. Nectar-feeding birds are a characteristic component of the fauna of box and ironbark forests where a diverse range of eucalypts provide year-round floral resources. The structure of these forests has changed since European settlement with widely-spaced, large old trees being replaced by relatively densely-spaced smaller trees. This study describes flowering patterns of seven *Eucalyptus* species in Rushworth State Forest, Victoria. Flower cover for over 750 individual trees in four size classes is sampled every three weeks. Results to date show that larger trees flower in significantly greater proportions than smaller trees. For most species, larger trees have a significantly higher flowering index than smaller trees. At peak flowering times, large trees tend to show higher flowering intensity than smaller trees. Flowering duration also differs between size classes. The diversity of birds and mammals that feed on nectar in box and ironbark forests, including threatened and migratory species, suggests that the change in forest structure is an important issue with implications for forest management and wildlife conservation.

Susan K. Wiser, Peter J. Bellingham and Robert B. Allen. Landcare Research, P.O. Box 69, Lincoln, New Zealand. **National Vegetation Survey database: Applications to current environmental issues.**

New Zealand is required to monitor changes in the structure, composition and extent of its indigenous forests. One resource that facilitates monitoring is data from more than 8000 permanent plots in the National Vegetation Survey database. We present three database applications to current environmental issues. Firstly, to estimate national carbon storage in above-ground forest biomass we selected a subset of plots, using data from the plot nearest to 571 points located on a 4 x 4 km national grid. Secondly, we examined long-term imbalances of tree mortality and recruitment nationally of species considered sensitive to introduced herbivores (e.g., *Podocarpus hallii*), by comparing localities throughout New Zealand with different management histories. Data were used from localities where many plots representatively sampled an area, and where mortality and recruitment for a species could be calculated from tagged individuals monitored for at least 8 years. Finally we quantified invasions of forests at a national scale by an introduced plant (*Mycelis muralis*). As plots were measured in different years, we could account for the influence of time before interpreting the invasion in terms of stand structure, composition and environment. These three applications demonstrate the utility of maintaining a central repository of comparable ecological data.

✉ Ian Wright and Mark Westoby. School of Biological Sciences, Macquarie University Sydney 2109. **Comparative ecology of leaf lifespan and nutrient status along resource gradients.**

Nutrient and water shortage have been key factors in the evolution of the endemic Australian flora. Sclerophylly, for example, is a character syndrome largely involving leaf strengthening which has evolved in response to shortages of one or both of these resources. Probably the best index of leaf strengthening and expected leaf lifespan is SLA (specific leaf area: the leaf area per unit leaf dry mass, describing the potential for carbon gain per unit investment in leaf tissue). A fundamental trade-off exists between SLA and leaf lifespan such that it is not possible to construct leaves which achieve both high short-term photosynthetic return and a long lifespan. Study sites have been set up along gradients of nutrient and water stress within New South Wales. From these sites about 100 plant species are being characterised in terms of their leaf construction, phenology, lifespan and nutrient status. I aim to examine the SLA-leaf lifespan trade-off along these gradients and to test the proposition that with decreasing soil nutrients the efficiency of internal nutrient recycling is greater. An overall aim is to integrate our understanding of the evolution of carbon and macronutrient acquisition strategies, both across a wide environmental space and across a number of plant lineages.

☺ Jeffrey Wright and Peter Steinberg. School of Biological Science, University of New South Wales, Sydney, 2052. **Recruitment, mortality and population genetic structure in the subtidal red alga *Delisea pulchra*.**

Local populations of many marine organisms are considered to be open, with the supply of new recruits coming primarily from areas outside of them. The implications of this are important not only for population dynamics but also population genetic structure as there is the potential for gene flow to exist between distant populations. *Delisea pulchra* is a widely distributed shallow subtidal red alga in temperate Australia. Demographic surveys of *D. pulchra* revealed that (1) recruitment was largely decoupled from local adult abundance, (2) mortality was density independent and occasionally intense and (3) variable recruitment was of major importance in limiting population densities even when mortality was high. Population genetic structure was examined at 2 locations using RAPD (Randomly Amplified Polymorphic DNA) markers. Of the total genetic variance, 46 % occurred between locations, 4.5 % occurred between sites within those locations and 49.5 % occurred within sites. These results indicate that there is significant genetic structure between the two locations, but that broadcast dispersal of spores between sites within locations probably restricts the formation of genetically distinct groups of plants at that scale.



Brian Zancola. School of Applied Science, Griffith University, Gold Coast Campus, Qld 9726. **Inhibition of an exotic weed by native flora and fauna.**

*Ageratina riparia* (Asteraceae), mistflower, creeping crofton weed or hamakua pamakani is a serious weed problem in mesic locations in Australia, Hawaii, India and New Zealand. In Australia *A. riparia* is limited to the sub-coastal ranges of southern Queensland and New South Wales. Despite extensive research in several of these countries the biological control of this weed has had limited success. This work reviews the ecology of the weed reported elsewhere, and compares it with research currently being conducted in southeast Queensland. I will report on some of factors that limit the establishment and persistence of *A. riparia* in the region. Field enclosure experiments demonstrated that predation on *A. riparia* by *Thylogale thetis*, red-necked pademelons, influenced weed density. Flower production potential of the weed was also affected. The physical disturbance of the weed by *T. thetis* as well as predation negates the suggested inhibition of rainforest regeneration by *A. riparia*. Field studies showed that leaf litter layer has a strong relation to the establishment of *A. riparia*. The results from field transplants of *A. riparia* into varied microhabitats will indicate other limitations to the invasiveness of *A. riparia* into rainforests of the region.

