Venue: University of Waikato

Sponsored by:

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General Information

Registration
Registration will take place in the Management Studies Building Foyer from 3 - 8:30 pm on Sunday 19th November, from 8 am – 5 pm on Monday 20th November and Tuesday 21st November, and 8 am – 3 pm on Thursday 23rd November.

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 Landcare Research, Hamilton at 07-858-3700.

Morning tea, afternoon tea and lunches
The registration fee includes these refreshments which will be served in the Management Studies Building Foyer.

Conference assistants
The organisers of the conference will be wearing conspicuous t-shirts during the conference. Please approach them if you have any problems.

Instructions for presenters

Information for oral presenters

Both lecture rooms are equipped with 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 and a student helper will be present at the venue in the break prior to your session and can help with problems. It is your responsibility to have slides in order and oriented correctly. The projectors hold in-line slide cartridges (Universal). If you are unable to access these types of cartridges, there will be spare cartridges available to load slides into at the registration desk. There will also be spare projectors in the foyer for presenters to run through their slides for orientation. Powerpoint presentations can be read into the dataprojector from standard floppy disks (1.4Mb) or directly from your own laptop. **Speakers are expected, as professionals, to keep within their allocated times.**

Information for poster presenters

Posters should fit within an area of 1.0m wide by 1.8m high. Please put up your posters as early as possible in the conference but no later than Tuesday morning. Pins will be available at the registration desk to fix posters to boards. Presenters should stand by their posters during the poster session from 1:20 – 2:30 on Tuesday 21st November. Please remove your posters before 3 pm, Thursday 23rd November.

Programme

Sunday 19th November, 2000

Student colloquium (students only!)

9:45 – 10:15 Registration and morning tea

10:15 Session 1, MSB101, School of Management, University of Waikato
Chair: Wade Tozer

10:20 ☺ Carlos A. Lehnebach. Pollination ecology and survival of New Zealand orchids

10:40 ☺ Melissa Hutchison. Population dynamics and seasonality of ground beetles (Coleoptera: Carabidae) in New Zealand native forest remnants.

11:00 ☺ James Russell. Modelling the biological invasion of offshore islands.

11:20 ☺ Kate G. McAlpine & Donald R. Drake. The effects of small-scale environmental heterogeneity on seed germination in experimental treefall gaps.

11:40 ☺ Xiaoling Li. Bellbird (*Anthornis melanura*) vocal repertoire and the functions of female song.

12:00 ☺ Joanna McQueen, Bruce Burns & Warwick Silvester. *Acacia longifolia* invasion of Kaimaumau Gumland, Northland, New Zealand.

12:20– 1:10 Lunch

1:10 Session 2, MSB101, School of Management, University of Waikato
Chair: Joanna McQueen

1:10 ☺ Paul Jamieson, C.M. King, Chrissen Gemmill & Stephen Sarre. The taxonomic classification of the house mouse in New Zealand.

1:30 ☺ Paul Leisnham & Ian G. Jamieson. Social structure of an insect (mountain stone weta *Hemideina maori* (Orthoptera: Anostostomatidae)) with a female-defence mating system.

1:50 ☺ Roger Dungan, David Whitehead, Matt McGlone, Rob Allen, & Richard Duncan. Seasonal photosynthetic response of leaves of two co-occurring tree species with contrasting leaf habit.

2:10 ☺ Wendy Dimond, Doug P. Armstrong & Tim G. Lovegrove. The effect of a translocation on a source population using North Island robins (*Petroica australis longipes*) as a case study.

2:30 ☺ Douglas Bridge, Warwick Silvester, & Bruce Burns. Does a mycorrhizal association of prostrate kanuka facilitate its survival in geothermal steamfields?

2:50 ☺ Kevin Parker. Breeding success of North Island fernbird.

3:10 – 3:30 Afternoon tea

3:30 Session 3, MSB101, School of Management, University of Waikato
Chair: Doug Bridge

3:30 ☺ W. Ji, S.D. Sarre, N. Aitken, R.K.S. Hankin & M.N. Clout. Sex biased dispersal and a density independent mating system in the Australian brushtail possum, as revealed by minisatellite DNA profiling.

3:50 ☺ Susan M. McCurdy, T.G.A. Green, W.B. Silvester & Roman Tuerk. Lichen ecology and diversity in a regenerating forest in Tongariro National Park, New Zealand.

4:10 ☺ L.A. Hathaway & C.E.C. Gemmill. Origin, evolution and relationships of the New Zealand *Pittosporum* (Pittosporaceae) based on nucleotide sequences.

4:30 ☺ Anthony Keen. Ecotones: Their role in the landscape and their application in restoration.

4:50 ☺ Wade C Tozer, Bruce D. Clarkson, & Warwick B. Silvester. Identifying sources of nitrogen in primary succession on Mt Tarawera, New Zealand.

5:10 ☺ Amy Trass & Alastair Robertson. Berries and birdpoo – the ins and outs

5:30 Finish

6 pm Students Aftermatch, Station Cafe

Monday 20th November, 2000

8:30 Registration

9:10 PWC Lecture Room, School of Management, University of Waikato
Chair: Bruce Burns

9:10 Conference opening

9:20 NZES President's welcome – Carol West

9:30 1999 NZES prize winner
C.M. King. An online bibliography on stoats and weasels: introduction and analysis

10:10 – 10:50 Morning tea

10:50 Symposium 1: Wetland ecology
PWC Lecture Room, School of Management, University of Waikato
Chair: Keith Thompson

10:50 Bev Clarkson, Louis Schipper, & Tony Lehmann. Restiad bog succession in the Waikato region since *c.* 13 000 ^{14}C years BP

11:10 Louis Schipper, Bev Clarkson, Maja Vojvodic-Vukovic, & Rachel Kelleher. Restoration approaches for mined restiad peat bogs.

11:30 Rachel Kelleher & Paul Champion. Willow control in the Whangamarino wetland – a tool for native sedge restoration.

11:50 David I. Campbell. Hydrology of Waikato peat bogs

12:10 ☺ Jeff Smith, David I. Campbell, & Louis Schipper. Fluxes of Water Vapour and CO_2 at a Waikato Peat Bog.

10:50 Contributed Papers 1: Pest species
MSB101, School of Management,University of Waikato
Chair: C.M. King

10:50 Jim Hone. Responses to fertility control of vertebrate pests

11:10 Robbie A. McDonald. Conserving native predators: The status of weasels and stoats in Great Britain.

11:30 ☺ W. Ji, S.D. Sarre, N. Aitken, R.K.S. Hankin & M.N. Clout. Sex biased dispersal and a density independent mating system in the Australian brushtail possum, as revealed by minisatellite DNA profiling

11:50 Lindsay Wilson. Intensive Non Toxic Multi Pest Control. A Viable Alternative To Brodifacoum, The Te Urewera Experience

12:10 Deborah J. Wilson & Wendy A. Ruscoe. Effects of vertebrate pests on recovery of New Zealand forests after disturbance: a planned experimental study.

12:30-1:40 Lunch

1: 40 Symposium 2: Keystone species: ecological naivety or critical paradigm?
PWC Lecture Room, School of Management, University of Waikato
Chair: Bill Lee

1:40 Ian J. Payton, Michael Fenner, & William G. Lee. Keystone species: useful concept for the management of indigenous biodiversity in New Zealand's natural ecosystems?

2:00 ☺ Douglas Bridge, Warwick Silvester, & Bruce Burns. Does a mycorrhizal association of prostrate kanuka facilitate its survival in geothermal steamfields?

2:20 ☺ Jon J. Sullivan. How a sapling specialist shoot-boring insect alters the population dynamics of a Costa Rican tree.

2:40 Mick Clout & Astrid Dijkgraaf. Pigeons and possums as keystone species?

3:00 B.D. Clarkson, L.R. Walker, W.B. Silvester & B.R. Clarkson. Colonisation dynamics and impacts of a nitrogen-fixing native shrub (*Coriaria arborea*) in post-volcanic primary succession.

1:40 Contributed Papers 2
MSB101, School of Management,University of Waikato
Chair: Susan Timmins

1:40 ☺ Paul Jamieson, C.M. King, Chrissen Gemmill & Stephen Sarre. The taxonomic classification of the house mouse in New Zealand.

2:00 Pauline Syrett. Establishment of *Arytainilla spartiophila* (Hemiptera: Psyllidae) for biological control of broom in New Zealand.

2:20 ☺ Joanna McQueen, Bruce Burns & Warwick Silvester. *Acacia longifolia* invasion of Kaimaumau Gumland, Northland, New Zealand.

2:40 Peter Wardle. Are there significant environments within New Zealand that are vulnerable to invasion by introduced trees, but beyond the ecological potential of native trees?

3:00 N D Mitchell, J L Craig, G Ussher, R Jones & R Jessop. New Zealand, the foreign country. A changed paradigm to generate new conservation opportunities.

3:20-3:50 Afternoon tea

3:50 Symposium 2: Keystone species: ecological naivety or critical paradigm? (continued)
PWC Lecture Room, School of Management, University of Waikato
Chair: Ian Payton

3:50 Sandra Anderson. Desperate and dateless: pollinator limitation in *Rhabdothamnus solandri* on the New Zealand mainland.

4:10 ☺ Debra Wotton. Frugivory and seed dispersal by the common gecko *Hoplodactylus maculatus.*

4:30 ☺ Frances Schmechel. Between the devil and the deep blue sea: nest site selection in the Chatham Island oystercatcher (*Haematopus chathamensis*).

4:50 ☺ Rachel J. Standish, Peter A. Williams, Alastair W. Robertson, & Neal A. Scott. Invasion by *Tradescantia fluminensis* increases decomposition rate and alters nutrient cycling in a New Zealand lowland forest remnant.

5:10 Panel discussion. Keystone Species: ecological naivety or critical conservation paradigm?

3:50 Contributed Papers 3
MSB101, School of Management,University of Waikato
Chair: Neil Mitchell

3:50 Jo Ritchie. Creating new mainland islands – what are the essential ingredients for success?

4:10 Marta Treskanova, Cathie Brumley & Pam Guest. Practical application of an ecosystem-based framework to address land degradation in the Canterbury high country: an evolving concept.

4:30 Helmut J. Janssen. Biodiversity restoration on private land. Manawatu -Wanganui region (horizons.mw).

4:50 Robyn Simcock, Craig Ross, & Peter Williams. Accelerating rehabilitation of native ecosystems: successes and failures of the direct transfer technique.

5:10 John Craig. Sustainability & Ecology: The Natural Step TM

6:00 Dinner. Station Cafe

7:30 Natural History Unit Film Evening. PWC Lecture Room, University of Waikato

Films to include:
1. "The Devil's Playground" - directed by long-time Natural History producer Rod Morris, this story about Tasmanian devils has just won the prestigious "best animal behaviour" award at Wildscreen, the biggest Natural History film festivsl in the world. (52 minutes)

2. "Twisted Tales - The Bat" - Ian McGee won an Emmy for the script of this quirky show. Not your usual Wild South, this is a good example of the varied programmes we are making for the American TV market. (26 minutes)

3. "Octopus's Garden" - underwater cameraman and producer Andrew Penniket's film about an octopus was shot around Otago and Stewart Island, and is one of the few programmes we have recently made in New Zealand. (52 minutes)

Tuesday 21st November, 2000

8:30 Symposium 3: Ecosystem management: food webs
PWC Lecture Room, School of Management, University of Waikato
Chair: John Innes

8:35 Conference Guest Speaker: Neo Martinez. Studying and managing complex food webs: advances in research and plans for application.

9:25 Simon Fowler. Food webs for exploring indirect effects of weed biocontrol agents

9:45 Jacqueline Beggs, David Butler, & David Norton. Ecological interactions in a honeydew beech forest – past, present and future.

10:10 – 10:40 Morning tea

10:40 Symposium 3: Ecosystem management:
PWC Lecture Room, School of Management, University of Waikato
Chair: Theo Stephens

10:40 Clare Veltman, John Daly, Max Suckling & Graham Burnip. Are native leafroller moths affected by possum control?

11:00 Rosemary Barraclough. Time scales, area and goals of ecosystem monitoring: A northern Te Urewera example.

11:20 Gary Barker. Quantitative methods for the selection of indicator species.

11:40 John Leathwick & Jake Overton. Hunting the snark – in search of the elusive ecosystem.

12:00 Sam M Ferreira & Dave R Towns. Ecosystem approaches to maximise conservation of biological diversity.

10:40 Contributed Papers 4.
MSB101, School of Management,University of Waikato
Chair: Mick Clout

10:40 Isabel Castro, Dianne H. Brunton, Deborah J. Anthony, & Sandra Anderson. Is blood sampling of birds truly harmless?

11:00 Doug P. Armstrong & R. Scott Davidson. Estimating impacts of poison operations on native birds using mark-recapture analysis

11:20 ☺ Amy Trass & Alastair Robertson. Berries and birdpoo – the ins and outs

11:40 Ron Moorhouse, Les Moran & Genevieve Taylor. Increase in kaka (*Nestor meridionalis*) breeding success following control of mammalian predators.

12:00 ☺ Wendy Dimond, Doug P. Armstrong & Tim G. Lovegrove. The effect of a translocation on a source population using North Island robins (*Petroica australis longipes*) as a case study.

12:20-1:20 Lunch

1:20 Conference poster session
School of Management foyer

Gary M. Barker, Beverley Clarkson & Louis A. Schipper. Successional developoment of restiad bogs: patterns in invertebrate communities.

☺ Roger Dungan, David Whitehead, Matt McGlone, Rob Allen, & Richard Duncan. Seasonal photosynthetic response of leaves of two co-occurring tree species with contrasting leaf habit

Mel Galbraith. Uruamo Headland: urban ecological management by accord.

☺ Melissa Hutchison. Population dynamics and seasonality of ground beetles (Coleoptera: Carabidae) in New Zealand native forest remnants

Peter R. Johnston. Communities or Plantations? Microbes and site restoration

C.M.King, R.A.Powell & M.G.Efford. The paradox of variable reproductive effort in female stoats during rodent cycles.

Alison J. Perfect, Elizabeth Grove, Jennifer M. Hurst, Pim J.M. de Monchy & Patrick Stewart. A Different Kettle of Trees - how valid is the comparison of offshore island data to mainland sites when evaluating forest health?

Paul G. Peterson, A.W.Robertson & B.Lloyd. Pollination by short-tailed bats

Ben Reddiex. Impact of rabbit haemorrhagic disease (RHD) and predation on rabbit population dynamics

Craig Ross, Peter Williams, & Robyn Simcock. Can pakihi fernland be restored after mining?

James Ross & Chris Frampton. Trap-catch probabilities of brushtail possums (*Trichosurus vulpecula*) prior and preceeding a major control operation.

☺ James Russell. Community involvement in an urban kereru assessment

☺ Stokes, K, Bullock, J, & Watkinson, A. Ecological processes controlling the range distribution of *Ulex minor* and *Ulex gallii*

☺ Gareth Wilson, Megan Balks, Keith Thompson & Kerry Brown. The impact of hydro-electricity generation developments on the extent of braided rivers and adjoining wetlands in the Upper Waitaki Basin, South Island, New Zealand.

Wright, G.R.G., Brown, L.E., Radford, C.D., Eason, C.T. Trends in vertebrate pesticide contamination of wildlife.

2:30 Symposium 3: Ecosystem management:
PWC Lecture Room, School of Management, University of Waikato
Chair: Theo Stephens

2:30 Alan Saunders and Paula Warren. Preparing a strategy to guide the Department of Conservation's ecological management programmes.

3:05 Kirsty Johnson. Environmental Performance Indicators Programme Update.

2:30 Contributed Papers 5
MSB101, School of Management,University of Waikato
Chair: Carol West

2:30 Susan Walker, Laurence J.Smith, W. McG. King & J. Bastow Wilson. How useful is the plant functional type concept? A comparison of morphological characters and responses to nutrients, water, and the cessation of grazing in semi-arid New Zealand grassland.

2:50 Susan Walker & William G.Lee. Exotic plant invasions and invasibility: pattern, process and community changes in alluvial grasslands.

3:10 Duane A. Peltzer, Scott D. Wilson & Norm C. Kenkel. Why does diversity not beget stability or productivity in some grassland ecosystems?

3:20-3:50 Afternoon tea

3:50 Symposium 3: Ecosystem management: deer management - a case study
PWC Lecture Room, School of Management, University of Waikato
Chair: John Innes

3:50 Graham Nugent. Hunting impacts on deer impacts on conservation values: An update.

4:15 John Henderson. New Zealand Deerstalkers Association: hopes, policies, actions

4:40 Sean Goddard. Department of Conservation policies, actions, update on recent submissions

5:05 Convened panel discussion (end 5:35)

3:50 Contributed Papers 6
MSB101, School of Management,University of Waikato
Chair: Avi Holzapfel

3:50 Kerry-Jayne Wilson, N.W. Was & W. Sullivan. Prion problems. Early breeding and non-breeding season colony visits enable broad-billed prions to exclude endangered Chatham petrels.

4:10 Merilyn Merrett. A native sand dune species in decline: what threatens *Pimelea arenaria*?

4:30 ☺ Wade C Tozer, Bruce D. Clarkson, & Warwick B. Silvester. Identifying sources of nitrogen in primary succession on Mt Tarawera, New Zealand.

4:50 T.G.A. Green, W.B. Silvester & ☺ S.M.McCurdy. Nitrogen isotopes in nitrogen fixing and non-fixing lichens and other plants in Tongariro National Park, New Zealand.

5:10 Richard Gordon, Phil Hart & Bruce Burns. Ecol Soc 2001: an environmentally sustainable conference?

6:00 AGM MSB101, University of Waikato

7:00 Wine and pizza evening, Station Cafe

Wednesday, 22nd November, 2000

8:00am – 5:00pm Field trips

Buses leave from and return to College Hall, University of Waikato, Hillcrest Rd

1. **Botany of the Waikato**
   Leaders: Bruce & Bev Clarkson

The flora of the Waikato is a mixing ground of northern and southern elements, e.g., kauri/hard beech forest. Visit key natural ecosystems that make up the Waikato landscape such as restiad peat bogs and diverse forest communities including semi-swamp forest.

2. **Managing ecosystems: Mapara & Warrenheip**
   Leaders: Karen Denyer & Phil Bradfield

Compare two approaches to restoration of natural ecosystems: Mapara Forest - intensively managed for kokako from 1989-1997, and Warrenheip - a private restoration project using a pest-proof fence.

3. **Karst ecology at Waitomo**
   Leaders: Bruce Burns & Dave Smith

Explore the peculiar ecology of cave and other karst ecosystems. The trip will highlight cave faunas, karst vegetation, ecosystem management for cave conservation, and past fauna records from cave deposits.

6:30 pm Dinner and Dance, College Hall Dining Room, University of Waikato

Thursday, 23rd November, 2000

8:30 Symposium 4: Ecology in human-dominated landscapes
PWC Lecture Room, School of Management, University of Waikato
Chair: Craig Miller

8:40 Conference Guest Speaker: Richard J. Hobbs. Landscape ecology: management and restoration of extensively modified landscapes in Western Australia.

9:20 David Norton, Jenny Ladley & Hamish Cochrane. Forest fragmentation and fruit dispersal of the mistletoe *Peraxilla tetrapetala.*

9:40 Mark Bellingham. Bird communities in small forest remnants.

10:00 Jake Overton & Mark Smale. Biodiversity of New Zealand road reserves.

10:20 – 10:50 Morning tea

10:50 Symposium 4: Ecology in human-dominated landscapes
PWC Lecture Room, School of Management, University of Waikato
Chair: Bruce Burns

10:50 Claire L. Newell, Kathryn Whaley & Colin D. Meurk. Exotic plant invasion in Auckland native forest fragments

11:10 Craig Miller. Management of riparian forest remnants in a New Zealand agricultural landscape.

11:30 Eckehard Brockerhoff, Chris Ecroyd, & Mark Kimberley. Biodiversity in *Pinus radiata* plantation forests.

11:50 Shona Myers. Urban Biodiversity - Protecting and restoring a unique part of New Zealand.

12:10 ☺ Karen Denyer. The effects of adjacent land use on indigenous forest fragments in the Waikato Region.

10:50 Contributed Papers 7
MSB101, School of Management,University of Waikato
Chair: Bruce Clarkson

10:50 ☺ Bestic, K.L.; Meurk, C.D., Wilmshurst, J.M., & McGlone, M.S. Recent spread of *Dracophyllum* scrub on Campbell Island, subantarctic New Zealand.

11:10 ☺ Kate G. McAlpine & Donald R. Drake. The effects of small-scale environmental heterogeneity on seed germination in experimental treefall gaps.

11:30 Laura A. Sessions & Dave Kelly. Predator-mediated apparent competition between an introduced grass (*Agrostis capillaris*) and a native fern *Botrychium australe* (Ophioglossaceae) at Cass, inland Canterbury.

11:50 ☺ Tristan Armstrong & Julian Ash. The ecology of speciation: patterns and processes in Australian alpine *Ranunculus.*

12:10 Dave Kelly, Mark Rees & Ottar Bjornstad. Weather versus predator satiation: the role of resources and cues in mast seeding by *Chionochloa pallens* (Poaceae) in New Zealand

12:30-1:30 Lunch

1:30 Symposium 4: Ecology in human-dominated landscapes
PWC Lecture Room, School of Management, University of Waikato
Chair: Gary Barker

1:30 Sarah Flynn & Dan McClary. Riparian restoration in an urban environment

1:50 Mairi Jay. Dairyfarming: information flows and biodiversity loss

2:10 T.M. Downs & B.D. Clarkson. Identification and management of key ecological sites of Hamilton City.

2:30 Robin Janson & R. L. Farrell. Fungal diversity in imported wood packaging: a biosecurity threat.

2:20 Contributed Papers 8
MSB101, School of Management,University of Waikato
Chair: John Leathwick

1:30 ☺ Britta Basse, John Innes, & Ian Flux. Comparing pulsed management strategies for North Island kokako using mathematical modelling.

1:50 Lars Brabyn. The use of GIS for biodiversity mapping in New Zealand

2:10 ☺ B. L. Chisnall, B. J. Hicks, & M. L. Martin. Size, abundance, and production of harvested freshwater eels (*Anguilla australis* and *A. dieffenbachii*) in a New Zealand stream.

2:30 D. Gleeson, S. Binzegger, and N. Ling. Conservation genetics of *Galaxias gracilis*, a rare endemic freshwater fish.

3:00 Close and prize-giving

Abstracts (student session only)

Abstracts listed in alphabetical order by surname of first author, presenting author underlined. ☺ = student presenter.

Origin, evolution and relationships of the New Zealand *Pittosporum* (Pittosporaceae) based on nucleotide sequences

☺ L.A. Hathaway & C.E.C. Gemmill
Department of Biological Sciences, University of Waikato, Private Bag 3105, Hamilton

Pittosporum is one of the largest native plant genera in New Zealand. There is disagreement over how many species there are with estimates ranging from 19 to 26. Many of the distinctive features of the New Zealand flora, such as the divaricating habit, are found in the endemic *Pittosporum* species, making it an ideal group to use to investigate their evolution.

Using the sequence variation of the ITS region of nrDNA the main objectives of this project are: 1) to determine how many *Pittosporum* taxa there are in New Zealand and their taxonomic status, 2) to investigate their phylogenetic relationships, 3) to find out how may colonisation events occurred into New Zealand and from where? 4) and to reconstruct the evolutionary pathway of various characters by mapping them to the phylogenetic trees.

Preliminary results indicate that the lower estimates of species number appear to be more correct, although there does not appear to be much genetic differentiation within the New Zealand species. There have been at least two colonisations into New Zealand but no indication is given of where they may have originated from. The divaricating habit appears to have evolved independently in each taxa, while heteroblasty seems to have arisen at least four times.

Ecotones: their role in the landscape and their application in restoration

☺ Anthony Keen
University of Auckland, Private Bag 92019, Auckland

This study aims to examine the significance of transitional vegetation communities in the landscape, called ‘ecotones’. The study is site specific, situated in a forested catchment system on the Tawharanui peninsula, 90km north of Auckland City, on the East Coast. By studying various aspects of the indigenous vegetation, soil and hydrology of the area conclusions can be made about the changes in the plant communities from wetland to upland vegetation communities and from wetland to wetland vegetation communities. A reconstruction of the palaeo-vegetation will be made from pollen analysis of cores extracted at the site. An examination of the stratigraphy in the cores will help explain the rate of change in plant community composition related to soil types and elevational gradients. The study will be concluded with recommendations for restorative work on areas of similar profile or potential.

Social structure of an insect (mountain stone weta *Hemideina maori* (Orthoptera: Anostostomatidae)) with a female-defence mating system

☺ Paul T. Leisnham & Ian G. Jamieson.
Dept. of Zoology, University of Otago, New Zealand.

Adult male tree weta (Orthoptera: Anostostomatidae; *Hemideina* spp.) have heads twice the size of those of adult females. This sexual dimorphism is thought to be the result of sexual selection on larger males to aggressively defend groups of reproductive females from other rival males in refuge sites such as tree holes or rock cavities. Mountain stone weta (*H. maori*) on the Rock and Pillar Range in Central Otago live under rocks that have broken off isolated rock outcrops called "tors". We marked 236 adult males and 244 adult females on 16 tors over three years and recorded their location to obtain data on their social structures. We found a significant positive correlation between female group size and male head size of males, and that under rocks with the largest female groups, the vast majority (72%) of male takeovers were by larger individuals. We also found a significant positive correlation between the residency time spent under the same rock and the head size of males. These results suggest that in mountain stone weta larger adult males guard bigger groups of reproductive females from smaller rival males. Small males might exhibit an alternative mating strategy of "sneaking" between rocks to obtain copulations with reproductive males females.

Pollination ecology and survival of New Zealand orchids

☺ Carlos A. Lehnebach
Department of Ecology, Massey University, Private Bag 11 222, Palmerton North. Email: C.Lehnebach@massey.ac.nz

The orchid family in New Zealand comprises 22 genera and *ca*. 110 species that are distributed throughout the North and South Island. Their habitats range from forests to roadsides, and their growth habit could be epiphytic (4 genera) or terrestrial. The most speciose genera are *Pterostylis* (20 taxa), *Corybas* (13 taxa) and *Thelymitra* (12 taxa). Although several botanists, naturalists and amateurs have been studying NZ orchids since mid 1800's, aspects of their taxonomy and ecology remains unstudied or poorly understood. Currently, after habitat disturbances by human activities (urbanization processes, change in the land use, disruption of mutualisms and chemical pollution) the number of orchid taxa considered under threat is considerable. The main goal of this study is to assess the survival capability of some epiphytic and terrestrial orchids based on features of their breeding system, pollination syndromes and their pollinator-dependence. Preliminary results in *Earina autumnalis* (G.J. Forts.) J.D. Hook. have shown that, although the species is self-compatible (S.I.I.: 0.9) and the pollinia removal is high (91.52%), fruit-set is rather low due to a limited pollinia deposition. On the other hand, apomixis and automatic self-pollination are not involved in seed-set, thus the dependence of this species to the pollinator is absolute.

Bellbird (*Anthornis melanura*) vocal repertoire and the functions of female song

☺ Xiao Ling Li
School of Biological Sciences, University of Auckland, Private Bag 92019, Auckland

The bellbird is one of three extant New Zealand honeyeater species and has been identified as an important pollinator in native forest, and hence plays an important role in forest ecosystem and conservation biodiversity. Bellbirds have evolved a highly sophisticated system of acoustic communication used for both individual and species recognition. Unlike most passeriformes, female bellbird sings year round in a functional frequency and context. However there is no published spectrographic analysis bellbird song repertoire and vocalization, and the context and functions of female song remain unclear. The aims of my research include: 1) investigating the different song types of male and female bellbirds and determining their repertoires; 2) examining the context and functions of female bellbird song; 3) describing geographic differences in bellbird song. Intensive field observations and recording have been made to determine the context and function of female song. Observations have been conducted from match to November 2000 on Tiritiri Matangi Island. In total 10 trips and about 60 hours recording have been made. All songs have been recorded using a digital audio tape recorder (DAT) and a unindirectional microphone. Male and female bellbird songs have been analysed using the computer software CANARY. It has been found that there are 3 main types of male song and 2 main female song types. Female song is a normal behaviour in this species in the breeding season, and females sing more frequently than male birds after paired. Compared to male song, female song is short and rapid. Group cohesion and communication with males are considered to be the major functions of female song. The songs of different bellbird populations also appear to be different in several aspects.

Lichen ecology and diversity in a regenerating forest in Tongariro National Park, New Zealand.

☺ Susan M. McCurdy, T.G.A. Green, W.B. Silvester, & Roman Tuerk.
Department of Biological Sciences, University of Waikato, Private Bag 3105, Hamilton

The regeneration pattern of manuka (*Leptospermum scoparium* J.R. et G Forst) (and kanuka (*Kunzea ericoides* var. ericoides (A. Rich.) J. Thompson) regrowth is fairly common in New Zealand. The Rangipo Desert site has been subject to periodic fires, which has provided a chronosequence of trees, 56, 36, 26 and 16 years old. In the early stages of regeneration there is little in the way of other tree species but the scrublands are visually dominated by macrolichens. Lichen is a 'consortium' that has resulted from the symbiosis of a fungus and an alga. The algae may be chlorophytes or cyanobacteria or a combination of both. Those that have a cyanobacterial component fix atmospheric nitrogen and this study is part of ongoing research into the contribution of these lichens to the nitrogen cycling in this ecosystem. The lichen species have been identified and the chronosequence of the study site has provided an opportunity to compare lichen recruitment and species diversity between age grouped trees. The presence or absence of lichen on the two tree types has also been investigated and a distinct preference for kanuka as substrate is obvious. Data has been collected on light levels, temperature and relative humidity, all of which have an impact on the species type that establishes as well as the ongoing survivorship in this ecosystem.

Breeding success of North Island fernbird

Kevin Parker
University of Auckland, Private Bag 92019, Auckland

Introduced mammals and habitat clearance have had a profound effect on most New Zealand bird species. The endemic fernbird (*Bowdleria punctata*) was once widespread throughout New Zealand in upland scrub and wetland habitats. Current distribution is primarily based on anecdotal observations but suggests they are widespread but patchy. Fernbird have become rare in upland and lowland scrub habitat and in some cases have disappeared altogether. They are now primarily associated with wetland habitats. It is hypothesised that introduced predators have a greater impact on upland and lowland scrub populations than wetland populations.

My study aims to compare the breeding success of two North Island fernbird (*B.p. vealeae*) populations, in upland scrub habitat at Orewa and saltmarsh habitat at Omaha, with results from previous studies conducted on South Island fernbird (*B.p. punctata*) and Snares Island fernbird (*B.p. caudata*). Breeding success will be determined by monitoring of nests and identification of causes of nest failure. Nests will be monitored by direct observation and video camera. Chicks and adults will be banded to determine annual mortality. A survey method suitable for determining population levels of fernbird will be developed. The abundance of introduced predators will be estimated using tracking tunnels, spot light counts and video cameras. An experimental removal of key predators will be used to assess direct and indirect impacts on fernbird breeding.

This research is necessary for determining information on a little known endemic and may provide implications for the future management of mainland fernbird populations.

Modelling the biological invasion of offshore islands

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In 1967 MacArthur and Wilson's published work "The Theory of Island Biogeography" revolutionised the field of ecology. Since then their theory has seen wide application in such areas as nature reserve design, population modeling, behavioural ecology and many more related fields of ecology. The New Zealand archipelago represents a vast data set of over 800 offshore islands, which over the last 200 years have been subjected to intensive invasion by both introduced mammalian and avian species. I propose that the underlying processes regulating the invasion of New Zealand's offshore islands are those (and the extensions thereof) based upon MacArthur and Wilson's work. By using primarily statistical regression, but also other appropriate statistical techniques, I hope to be able to model the past invasion probabilities of offshore islands, and from these assume future invasion probabilities for islands that have either not yet been colonised, or have had their resident invasive species eradicated and may be subject to recolonisation in the future. This topic shall be my Masters of Science thesis topic in 2001.

Abstracts

Abstracts listed in alphabetical order by surname of first author, presenting author underlined. □ = poster, ☺ = student presenter.

Desperate and dateless: pollinator limitation in *Rhabdothamus solandri* on the NZ mainland

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Recent attention to the pollination ecology of the New Zealand flora has revealed a general lack of understanding of the interactions involved in biotic systems. While for most plants the flower-pollinator association is inherently flexible, the loss of a range of native floral visitors has drastically reduced the options available.
A study of the native gloxinia *(Rhabdothamnus solandri)* highlights the predicament for animal-pollinated native plants. *R. solandri* is a shrub previously widespread throughout lowland northern forest, with orange gullet blossoms 17mm long containing copious nectar. Only the native honeyeaters are able to reach the nectary down the floral tube. The flowers are visited rarely by birds on the mainland, but frequently by honeyeaters on Little Barrier Island. The pollen is presented in a disk, which shows marks after visitation. Observation of these disks showed that low fruit set on the mainland was associated with low visitation to flowers. Flowers were also frequently robbed on the mainland. Fruit set was 4 times higher on Little Barrier Island than the mainland, and flowers were rarely robbed. *R. solandrii* probably now persists on the mainland largely due to its ability to sucker from the parent plant, with possible consequences for its long term genetic variability.
The ability to recognise such vulnerable plant-animal mutualisms is essential if we are to effectively manage diverse and self-sustaining native ecosystems.

Estimating impacts of poison operations on native birds using mark-recapture analysis

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Several recent studies have used "roll calls" – searches for individually-marked birds – to assess impacts of aerial poison operations on non-target species. Roll calls have advantages over methods such as 5-minute bird counts, call counts, and dead body counts, but roll calls are based on the assumption that detection rates are 100%, or that detection rates are constant over time and space. They also require more than one group of birds, at a poisoned and unpoisoned site for example, for valid statistical comparisons. With minor adjustment of field methods, however, a series of surveys can be treated as a mark-recapture experiment, allowing powerful analysis without such restrictive assumptions. Survival and detection rates can be estimated independently for each time interval, and alternative models fitted to the data for factors affecting those rates. Mark-recapture analysis can therefore be used to obtain reliable estimates of the effects of poison operations on many species, and avoids the expense of using radio telemetry. We present mark-recapture analyses used to estimate impacts of brodifacoum poison drops on robin, saddlebacks and stitchbird populations.

The ecology of speciation: patterns and processes in Australian alpine *Ranunculus*

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Nuclear and cpDNA sequence data support a model of recent dispersal of *Ranunculus* (sect.Acris) to the Australian alpine area, with a subsequent rapid radiation during the Pleistocene, giving rise to seven recognised species. The Australian alpine zone has remained relatively small in area throughout the Quaternary (currently only 120 km^2) and is confined to a single uplifted plateau. It is therefore likely that these lineages have coexisted in close proximity throughout their evolutionary history.

These *Ranunculus* species hybridise extensively, with hybrids found in narrow ecotonal areas between the micro habitats occupied by each parental species. The species possess a diverse array of leaf forms, floral characteristics and plant architectures, with hybrids intermediate between parental types in all characters examined. Hybrid zones between populations of different species are characterised by narrow clines in morphological transition which correspond to narrow clines in allozyme allele frequencies. All species in the group are entirely interfertile, as revealed by artificial crossing, with F1 and F2 interspecific hybrids and backcrossed individuals viable and fully fertile. Natural interspecific pollen transfer is broad relative to the width of hybrid zones, leading to substantial hybrid seed set within parental populations, where hybrid plants are absent.

The hypothesis that hybridisation is restricted simply by habitat specialisation and selection against hybrids was tested using field trials conducted over two years. The performance of parental and hybrid seedlings planted into parental habitats differed markedly. Parental species were most successful in their own habitat, with F1 hybrid performance intermediate to that of the two parental species. In light of the field trial results, it can be hypothesised that once adaptations to exploit novel habitats arose, sympatric lineages may have become isolated through strong selection against hybrids. This study clearly emphasises the importance of selection rather than genetic drift as a force in speciation.

Quantitative methods for the selection of indicator species

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There is widespread advocacy for use of indicator species in biodiversity assessment and environmental monitoring. However, as nicely summarised by Williams & Gaston (1994. *Biological Conservation*), "often 'indicator groups' seem to be simply the groups which their advocates work with, no evidence being provided that they indicate anything". The criteria for the selection of indicator species promoted in several seminal publications are reviewed, highlighting the lack of focus on the real issues and the general absence of a quantitative methodology. The key criterion should be that the indicator species/species group robustly reflect changes in the resource of interest. This requires *a priori* identification of the resource to be managed and thus monitored, and understanding of the contribution of the indicator species/group to the pattern observed in that resource. This quantitative approach to selection of indicator species/species groups is demonstrated with several examples. As a summary, a new set of criteria for the selection of indicator species is developed.

Successional development of restiad bogs: patterns in invertebrate communities.

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Lowland raised peat bogs in mainland New Zealand differ from Northern Hemisphere sphagnum bogs in that the vegetation is dominated by *Empodisma minus* and *Sporadanthus ferrugineus*, members of the Southern Hemisphere rush-like family Restionaceae. *Empodisma-Sporadanthus* bogs covered more than 100,000 ha in northern North Island before European arrival, but have been severely reduced by drainage and conversion to pasture. Ongoing management is now required to minimize further bog loss and/or unwanted changes in structure and function. Such management requires a sound understanding of the geochemical, hydrological and ecological processes of the bogs. This paper reports on the first phase of research on invertebrate communities in these *Empodisma-Sporadanthus* bogs. It focuses on pattern in invertebrate assemblage along a gradient of successional development.

The major environmental determinants of vegetation pattern and process associated with successional development in bogs over the past ca. 15,000 years had previously been identified from analyses of vascular plant assemblage and environmental data for 65 plots established the Waikato lowlands. From these analyses, a spatial chronosequence of 14 sites, providing for coverage of the full successional gradient, was selected for invertebrate sampling. At each site, epigeal invertebrate communities were sampled by 10 pitfall trapping operating over a 3-week period in December 1998. The captured invertebrates were subsequently identified to species.

Collectively, our data indicate a strong linkage between bog successional development and invertebrate community structure. Abundance in many invertebrate species was correlated significantly with the principal axis of succession evident in the vascular plant assemblage data. Generally the correlations were negative, indicating decline in abundance and species richness with bog successional development. Only in the case of *Paracephaleus* sp1 (Hemiptera: Cicadellidae) was there a positive association with Axis 2 scores. These trends were particularly strong for richness and diversity in Araneida, and richness and total abundance in Diptera. Ordination analyses indicate a strong association of invertebrate assemblage with a gradient of nitrogen and phosphorus content, bulk density and decomposition (Von Post) of the peat substrate, which were earlier shown to be important in the successional gradient in the ordination of plant assemblage data.

The primary conclusions are that (i) Successional development of the bogs is strongly reflected in the composition and structure of the invertebrate communities, and (ii) Invertebrate abundance and diversity generally declines with bog successional development.

Time scales, area and goals of ecosystem monitoring: A northern Te Urewera example.

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A portion of the monitoring data from the northern Te Urewera ecosystem restoration project will be used to help illustrate issues of time-scale, area and goals in ecosystem monitoring. To design an appropriate monitoring regime it is crucial to define management strategy goals and consider issues of area and time scales. Due to the absence of pristine New Zealand mainland forested sites to provide benchmarks, a final long-term goal for the restoration of forests is difficult to define. Furthermore, a number of indigenous species have been lost to extinction and a range of invasive species will be permanently incorporated in any future system. However, what is certain is that the long-term control of invasive species and the rehabilitation of populations of indigenous fauna and flora will both be integral to any 'ecosystem restoration' strategy. However, although a defined ecosystem goal will generally be absent, it will be possible to focus on the 'stability' of the new system that emerges from any ecosystem restoration management, to define success. Long-term monitoring, for stability, would necessarily be structured differently from shorter-termed outcome monitoring. Time-scales that are dictated by non-biological considerations, such as financial limitations, can potentially lead to misleading or unclear results due to the short time frames. The area over which monitoring is conducted also becomes harder to define in cases such as the northern Te Urewera, where contiguous forest is undergoing heterogenous management. Although the 'ecosystem' by definition includes the whole suite of physical factors, rather than only the organism-complex, ecosystem monitoring can focus on assessing those forces that drive or control an ecosystem. One of the most important reasons for using an ecosystem approach is because ecosystems have high interdependencies and strong feedback loops, a simple example of which is seed dispersal by forest birds.

Comparing pulsed management strategies for North Island kokako using mathematical modelling

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The North Island kokako, *Callaeas cinerea wilsoni*, is an endangered bird endemic to New Zealand. The recovery plan for this bird includes mathematically modelling the change in kokako densities over time. The modelling is generic in nature and can be used to compare different pulsed management strategies. It is also used to explain the gender imbalance in some isolated populations where males outnumber females. The long term goals of the modelling will be to predict the least amount of intervention required to achieve an acceptable number of breeding adults by the year 2020. In this presentation the model formulation and some preliminary results will be discussed.

Ecological interactions in a honeydew beech forest – past, present and future.

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It's AD 1200. Extensive tracts of beech forest in the northern South Island are infested with honeydew-producing scale insects. This sugary exudate provides a major energy source at several trophic levels. It is consumed by native birds, lizards and invertebrates. Most of the honeydew falls to the ground around the tree, adding a high load of carbohydrate that affects micro-organisms and hence nutrient cycling.

Fast forward to the 1990s. About one million ha of honeydew beech forest remain. But it has been invaded by a raft of animals including possums, stoats and rodents. Perhaps worst of all is the wasp which attacks one of the ecosystem's most important features – honeydew. For 5 months of the year, wasps reduce the standing crop of honeydew by more than 90%. The abundance of honeydew supports high numbers of wasps, and hence the consumption of large quantities of invertebrates as well.

Is it possible to predict how key ecological interactions may change in the next 50 years? Can we restore the ecosystem or at least maintain what remains? The Department of Conservation has established the Rotoiti Nature Recovery Project in honeydew beech forest. Preliminary results give us a glimpse of what could be achieved.

Bird communities in small forest remnants

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Small indigenous forest remnants are often all that remains of New Zealand's indigenous biodiversity in the extensive agricultural matrix of the lowlands, and birdlife is an obvious candidate as a sustainability indicator of biodiversity for these forest remnants. The key issues for biodiversity planning for indigenous forest remnants include changes in bird abundance with indigenous forest remnant size, the minimum size of indigenous forest remnant necessary to sustain indigenous bird species and effects of habitat quality on bird abundance. This study used distance sampling to estimate bird abundance in isolated indigenous forest patches (2-1000 ha) in Rodney District, Auckland. They revealed differences in density of a number of bird species in indigenous forests with varying patch size and differences in density of indigenous and exotic birds and bird communities between the edge and the interior of indigenous forests. Minimum patch sizes were established for four bird indigenous and three exotic species in their breeding seasons. The results were not comparable with other studies in New Zealand, as almost all bird research for common bird species has used the five minute point count method (Dawson & Bull 1975) for estimating relative densities of birds. In addition there are very few ecological studies in New Zealand on the common bird species that are the majority of our bird species and numbers.

Recent spread of *Dracophyllum* scrub on Campbell Island, subantarctic New Zealand.

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The vegetation of subantarctic Campbell Island consists mostly of *Dracophyllum* scrub, tussock-grassland and upland tundra associations. First human contact with the island began in the 19th century. The earliest accounts and photographs of the island vegetation (1888 and 1907) indicate the scrub was highly restricted to shoreline fringes and extending up slope in sheltered gullies. Since the 1960s, photographs have been retaken at intervals from the same viewpoints to document the changing distribution of scrub. We analysed 33 of these photographic sequences to estimate the changing distribution of *Dracophyllum* scrub over the last 110 years (measured as change in percentage cover between sequential photographs). There has been an ongoing increase in woody vegetation, seen mostly as an expansion of pre-existing scrub patches. Selected topographic units on these photographic sequences were also analysed for any change in scrub cover to determine if topography was a factor influencing change. Increases in scrub cover occurred mostly on the mid slopes down to the foreshore and on flat bogs, but not on the upper slopes (>200m a.s.l.). Such a dramatic change in the vegetation cover of the island is of intrinsic interest from an ecological and environmental viewpoint, and has implications for the management of the island for wildlife values.

The use of GIS for biodiversity mapping in New Zealand

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This paper discusses potential applications and current limitations of GIS for mapping and modelling biodiversity in New Zealand. Three functions of GIS that are important for biodiversity modelling are demonstrated. These are terrain analysis, data integration and data visualisation. Terrain analysis can be used to identify micro, meso and macro terrain indices. Data integration can be used to determine the environmental characteristics of known habitats of species. Data visualisation uses maps, graphs and statistics to make the enormous amount of data that can be derived on a species' habitat easy to understanding. This research has attempted to use "Public Good" New Zealand species location data sets but had problems with access and format. It is argued that the ability of computer hardware and the functionality of GIS software is being under utilised in New Zealand for biodiversity mapping because of poor sharing and storing of data, and an overall lack of co-ordination and leadership in environmental information management.

Does a mycorrhizal association of prostrate kanuka facilitate its survival in geothermal steamfields?

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Geothermal regions are extreme environments with factors limiting plant growth. These include high soil temperatures, low soil pH, and restricted nutrient supply. Plant survival in such conditions requires successful adaptation to, or tolerance of, these stresses. Anecdotal evidence suggests a unique association between *Kunzea ericoides* var. *microflora* (prostrate kanuka) and the ectomycorrhiza *Pisolithus tinctorius* (Pt). It is hypothesised that the Pt association facilitates the survival of prostrate kanuka in the extreme conditions of geothermal regions. Field surveys have confirmed this association which has been measured by plant response to temperature and pH gradients. Laboratory experiments have successfully synthesised Pt associations with prostrate and erect kanuka and have been assessed by measuring plant growth and the level of mycorrhizal association developed. Semi-sterile bioassays have been carried out to replicate natural conditions showing the effect of temperature gradients. Sterile test tube and plated media show the effects of phosphorus concentration and pH on plant growth and degree of successful inoculation in artificial conditions.

Biodiversity in *Pinus radiata* plantation forests

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Increasing awareness of the need for sustainable forest management, together with new Government policies and international commitments has led to biodiversity becoming an issue for New Zealand's plantation forestry. We studied the understorey vegetation and Coleoptera assemblages of four *Pinus radiata* plantations in the North and South Islands. The understorey vegetation of young, mid-rotation and mature stands, ca. 5, 16, and 27 years old, respectively, showed a successional pattern progressing from a dominance of herbs and shrubs, with a high proportion of adventives, to one of mostly indigenous ferns and small trees. This pattern appears to be caused by the colonisation of disturbed post-harvest sites by 'weedy' colonisers and their progressive replacement by shade-tolerant, later seral species that benefit from the increasing shading from pines. Pine plantations are surprisingly species rich; in the 20 stands studied, we recorded ca. 270 vascular plant and 350 beetle species, most of which are indigenous. Malaise-trapped beetle assemblages showed no obvious relationships with stand age, contrary to plants, but beetle and plant richness were correlated among regions. Because of the considerable regional variation in composition and species richness, using biodiversity indicators will require a sound knowledge of the regional flora and fauna of plantations.

Hydrology of Waikato peat bogs

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The functioning of all wetlands rely on the fluxes and storage of water within them, however raised peat bogs are particularly sensitive to these hydrological processes. This paper will describe the key results of recent hydrological research carried out within Waikato peat bogs. Micrometeorological studies within the Waikato bogs indicate that the restiad species dominating their vegetation covers possess a highly tuned ability to conserve water by minimising transpiration and evaporation from the moist peat surface. A combination of strong physiological control over transpiration and an extremely dense canopy, which limits evaporation from the peat surface, are the key factors. Simplified predictive models of evaporation have allowed seasonal and annual estimates of evaporation to be used in water balance studies.

A recent study of the groundwater regime at Moanatuatua peat reserve has provided a description of sub-surface water flow directions and rates. A numerical groundwater model was used to investigate the effect of farm drainage, climate and vegetation on the water table within the bog. Farm drainage practices have a large impact at the margins of the bog and upon the evolution of the domed shape of the bog, while fluctuations in seasonal and annual rainfall impact most on the water table regime within the bog. Vegetation type, via its controls on evaporation, also has a large effect on the water table.

Is blood sampling of birds truly harmless?

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Blood sampling is currently the principle method of obtaining samples for assigning paternity, measuring hormonal levels, developing phylogenetic trees, determining blood characteristics, studying energetics, and investigating population genetics in free living avian species. Molecular ecology techniques are currently being used to develop strategies for conservation programmes, thus involving blood sampling of endangered birds. Despite the wide use of blood sampling, we found only 13 (6% of bird species) instances where the effect of this technique had been considered. Theses studies failed to detect any significant impacts from blood sampling. Contrary to these results we found that blood sampling of hihi chicks significantly alters the mother's behaviour, reduces chick begging, and slows down weight gain by chicks.

Size, abundance, and production of harvested freshwater eels (*Anguilla australis* and *A. dieffenbachii*) in a New Zealand stream

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Sympatric longfinned eels (*Anguilla dieffenbachii*) and shortfinned eels (*A. australis*) in a previously unfished pastoral stream in the Waikato region, New Zealand, were studied over a 10-year period. Species dominance changed over the period, as the size, density, and biomass of the two species responded differently to four years of annual harvest. The density of small shortfinned eels increased 3-fold following the removal of the 26 large longfinned eels from the 600-m^2 reach. The density of longfinned eels was 4.4 fish/100 m^2 (38 g/m^2) before harvest compared to 1.2 fish/100 m^2 (5 g/m^2) one year after harvest. The density of shortfinned eels was 17 fish/100 m^2 (12 g/m^2) before harvest compared to a maximum of 56 fish/100 m^2 (15 g/m^2) two years after harvest. Following 5 years without harvest, the total biomass had returned to preharvest levels, but in contrast to the situation before harvest, the biomass of both species was about equal. Large eels, particularly longfinned eels, appeared to regulate density and structure of the population present. Harvest appeared to cause increased recruitment of juvenile shortfinned eels to the study reach, but did not increase total eel production. This study highlights the vulnerability of eel populations in small streams to overfishing.

Restiad bog succession in the Waikato region since *c.* 13 000 ^{14}C years BP

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A spatial chronosequence of restiad peat bogs in the Waikato region was sampled to identify the major environmental determinants of vegetation pattern associated with temporal succession since *c.* 13 000 ^{14}C years BP. Classification of spatial data from nine different-aged bogs identified six main vegetation groups forming a sequence from sedges, through *Empodisma minus* the key peat-forming restiad species, to phases dominated by a second restiad species *Sporadanthus ferrugineus*. This sequence closely paralleled rates and patterns of temporal succession (early successional sedges to late successional *Sporadanthus*) derived from plant macro- and micro-fossils in peat cores dated by radiocarbon techniques and tephrochronology. Peat analysis showed that nutrients (N and P) declined and peat became increasingly less decomposed along the successional sequence. Environmental profiles of the main plant species were modelled and the predicted species response curves separated the species along nutrient gradients. Early successional species had wider potential environmental ranges than late successional species. *Empodisma minus*, a mid-successional species, also had a relatively wide environmental tolerance, which probably contributes to its key role in restiad bog development.

Colonization dynamics and impacts of a nitrogen-fixing native shrub (*Coriaria Arborea*) in post-volcanic primary succession

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We examined the colonization dynamics and successional impacts of a thicket-forming actinorhizal shrub, *Coriaria arborea*, on primary succession on Mt. Tarawera, a North Island volcano that last erupted in 1886. Seed production was high but most seeds did not remain viable for >6mo. Germination was inhibited by nitrogen fertilization in indoor experiments and by the nitrogen-rich soils under *Coriaria* shrubs in the field but promoted by wind protection provided naturally by shrubs or by artificial barriers. Transplanted *Coriaria* seedlings only survived if nodulated with *Frankia* and *Coriaria* soils slowed *Coriaria* seedling growth and did not improve seedling survival. Therefore, establishment of *Coriaria* seedlings is found mostly in protected habitats where adult *Coriaria* are absent, suggesting that *Coriaria* thickets are not self-replacing. *Coriaria* thickets increased soil fertility by increasing leaf litter depth (3-fold over a pre-*Coriaria* stage dominated by herbs), SOM (40-fold), TKN (20-fold), P (2-fold), CEC (4-fold), Ca (8-fold), K (3-fold), and Mg (5-fold). When *Griselinia*, a later successional tree on Mt. Tarawera, was grown in *Coriaria* soils in a glasshouse, 3-6 fold increases in growth, seedling height, leaf number, and biomass resulted. Where frost prevents *Coriaria* establishment, mosses and *Dracophyllum* shrubs that are adapted to low nutrient levels dominate succession. We suggest that *Coriaria* on Mt. Tarawera provides a classic example of a nitrogen-fixer facilitating primary succession, and it can be considered both a key or keystone species in this setting.

Pigeons and possums as keystone species?

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The New Zealand pigeon, or kereru, (*Hemiphaga novaeseelandiae*) is a major native frugivore and folivore in forest ecosystems, and is effectively the sole disperser of a number of large-fruited species. Several of these species are structurally important components of northern New Zealand forests. The introduced brushtail possum (*Trichosurus vulpecula*) is also a major frugivore, folivore and a predator of native species. Possums are known to alter the structure and composition of forests through their browsing habits. Both kereru and possums can be viewed as keystone species and "drivers" of ecosystem processes. Moreover, these two important species also interact with each other on various levels.

In this paper we summarise the ecosystem linkages of these two species and consider their "keystone" roles.

Sustainability & Ecology: The Natural Step TM

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Sustainability is an imperative for the future that requires the inputs of science and especially ecology. Commitment to the journey toward sustainability necessitates a widely accepted set of core conditions plus pragmatic steps that advance ecological, economic and social returns. The Natural Step TM (TNS) is a science based, international movement that offers a consensus built framework for progress.

The basic principles of science including ecology form the foundation of four necessary conditions for approaching sustainability. There is an urgent need for more research and open discussion among ecologists that leads to solutions that advance the triple bottom line rather than the current emphasis on purely ecological ideals.

This paper briefly outlines the basis of the TNS Framework and current progress with business and other organisations. Examples of the ways ecologists can contribute to decision making will be outlined.

The effects of adjacent land use on indigenous forest fragments in the Waikato Region.

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Fragmentation is one of the key issues for New Zealand biodiversity, and the functioning and composition of fragments may be influenced by the type of adjacent land use. Six native forest fragments with pasture and/or mature radiata pine boundaries were studied to test the hypothesis that microclimate and composition of forest fragment edges adjacent to pasture are significantly different from the forest interior, but those adjacent to pine forest are not. Daytime air temperature, photosynthetically active radiation, and vapour pressure deficit were significantly lower at pine/fragment edges. Microclimate edge effects extended into native forest for at least 50 m from pasture, but only 30 m from pine. Fragment edges adjacent to pasture had different plant composition, more adventive species, higher stem densities, and a lower proportion of bird-dispersed seedlings than interiors. Pine edges differed from interiors only in their higher densities of stems and dead saplings; their vegetation composition showed affinities to both pasture edges and interiors. These results suggest that the most important ecological influence of adjacent land use is on regeneration processes occurring at the edge. A pine buffer may speed up the development of a shade-tolerant edge community, and facilitate establishment of mesophytic rather than xerophytic species.

The effect of a translocation on a source population using North Island robins (*Petroica australis longipes*) as a case study.

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Translocating birds from established areas to initiate new populations, or augment small populations, is becoming more common in New Zealand. While translocated populations are often studied, the potential effects on the source populations have been almost entirely ignored. If a recovery takes a long time and/or the source is placed at risk of extinction, this cost will probably outweigh the potential conservation gains from the translocation.

This project aims to test whether small island populations can be sustainably harvested for translocations to the mainland. A robin translocation to Wenderholm Regional Park was used as a case study. Research on Tiritiri Matangi Island (Hauraki Gulf) suggests that the population is limited to about 60 birds by the available habitat. There is high (about 75%) juvenile mortality each year, and the number of juveniles surviving closely matches the number of adults dying. It has been therefore hypothesised that juvenile survivorship is density dependent, and that a portion of the population could thus be removed each year with little impact.

In combination with previous years' data, mark-recapture analysis will be used to test whether the experimental reduction in density increases juvenile survival.

Identification and management of key ecological sites of Hamilton City

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Hamilton is among New Zealand's largest cities and although the landscape has been highly modified both within the city and in the peri-urban zone opportunities still remain for conservation of indigenous biodiversity. A survey recently conducted in Hamilton City documents 67 key sites of remnant and regenerating native terrestrial vegetation. The sites are typically small (average size 0.8 ha) and widely distributed throughout the city. Three quarters of sites identified are however located along gullies or banks of the Waikato River. This presents strategic restoration opportunities in the establishment of 'green networks' and ecological corridors. An ordination of vegetation types shows complex gradations and regeneration interactions between types dominated by either indigenous or exotic species. Case studies will illustrate several important sites within the city. Hammond Bush, one such site, supports a small population of the regionally uncommon tree swamp maire (*Syzygium maire*). Population structure analyses show the species is successfully spreading into adjoining areas dominated by exotic species such as alder and willow. Restoration strategies developed range from minor weed removal, to manipulation of exotic tree canopies and establishment of a native cover. Implications for management and restoration of sites throughout the city and opportunities for community involvement will also be considered.

Seasonal photosynthetic response of leaves of two co-occurring tree species with contrasting leaf habit

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The photosynthetic response of leaves of evergreen wineberry (*Aristotelia serrata*) and winter-deciduous fuchsia (*Fuchsia excorticata*) were measured seasonally at a site in the Taramakau Valley, Westland. Maximum rates of CO_2 assimilation (A_{max}) of mature leaves of wineberry and fuchsia were high, with average values of 12.9 and 14.7 ÿmol m^{-2} s^{-1} respectively. A_{max} of senescing fuchsia leaves declined in April to 10.2 ÿmol m^{-2} s^{-1}, whereas A_{max} of wineberry was less than half the summer time value at 5.9 ÿmol m^{-2} s^{-1}. A_{max} of wineberry leaves measured un August was only slightly lower than in April (5.23 ÿmol $m^{-2}s^{-1}$). A_{max} in both species was linearly related to nitrogen concentration on an area basis (N_{area}), suggesting that seasonal A_{max} decline is related to withdrawal of nitrogen from leaves during senescence. These results will be used (along with seasonal phenology measurments and site environmental data) to parameterize a model of annual carbon uptake for both species. The model will be used to investigate the effect of leaf loss on annual carbon uptake.

Ecosystem approaches to maximise conservation of biological diversity

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Recent conceptual development in conservation biology promotes the importance of process orientated conservation management, i.e. ecosystem management. Divergent ideas of ecosystem management have been proposed. We develop a simple conceptual model for maximising protection of biological assets in the New Zealand context where the portfolio has been depleted by species loss. Our model focuses first on managing those human-induced disturbances that impinge on natural processes and second on managing other processes that limit predetermined outcomes. Our approach is based on achieving stable ecosystems (i.e. systems that are resilient and resistant) as a target for conservation management. Before our model can be applied, appropriate areas need to be identified. Conservation managers have limited information, but some ecological assumptions can be used to direct planning. We suggest a simple model based on three criteria: habitat diversity, optimal area and minimum existing human disturbance. This ecosystem model is applied to the Great Barrier Ecological District. The model is then evaluated against threatened species distribution data for selected taxonomic groups. The comparison tests the effectiveness of an ecosystem approach in a matrix of species with fragmented populations. We conclude that if fine filters are applied to sift assets at large scales (ecosystem type) and fine scales (site location), it may be possible to avoid oversight of significant biological diversity.

Riparian Restoration in an Urban Environment

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This paper examines the objectives and approach to riparian restoration in urban areas, outlining issues and opportunities that are particular to the urban environment.

The characteristics of urban stream environments differ in a number of ways from rural streams. Urban waterways are extensively modified as a result of surrounding development. Stream systems are largely utilised for disposal of stormwater and other effluent, and have often been channelised to improve drainage. The natural floodplains of most urban streams have been reclaimed and developed. However, many urban areas have extensive networks of esplanade reserves, which offer opportunities to repair ecological linkages between coastal and terrestrial ecosystems, and to enhance instream and terrestrial biodiversity.

Some of the key challenges for restoration include working in a disturbance-prone environment characterised by intermittent, high velocity flows, abundant animal and plant pests, and inputs of contaminants and rubbish. Riparian restoration in urban areas must have regard to aesthetic and amenity values, and recognise the diversity of uses associated with the urban surroundings, while at the same time emphasising improving ecological health.

Food webs for exploring indirect effects of weed biocontrol agents in New Zealand ecosystems

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The introduction of a classical biological control agent can be viewed as a large-scale ecological field experiment, where a component of a food web is taken from its native range and inserted into a novel food web in the target country. Direct effects of weed biocontrol agents on non-target plants are predicted from host range tests, but there has been growing concern about other indirect effects that agents might have via more complex interactions. For example, if a biocontrol agent becomes prey for an existing predator, could a resulting, increased abundance of the predator negatively affect other valued biota? Assessing these risks is now a requirement before biocontrol agents can be released in New Zealand. Here a retrospective study of one existing biocontrol agent in New Zealand, the broom twigminer (*Leucoptera spartifoliella*), is used to make a preliminary assessment of the value of food webs in exploring such indirect effects. Two approaches are used. Firstly a quantitative source food web for *L. spartifoliella* from its native range in the UK is built, and used to develop hypotheses on likely indirect non-target effects of this twig-mining moth in New Zealand. Secondly, a connectance food web of moths in the same family as *L. spartifoliella* in New Zealand is constructed, assuming the presence of hypothetical shared natural enemies between these related moths and *L. spartifoliella*. These food webs provide valuable visual models that demonstrate the complexity of possible negative and positive indirect effects from the introduction of a biocontrol agent, and suggest areas for research. However, they also highlight the limitations in our ecological and taxonomic knowledge, and problems in using food webs for predicting impacts of biocontrol introductions.

Uruamo Headland: urban ecological management by accord

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The urbanised environment of the Tamaki ecological district, centred on Auckland city, consists of a matrix of ecosystem fragments embedded in a mix of industrial, commercial and residential landscapes. The Uruamo Headland complex of North Shore City is an exception to this pattern of urbanisation. The headland is a section of the Waitemata Harbour coastline and hinterland, consisting of approximately 260 hectares of contiguous vegetation in the urban matrix, with tenure including local authority, government, private industrial and private residential. Although recognised as having regional ecological significance, only 35% of the headland is protected under statutory legislation.

Integrated environmental management for the headland that recognises and conserves the ecological goods and services it provides, and acknowledges the potential for ecological restoration, has been established through a voluntary accord between North Shore City Council, Royal New Zealand Navy, New Zealand Sugar Company Limited and the Chelsea Regional Park Association (CHERPA). CHERPA is a charitable society set up to promote preservation of the headland. Representatives of the landowners and CHERPA form the Uruamo Joint Environmental Advisory Committee (UJEAC). The management of this headland may represent a model for similar urban situations.

Conservation genetics of *Galaxias gracilis*, a rare endemic freshwater fish.

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Galaxias gracilis, or the 'dwarf inanga' is one of New Zealand's rarest fish species. This species is endemic to only nine sand dune lakes, distributed in three distinct geographic lake groups located in the west coast of Northland; the Kai Iwi lakes, Rototuna lake and the Pouto lakes. It is unclear whether or not *G. gracilis* was derived from the diadromous *G. maculatus* through a single founding event with latter dispersal or via several independant land-locking events. The long-term viability of *G. gracilis* is also threatened by habitat degradation and the introduction of exotic species. These combined factors have resulted in population densities having declined in over 80% of the lakes from which *G. gracilis* has previously been recorded. Our study investigated the population structure of *G. gracilis* by determining the extent of both morphological and molecular variation within each lake population. Little morphological variation was revealed, while meristic characters showed separation of the Kai Iwi lakes. DNA sequence data derived from the complete mitochondrial D-loop region of 93 individuals revealed three distinct groupings: the Kai Iwi lakes, Lake Rototuna, and the remaining Pouto lakes, indicating independent founding events. Inclusion of *G. maculatus* samples, both diadromous and land-locked revealed and non-monophyly of *G. gracilis* in relation to *G. maculatus*, raising questions regarding its taxonomic status. These data show the dynamic nature of the dune lake system and the effects of land-locking on freshwater fish speciation. It is advocated that conservation management priorities need to take into account such evolutionary processes as opposed to primarily focussing on the concept of "taxonomic species".

Deer management: DoC policies, actions, and an update on recent submissions.

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Consultation on deer control commenced in 1997 with the release of a public discussion document prepared for the Department of Conservation by a deer plan working party which included represenatives of hunter organisations and environmental NGOs. Submissions on the discussion document were strongly polarised between those who see deer as a pest and those who want deer managed as a game resource. Scientific evidence shows that deer browse alters the structure and composition of native forests. At critical sites this can lead to canopy collapse. The Department is currently finalising policies on deer control.

Ecol Soc 2001: an environmentally sustainable conference?

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Ecologists, while doing good, also contribute to degradation of the global environment. For example, one conference attendee flying return between Christchurch and Auckland adds about 77 kg of global warming carbon to the atmosphere from aircraft fuel combustion, alone. Conferences are major waste producers, sending tons of paper, plastic and food waste to landfill.

Concerned, as ecologists are, with the natural environment, we have the opportunity to take a lead in promoting the environmentally sustainable conference. There are two fundamental opportunities as we plan for Ecol Soc 2001:

1. To document the positive outcomes for the environment which will come from the research programmes being presented at the conference. How can we measure and thus demonstrate those benefits? Over what timescale will they be realised?
2. To document and reduce where possible the negative impacts of the conference (travel, materials, energy, etc), and then to mitigate the residual impacts. For example, we could optimise the ratio of renewable to non-renewable resources used by the conference. Another is the percentage of waste sent to recycling rather than landfill.

One mitigation strategy is the planting of indigenous trees as a future carbon sink. Such planting has a range of benefits besides mitigating greenhouse gas emissions. It contributes to our biodiversity goals; it may provide erosion control, or other local ecosystem services; and it provides economic and educational benefits through the involvement of schools, nurseries, landscapers, etc.

How far do we wish to go towards the target of an environmentally sustainable Ecol Soc conference in 2001? The first step is commitment to maximising our positive impacts and to minimising the negative.

Nitrogen isotopes in nitrogen fixing and non-fixing lichens and other plants in Tongariro National Park, New Zealand.

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There is a natural abundance of nitrogen isotopes, ^{14}N and ^{15}N in the atmosphere. The ratio of one isotope to another can be used to explore nitrogen processes , with plants that fix nitrogen having a ^{15}N value close to zero. In this study the ^{15}N values of several lichen species have been investigated. Homoiomerous cyanobacterial lichens have a positive value indicating di-nitrogen fixation from the atmosphere and possibly the discrimination against the heavy isotope in biosynthetic pathways and leading to an enrichment of ^{15}N in the tissue. Heteromerous cyanobacterial lichens show small negative values while green algal lichens with some cyanobacterial content are more negative. Green algal lichens with no cyanobacterial content are even more negative while higher plants associated with the area show a range of increasingly negative values indicating further discrimination against the heavy isotope. ^{15}N values show a relationship between these organisms and their ability to fix nitrogen and the discrimination against the heavy isotope in biological processes.

Landscape ecology: management and restoration of extensively modified landscapes in Western Australia.

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We are currently at a crossroads in science, where we have to make some hard decisions about what we want to achieve and how we want to achieve it. Classical reductionist methods, while successful up to a point, cannot adequately deal with complex broad-scale environmental questions. Similarly, the fragmentation of science into many disciplines has led to a fragmentary approach to these same questions. Finally, the separation of science from other types of human endeavour has led to an isolationist view which prevents the integration of scientific information with other types of knowledge.

Set against this is an increasing need for methods and options for managing and planning landscapes that are in various states of disrepair. The development of such options has to take account of not just the biophysical elements and all the complexity and interrelationships between these elements, but also the social and economic contexts, and all their inherent complexities and uncertainties. Options have to take the form, not of vague guiding principles, but of guidelines that can be applied in a quantitative way in any particular situation.

We thus have to struggle with these apparently opposing needs - i.e. the need to include as much of the complexity and context as possible in our investigations versus the need to deliver simple quantitative options for what actions to take in any given situation. The field of landscape ecology has the potential to achieve this, since it aims to consider both complex multiscale biophysical issues and the broader socio-economic and planning context. Here I discuss the development of landscape ecology and its potential role in this arena, firstly with reference to our work in the Western Australian wheatbelt, and then in a New Zealand context.

Responses to fertility control of vertebrate pests

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The response of populations, species and communities to pest control including fertility control, is a topical issue. Pests contribute to species declines and extinctions and to economic damage in agriculture, forestry and fisheries. Fertility control is a focus for research on vertebrate pest control in NZ, Australia and the USA. This paper examines the relationship between the level of fertility control and the response of what is being damaged; populations, communities and production systems. The relationship is broken down into three components and each is examined; the response to damage, the relationship between damage and pest abundance, and the relationship between abundance and the level of fertility control. The basic relationship between response and fertility control is shown to be positive, though the shape (linear or non-linear) differs with differing assumptions of compensatory changes in yield and in pest fecundity or mortality. The level of fertility control needed to achieve a management aim, will depend on what aim is desired. The results are illustrated with examples from studies of brushtail possums, rabbits and feral pigs.

Population dynamics and seasonality of ground beetles (Coleoptera: Carabidae) in New Zealand native forest remnants

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The carabidae or ground beetles have a worldwide distribution and are one of the most diverse beetle families in New Zealand, with 445 described species, and a further 200 undescribed species. Carabids are a dominant group of terrestrial predators, and may be effective biological control agents against agricultural pests. The taxonomy of New Zealand carabidae is reasonably well known, however next to nothing is known about their biology or ecology, especially in indigenous ecosystems. The aim of this study was to further knowledge about the life cycle and ecology of carabidae in New Zealand. The population trends and seasonality of carabid beetles in indigenous forests were investigated using a variety of sampling methods. Live pitfall traps and manual habitat searches were used in a mark-recapture experiment, as well as conventional pitfall trapping. New Zealand carabidae were found to exhibit seasonal fluctuations in their populations, with most species showing a peak in numbers in mid summer, although two species also had a second peak during winter. The limitations of pitfall trapping for studying population dynamics may be overcome by using a combination of sampling methods, however further research into pre-adult stages in necessary to fully elucidate the life cycles of these fascinating animals.

The taxonomic classification of the house mouse in New Zealand.

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Genetic techniques have been used increasingly to assist in the determination and clarification of the taxonomic status of species. The house mouse complex (*Mus*) is one such group to have been recently redefined using molecular and biochemical techniques. The taxonomic status of the introduced New Zealand mouse is unclear, as it has been shown that some individuals show morphological characteristics intermediate between the two genetically distinct commensal subspecies *Mus musculus musculus* and *Mus musculus domesticus*. I am using both classic morphological and current molecular techniques on populations from around New Zealand, to determine their taxonomic status.

The data should permit discrimination between 2 competing hypotheses: (1) that the mice colonising New Zealand represented both European subspecies and have hybridised since, or (2) that the mice colonising New Zealand represented only one subspecies, *Mus musculus domesticus.*

Fungal diversity in imported wood packaging: A biosecurity threat?

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The wellbeing of New Zealand's biodiversity is vital to its cultural and economic survival. International commitments to free trade, however, have placed a strain on national priorities set out in recent Biosecurity related legislation. Measures taken to accommodate these needs have seldom been entirely based on scientific observation due largely to the uncertainty as to what constitutes a threat to biosecurity, and if identified, how to monitor what is being imported. The present project was undertaken to assess the range of fungi inadvertently being imported on dunnage (crating material). Samples were taken at three ports of entry. Both visually compromised (overt mycelial growth, evidence of mycostaining, bacterial growth/slime or algal growth) and non-compromised wood ("clean") samples were collected. Sterile techniques were employed in the sampling avoiding, inasmuch as possible, cross contamination.Visually compromised samples showed a decreased diversity of fungi as compared to "clean" samples. No major influence was seen by the port and season of sampling. The most frequently isolated fungi are ubiquitous in New Zealand. All the classes or genera isolated in this study are included in the New Zealand fungal database.

Biodiversity Restoration on Private Land. Manawatu -Wanganui region (horizons.mw).

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Regional Councils have an important role in biodiversity management on private land. horizons.mw addresses biodiversity issues in several areas:

- Research / Monitoring
- Policy
- Environmental education
- Implementation.

Horizons.mw identified biodiversity research objectives with particular emphasis on assessing the pressures and functional state of native habitats on private land. A comprehensive database of the region's native biodiversity (RBDB) is being developed. Habitat surveys will complement missing data to assess a habitat's functional state and restore native habitat viability. RBDB community data will be analysed spatially (GIS) with reference to the "Regional Ecosystem Classification" (REC) and the LCDB to prioritise habitat restoration projects. An integrated response to halt native habitat decline on private land will include:

1. Information transfer
2. Promoting Environmental Grants and offering a "First Aid Habitat Restoration" kit that:

- Identifies and remedies limitations to the viability of native animal and plant populations
- Safeguards food-supply continuity, population sizes, - recruitment.
- Controls animal and plant pests
- Integrates native ecosystem processes with farm management objectives
- Protects interior habitat
- Provides regeneration space (multiple purpose corridors)
- Identifies site-adapted species, seed sources (REC, LCDB) and forest establishment strategies.

Dairyfarming: Information flows and Biodiversity Loss

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The paper will deal with the results of research on information flows which influence land management decisions by dairy farmers in the Waikato. A key proposition is that the symbolic aspects of culture (values, belief, assumptions, knowledge, systems of meaning) are central determinants of the way that resource managers relate to their environment.

It is argued that commercial (dairy) farmers ignore or oppose conservation of indigenous biological diversity because they are mainly driven by a production ethic and by information flows from dairy industry, dairy research institutions and the dairy news media which emphasize production and profit at the expense of alternative land management values such as stewardship and landcare.

Sex biased dispersal and a density independent mating system in the Australian brushtail possum, as revealed by minisatellite DNA profiling

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In this paper we describe a field experiment in which we reduce the density of two populations of the Australian brushtail possum, and use genetic similarity, as estimated by minisatellite DNA profiles, to investigate dispersal in the original (undisturbed) and recovering populations. Our results show that the genetic similarity within the undisturbed populations was lower between males than between females. Conversely, the genetic similarities between males and females in the two recovering populations were not significantly different, while relatedness among males was significantly higher in the recovering populations when compared with those in the pre-removal populations. These data indicate that (1) that dispersal in established populations is sex biased towards males, and (2) that within the first three years following population control, "the vacuum effect", whereby individuals from areas adjacent to a control area, expand their home range and invade the depopulated area, is the most important factor in the re-colonisation process for possums. The mating system, which is polygynous, did not varied when the density was markedly reduced. These results indicate that the rate of spread of biological control agents that rely on sexual transmission by dispersal for dissemination, will not be affected by drastic population reductions.

Restored communities or poor imitations? Microbes and plant succession

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The tea-tree species manuka and kanuka are important colonisers of disturbed habitats, and many site restoration projects in New Zealand use nursery-raised seedlings as pioneer species. Typically, seeds are locally sourced, with the seedlings then being raised in nurseries in commercial potting mixes, under high nutrient and watering regimes. In a pilot scale study, two functional groups of fungi (ectomycorrhizal mushrooms and leaf endophytes) were sampled from stands of manuka at both natural and restored sites. Stands of tea-tree established in restoration projects appear to lack much of their natural microbial diversity, the microbial communities being dominated by widespread, weedy generalists. This lack of microbial diversity may have a flow-on effect to other members of the community, such as the invertebrates that feed on the fungi, and the birds that feed on the invertebrates. As yet, we do not know if the diversity in planted stands will increase and become more 'natural' as the stands age. Perhaps the early establishment of highly modified microbial communities will buffer the stands to resist establishment by the diverse group of species normally found within them. Are we establishing tea-tree plantations rather than tea-tree communities?

Willow Control in the Whangamarino Wetland – A Tool for Native Sedge Restoration

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One of the most significant changes within the Whangamarino Wetland since 1942 has been the invasion of mineralised swampland by exotic willow species. The encroachment of willow has resulted in the dramatic loss of native carex sedgeland from 2778 ha in 1942 to 26 ha in 1993 (Reeves, 1994[1]). In an attempt to restore the largest remaining remnant of sedgeland within the Whangamarino, the Department of Conservation has undertaken willow control over two successive summers, and has contracted NIWA to undertake monitoring of representative vegetation to evaluate the success of willow control. Eight permanent vegetation quadrats were established and species presence, percentage cover and average height were recorded pre and post herbicide application. A marked decline in vegetation cover was noted across the sedgeland quadrats during September 1999 but had increased to 100% cover by December. Regrowth was dominated by introduced species. The desirable sedges *Carex gaudichaudiana* and *Eleocharis acuta* were both heavily reduced in cover although some regrowth was noted in most tussocks of both species. Vegetation in the willow quadrats showed a similar pattern of decline and increase in plots dominated by grey willow as that observed in the sedge plots but remained similar pre and post treatment in plots dominated by crack willow.

[1]Reeves, P. (1994). 50 years of vegetation change in the Whangamarino Wetland. Unpubl. M.Sc. thesis, University of Auckland.

Weather versus predator satiation: the role of resources and cues in mast seeding by *Chionochloa pallens* (Poaceae) in New Zealand

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The New Zealand flora is remarkable for showing wild variation from year to year in seed crops (mast seeding), which affects both plant reproduction and animals which eat the seeds or fruits. *Chionochloa* (snow tussocks) have by far the most extreme mast seeding in the world. Various evolutionary benefits of mast seeding have been shown, such as satiation of seed predators. However, it has always been difficult to rule out the null hypothesis that in some years, more favourable weather allows plants to accumulate more resources, and thereby to flower more heavily. Here we report a study on *Chionochloa pallens* at Mt Hutt. Using data on the flowering of 82 individually tagged plants since 1990, we model resource accumulation (based on growing season temperature degree-days) and construct a "bank balance" for each plant which estimates its stored resources. We then tested the relative importance of stored resources, the favourableness of the current growing season, and climate cues, in determining the level of flowering of each plant. The results suggest that stored resources only play a minor "veto" role in flowering, and that the flowering pattern is consistent with strong evolutionary exaggeration of a temperature cue in order to maximise benefits of predator satiation.

An online bibliography on stoats and weasels: introduction and analysis

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I have compiled a comprehensive bibliography listing the global literature on small mustelids, mainly stoats *Mustela erminea* but including the closely related least weasels*, M. nivalis/rixosa* and longtailed weasels, *M. frenata*. At the meeting, I hope to launch a web-site which will host a publicly available, searchable database listing more than 850 references on these species published since 1792. This paper will provide a guided tour of the web site and an analysis of the main trends in New Zealand and international research on small mustelids.

The paradox of variable reproductive effort in female stoats during rodent cycles

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Interactions between stoats and mice in New Zealand beech forests are similar in principle to those between stoats and rodents in the high arctic, but are more easily sampled year- round. Stoats are restricted by delayed implantation to producing only a single litter a year. The maximum number of young that can be born in any given birth season is already fixed at ovulation in the previous year. Adult females do produce larger litters in peak rodent years, not by increasing their fecundity, but because the normally very high mortality of their pre-independent young is reduced when food is abundant. The young born in a peak year appear in very large numbers in late summer, but cannot breed in their turn until the following spring, by which time the peak population of rodents is already declining or has crashed. Many female stoats lose their entire litter in rodent crash years, so the individual reproductive success of the large numbers of stoats born in a peak rodent year is likely to be much lower than that of the much smaller numbers of stoats born in the more frequent average or poor years. Stoats of both sexes born in peak years also grow larger when young, and remain larger than average in condylobasal length for life, but their mortality rate is higher, especially in males. The paradox is that all of these effects are the opposite of those predicted by the so-called "silver-spoon" syndrome, which expects a lifetime advantage for individuals born in a year of abundant food supplies. We would like to know if the stoats' mechanism of adjustment of reproductive effort through the rodent cycle, and its consequences at the individual and population levels, are the same in boreal habitats.

Hunting the Snark – in search of the elusive ecosystem.

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The strong intuitive appeal of the ecosystem concept has resulted in its wide embrace by conservation and environmental managers seeking a framework for more integrative approaches to their work. However, considerable challenges need to be overcome if the ecosystem concept is to lead to better land and biodiversity management. One set of tools that is fundamental to ecosystem-based management are maps showing the spatial distribution of ecosystems, but producing such maps is made difficult by the infinite variety of ways in which ecosystems can be recognised. Here we present one attempt to define a classification of New Zealand suitable for use as a generic ecosystem framework. Rather than using biotic pattern as a basis for defining units, we use a set of environmental factors chosen for their demonstrable functional roles in driving both biotic patterns and processes. Classification of these drivers using standard multivariate tools produces a hierarchical classification that is consistent with the hierarchical behavior of ecosystems. Although classifications based on this approach are generally correlated with both biotic patterns and human landuse, this is not always the case. Biotic and environmental data may therefore need to be combined where ecosystem patterns also reflect the effects of historic disturbances, e.g., as in New Zealand's *Nothofagus* disjunctions.

Studying and managing complex food webs: advances in research and plans for application

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Food-web research has advanced considerably during the past several decades. Data and theory have progressed from focusing on abstract simple food webs with few species to focusing on highly complex webs that explicitly include much more of the biodiversity found within ecological systems. This focus has shown food webs to have higher connectivity, display greater sensitivity to species diversity, and to possess remarkably important weakly interacting species. More recently, models that successfully explain and predict this complexity have pointed towards simple mechanisms responsible for food-web structure and function. While detailed dynamics of complex food webs still need development, increased understanding of food-web structure is beginning to be applied to the management of ecosystems. Such application points towards specific effects of species loss and invasions that may be predicted through trophic monitoring programs. Delineating more general effects of biodiversity loss related to ecosystem health and integrity also appear within reach of ecosystem managers employing food-web approaches. The utility of food web based research and management depends on continued development of theory, its application in the field, and critical evaluation of related management decisions.

The effects of small-scale environmental heterogeneity on seed germination in experimental treefall gaps

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Seed germination was studied in treefall gaps in New Zealand to assess how microsite heterogeneity affects regeneration from seed. Gaps were created in a relictual *Pinus radiata* plantation destined for restoration to native forest. Seeds of the native species *Alectryon excelsus*, *Macropiper excelsum*, and *Fuchsia excorticata*, and the invasive alien species *Cytisus scoparius* and *Berberis darwinii* were sown in microsites differing in exposure, with and without 3 cm of pine litter. Litter promoted germination of *A. excelsus* and *M. excelsum*, independent of within-gap position. Without litter, percent germination of both *A. excelsus* and *M. excelsum* was negatively correlated with percent open sky overhead. Germination of *F. excorticata* was significantly higher in treefall gaps than in the forest understory, with litter having little effect. *Cytisus scoparius* germinated most successfully in sites exposed to direct solar radiation, with or without litter. Percent germination of *Berberis darwinii* was high in all sites, consistently promoted by litter, and positively correlated with percent open sky when covered with litter. Greenhouse trials produced similar results for all species. These data suggest that minor manipulations of environmental conditions can maximize potential germination of native species and minimize that of some invasive alien species in and around treefall gaps.

Conserving native predators: The status of weasels and stoats in Great Britain

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In contrast to New Zealand, where mustelids are serious pests, there is currently concern about the conservation status of stoats and weasels in Britain. However, several parallels to stoat and weasel management in New Zealand are apparent. Secondary poisoning by rodenticides is a problem for mustelids living on farmland. Traditional trapping to protect game birds appears not to influence long term population trends. The diet of both species is responding to changes in prey populations, notably the recovery of rabbits from myxomatosis. One of the main difficulties facing conservationists in Britain is monitoring populations of these hard-to-see predators. As a result, flaws in the interpretation of trapping records may have lead to the false conclusion that both species are declining. In the light of recent research, I discuss whether active conservation measures for these native predators are necessary.

Acacia longifolia invasion of Kaimaumau Gumland, Northland, New Zealand

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Acacia longifolia is a very widespread weed in the Kaimaumau Gumland, New Zealand. The Kaimaumau gumland is an area of high conservation value. The soils represent extremes in soil chemical and physical properties that have arisen from successive generations of kauri forest. Associated with this soil type are a range of specialised native plants producing a community of particular structure and physiognomy. *A. longifolia* is adapted to grow on nutrient poor soils as it can fix nitrogen, in contrast to the native species present here. It also has superior fire adaptations compared to the native flora. These features have given rise to fears that *A. longifolia* is capable of changing the characteristics of the gumland. This study was undertaken to measure the effect that *A. longifolia* is having on the gumland as part of a wider concern on the ecology of invasive weeds.

It was found that *A. longifolia* has a significant nitrogen input into the ecosystem. Age structures of *A. longifolia* populations determined that most germinated soon after a large fire and subsequent spread has been relatively slow. Seed bank studies found that other exotic weeds could replace *A. longifolia* on its removal, and rehabilitation will need to include planting of native species.

A native sand dune species in decline: what threatens *Pimelea arenaria*?

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Pimelea arenaria A. Cunn. (Thymelaeaceae) is a low growing, gynodioecious native shrub, one of about 17 *Pimelea* species in New Zealand. It is habitat specific, occurring on the coastal fringe, and one of a relatively small suite of native vascular plants found growing on sand dunes. Anecdotal evidence has indicated population decline and at some sites, local extinction. Results of investigations into structure, abundance, and habitat variables of 12 populations of *Pimelea arenaria* from northern North Island are examined. In addition, the results of population dynamics and reproductive biology investigations of 3 populations from the Coromandel Peninsula are analysed. Population decline results from of natural or anthropogenic events. Natural events include habitat loss during storms and associated high tides, or burial by wind blown sand. Human induced factors contributing to population decline of *Pimelea arenaria* is attributed to direct activities that result in habitat loss such as development for roads and housing, and/or in response to being outcompeted by deliberately or accidentally introduced, exotic plant species. Indirect activities may include loss of pollinators, dispersers, or germination requirements as a consequence of habitat disturbance, affecting population dynamics and the natural life cycle. Results show regeneration is poor at highly modified sites. This may be because of a decline in native dispersers, or the conditions required for seed germination are not being met.

Management of riparian forest remnants in a New Zealand agricultural landscape

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Pastoral agriculture is concentrated on recent alluvial soils of the west coast of the South Island, New Zealand. These soils account for 6% of the land area, and were once covered in tall podocarp (Podocarpaceae) forest. Now only 0.8% of the original forest cover remains as small scattered patches. This forest type is under-represented in the protected area network despite 76%, or 1.8 million ha, of the West Coast being protected for nature conservation purposes. Consequently the major land management issue is how to protect and maintain these remnants on private land and, if possible, increase their area without reducing the available area of prime agricultural land.

This paper examines some of the issues that need to be considered if riparian forest remnants within farmland on the West Coast are to be managed for nature conservation.

New Zealand, the foreign country. A changed paradigm to generate new conservation opportunities.

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68% of New Zealand is occupied by foreign ecosystems, with intense conservation efforts concentrated on a few of the remaining 'natural' areas. We allow exotic species free reign over the remainder of the country and worry about their invasive potential into 'natural areas'. Overseas, some New Zealand species have demonstrated a remarkable ability to be troublesome, ie they have behaved as typical 'invasive species'. Yet within our own national borders we have created a large foreign environment, where we rarely if ever allow native species to test their genetic potential. Where species have been put into such environments, as in restoration projects, or have naturally spread, they often show previously unknown potential.

We propose that there is strong evidence that the usual approach of concentrating active conservation in a very few natural areas is a mistake. Instead conservation efforts should be turned outwards to enable our native species to realise their genetic potentials in this foreign country of ours. Not only would this engage the *whole* country, but it would also be the first steps on the road to facilitating the permanent re-occupation of the landscape by native species.

Increase in kaka (*Nestor meridionalis*) breeding success following control of mammalian predators.

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A significant improvement in kaka nesting success was observed following control of ship rats (*Rattus rattus*), possums (*Trichosurus vulpecula*) and stoats (*Mustela erminea*) in the Rotoiti Nature Recovery Project (RNRP) area. Whereas only 10% (2 of 20) of nesting attempts monitored before the beginning of predator control succeeded, 80% (8 of 10) of nesting attempts monitored after its implementation were successful. Nesting success monitored over the same period in the absence of predator control remained at 10% (1 of 10). These results are demographically, as well as statistically, significant; more than enough young are now being produced within the RNRP area to compensate for adult mortality. The hypothesis that predator control improves kaka breeding success is supported by research at other study-sites which also indicate that kaka have better nesting success where mammalian predators are being controlled than where they are not.

Urban Biodiversity - Protecting and restoring a unique part of New Zealand

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In urban and peri-urban areas of New Zealand (as well as in rural areas) there has been a groundswell of interest in protecting and restoring biodiversity. The urban areas of New Zealand contain some of our scarcest habitats and ecosystems, including lowland and coastal forest and scrub ecosystems, freshwater streams and wetlands, harbours, estuaries, coastal duneland systems, and volcanic systems. The focus of formal protection of biodiversity, however, is often focussed on the larger, more remote parts of New Zealand, away from human settlement. Protection and restoration of biodiversity in urban areas is important for education and amenity reasons, for enhancing peoples well being and understanding of the natural environment, as well as for looking after examples of New Zealand's unique lowland and coastal ecosystems for future generations.

In the Auckland Region there are a number of natural areas which are highly significant for their biodiversity values and which contain unique associations of native flora and fauna. Many are threatened by surrounding landuse activities and the impacts of development (clearance, stormwater runoff, weeds and pests). Auckland forest and scrubland ecosystems provide a habitat for a number of nationally threatened species including a native frog, geckos and skinks, both species of native bats and the endangered kokako. Approximately half the region's threatened plants occur in scrubland and regenerating forest ecosystems.

Changes in land use and urban growth and development are the principal factor affecting indigenous biodiversity today. Vegetation clearance causes loss of habitats, loss of species, and invasion by weeds and pests. It can often be small scale but the cumulative effects on surrounding ecosystems, through fragmenting corridors and downstream impacts on estuaries and streams, and have significant long-term consequences. Many forest and remnant areas are small and fragmented and isolated from one another. For example in the Manukau Ecological District of the remaining 296 fragments of forest, scrub and wetland, 85% of the sites are less than 5ha in size. While the biological diversity and ecological viability of such

small remnants is often severely reduced, they are all that remains of the biodiversity in local areas, and are valuable as habitat for local species. There is a need to restore ecological corridors and linkages between these remnants particularly along riparian zones.

Improvements in our understanding of lowland ecosystems needs to include:
- Long-term viability of small remnants
- Impacts of fragmentation, edge effects
- Role of corridors and ecological linkages – for birds, invertebrates, seed dispersal, exchange of genetic material
- Importance of native scrub and shrubland communities, and of areas containing mixed native and exotic species
- Effects of subdivision on natural areas – impacts of houses and accessways built in bush
- Impacts of weeds and pests – this is a huge issue for New Zealand in both rural and urban areas

In order to protect these ecosystems there is a need for local and central government, community groups and landowners to work in partnership to incorporate biodiversity into planning and land management. There is a need for information sharing, education, advice and expertise. Local and central government and communities can work together to: investigate and monitor the long term health and viability of ecosystems, the successfulness of restoration efforts, the effectiveness of pest and weed control, the restoration of riparian and buffer areas and linkage areas. There is a need for greater support and encouragement for current efforts towards protection and restoration of biodiversity in New Zealand. Urban New Zealander's also need to provide greater support and encouragement for biodiversity protection in rural parts of New Zealand.

Exotic plant invasion in Auckland native forest fragments

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Exotic plant invasion is a major threat to the quality of native ecosystems. The impact of exotic invasion is potentially greater in fragmented ecosystems where native quality may already be compromised by, e.g., fragment size, isolation and composition of the surrounding landscape. We investigated exotic invasion in 65 forest fragments along a rural-urban gradient in the Auckland region to determine how physical fragment characteristics, connectivity with other fragments, and characteristics of the surrounding landscape influence exotic plant composition and richness. Native and exotic composition were quantified in separate DCA ordinations of native and exotic species. Exotic richness (number of exotic species) was predicted by native composition, human impact, and distance to the nearest road. Exotic composition strongly related to a fragment-characteristics gradient and human-disturbance gradient, collectively representing different components of fragmentation, degradation and landscape modification. The type of landscape surrounding a fragment also influenced exotic composition and richness, with richness higher in fragments surrounded by peri-urban and urban landscapes. Our results suggest that fragments in highly-modified, highly-disturbed (peri-urban and urban) landscapes, and small, isolated fragments have greatest risk from exotic plant invasion. Future management should reduce human impacts, improve the native integrity of a fragment, and increase connections between fragments.

Forest fragmentation and fruit dispersal of the mistletoe *Peraxilla tetrapetala*

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While the effects of forest fragmentation on individual species and groups of species have been extensively documented, fewer studies have attempted to quantify the effects on ecosystem processes such as seed dispersal mutualisms. We evaluated the effects of fragmentation on fruit dispersal in the New Zealand mistletoe *Peraxilla tetrapetala* by measuring fruit dispersal from mistletoe plants in eight forest remnants and an adjacent area of continuous forest. We found that while there was no correlation between total fruit removal and either remnant size or isolation, there were significant correlations between remnant size and cumulative fruit removal and the rate of fruit removal during the period of fruit dispersal. Our results show high dispersal from large remnants early in the season, and as this resource is consumed, increasing dispersal from smaller remnants later in the fruiting season. These results highlight the importance of considering seasonal patterns of dispersal when considering the effects of fragmentation of dispersal mutualisms.

Hunting impacts on deer impacts on conservation values: an update.

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Some of the most hotly argued questions in the long-running debate over how introduced wild deer should be managed in New Zealand are (i) what adverse effect do deer now have on ecosystem processes, and does it matter? and (ii) does recreational hunting, in particular, provide conservation benefits, and can they be enhanced? This papers reviews recent research on deer distribution, density, and impacts in relation to those questions. Despite large a overall reduction in wild deer numbers, deer do still affect regeneration and other processes in many forested areas. What is not clear is whether, where, and when those effects are sufficiently severe (relative to other drivers of compositional change such as climate change or weed invasion) to require further reductions in deer density. Where such reductions are deemed necessary, however, bioeconomic models indicate commercial or recreational hunting could sometimes, but only sometimes, provide a cost-effective adjunct or alternative to state-funded control.

Keystone Species: a useful concept for the management of indigenous biodiversity in New Zealand's natural ecosystems ?

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The keystone species concept has proved both promising and elusive in theoretical and applied ecology. The term has its origins in Robert Paine's studies of rocky shore communities in California. When the top predator (a starfish) was removed the species assemblage collapsed, prompting the architectural analogy with the keystone of an arch. By definition keystone species are those whose effect is large, and disproportionately large relative to their abundance. They include organisms that (i) control potential dominants, (ii) provide critical resources, (iii) act as mutualists, and (iv) modify the environment. Identifying keystone species can be problematic. Approaches used include experimental manipulations, comparative studies, natural history observations, and 'natural experiments', but no robust methodologies have been developed. Our inability to monitor and manage all aspects of biodiversity has led to the development of paradigms that focus on either single-species (e.g., indicators, umbrellas or flagships) or whole ecosystems (ecological processes and habitats). Not surprisingly both have their advocates and detractors. The keystone species concept, which retains a species focus while avoiding the need to examine every species, and emphasises processes that directly (e.g., predation, competition) rather than indirectly (e.g., nutrient cycling) control biodiversity, may allow conservation managers to combine the best features of both these paradigms.

Why does diversity not beget stability or productivity in some grassland ecosystems?

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Community stability is often thought to increase with species diversity, but despite several recent theoretical and empirical studies of diversity-stability phenomena, no consensus has emerged on the generality of this relationship. Here, we present results on resource availability, community composition and stability from a low-diversity grassland subjected to six years of N additions and soil disturbance. The species composition of this species-poor grassland was relatively stable across both N addition and soil disturbance treatments with the introduced grasses *Agropyron cristatum* and *Bromus inermis* dominating the community in all treatment combinations. In a second project, we determined that experimentally increasing the species richness of native prairie grasses did not significantly increase aboveground plant biomass or decrease soil available nitrate. In contrast to results from many previous studies, our results suggest that low-diversity communities can be relatively stable and productive. One explanation for these observations is that the traits of dominant species drive the response of these systems to environmental perturbations, supporting the view that species composition or functional diversity may affect ecosystem processes to a greater extent than species richness *per se*.

A different kettle of trees - how valid is the comparison of offshore island data to mainland sites when evaluating forest health?

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Outcome monitoring of Department of Conservation possum control operations in Waikato Conservancy is undertaken using the Foliar Browse Index (FBI) and Rata View methods. Forests where possums are absent, and forests where possum control does not occur, are also monitored to improve interpretation of pest control outcomes. There are now 2-3 years of data from Hauturu / Little Barrier Island and Whakau / Red Mercury Island, the possum-free sites used by Waikato Conservancy. We examine the patterns to date and ask what are the limits to the use of FBI and Rata View data from islands in evaluating pest control outcomes in mainland Waikato forests.

Pollination by short-tailed bats

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Little is known about the diet of short-tailed bats (*Mystancina tuberculata*) in New Zealand forests and even less is known about their importance as pollinators. Previous evidence for pollination by short-tailed bats includes findings of large amounts of *Metrosiderous* spp., *Knightia excelsa* and *Collespermum* spp. pollen in bat dung and fur by Daniel (1976) and Arkins (1999) and photographic evidence of a bat visiting a *Dactylanthus taylorii* flower (1993). Pollen recently found in short-tailed bat guano from the Central North Island is described. Large quantities of *Collespermum microspermum* and an unknown pollen was found.

Impact of rabbit haemorrhagic disease (RHD) and predation on rabbit population dynamics

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The impact of predation and rabbit haemorrhagic disease (RHD) on rabbit (*Oryctolagus cuniculus*) population dynamics, including the survival of juvenile rabbits, was investigated between July 1999 and March 2000 in North Canterbury, New Zealand. Rabbit abundance and pre- and post-emergent rabbit mortality were monitored on four sites, two of which were subject to predator control. RHD spread naturally through all sites from late November to early December. Rabbit densities declined on all sites, but these declines were significantly greater where predators had not been controlled. Rabbit nestling survival was lower where predators had not been controlled. All post-emergent radio-collared rabbits died at sites where predators had not been controlled, whereas 18 % of those collared at sites where predators were controlled survived to maturity. Unlike previous studies, rabbits born at the start of the breeding season had very high rates of post-emergent mortality, as they appeared to be susceptible to the RHD virus later in the breeding season. The age at which juvenile rabbits become susceptible to RHD, the timing of RHD epidemics, and the abundance of predators are all likely to be important in determining survival of juvenile rabbits.

Creating new mainland islands – what are the essential ingredients for success?

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The high public profile and conservation achievements of Department of Conservation mainland islands have led to a burgeoning interest in the development of similar initiatives by other agencies (such as the Auckland Regional Council), conservation groups and private individuals. Mainland islands – or more specifically the development and maintenance of areas intensively managed for conservation purposes – require considerable resources and planning to be successful. Vital components include recognition of the long-term commitment required to undertake the project; the identification of clear goals and objectives; and the development of a detailed project plan.

Also important at an early stage is to identify all the stakeholders in the project. These include those who will be directly involved with management, affected neighbours, community interest groups, and people able to provide ongoing practical and technical advice. Some lessons learned from the development of ecological restoration plans for Limestone Island and Tawharanui Regional Park will be discussed and emphasis put on the importance and value of developing project plans.

Can pakihi fernland be restored after mining?

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Pakihi fernland in North Westland includes open land dominated by tangle fern (*Gleichenia dicarpa*), wire-rush (*Empodisma minus*), sedges (*Baumea sp*), *Sphagnum* moss and scattered manuka (*Leptospermum scoparium*) on poorly drained, very infertile soils. A trial established in March 1994 tested three methods of restoring pakihi fernland after open cast mining. The trial compared direct transfer of one m^2 sods of vegetation with 300 mm of topsoil over 80–90% of the surface, direct transfer of sods over 20–40% of the surface, and no artificial restoration. Recovery of pakihi vegetation in this infertile, waterlogged environment took 4 to 6 years. The fastest, most restorative treatment was covering 80–90% of the surface with directly transferred sods, as the small area of exposed soils limited establishment of adventive plants and both tangle fern and wire-rush spread from transferred sods. Covering 20–40% of the surface with sods gave similar total cover after 6 years, but less tangle fern and more *Gahnia rigida* and manuka. Greater cover of manuka in this, and the no restoration treatment, indicate these treatments are developing more rapidly than the original fernland to forest. Exotic rushes quickly colonised bare ground but declined in both direct transfer treatments after 4 years.

Trap-catch probabilities of brushtail possums (*Trichosurus vulpecula*) prior and preceding a major control operation.

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The brushtail possum has been identified as a significant NZ conservation pest and a major wildlife reservoir of bovine tuberculosis (Tb; *Mycobacterium bovis*). To combat their continuing impact, control agencies currently spend >$50m per annum on possum management activities. The current goal of this control effort to achieve a sustained population reduction in key-priority zones. Generally it is accepted that a sustained 80% population reduction should eliminate Tb and protect most indigenous species. Accordingly, population monitoring is fundamental to determine target population densities have been achieved following control. New Zealand researchers have investigated several techniques for estimating possum abundance. For a number of reasons, the methodology currently favoured for monitoring possum abundance relies on leg-hold trapping. However, this technique is dependent on the capture probabilities (for both sexes) remaining relatively constant over time. Recent research has demonstrated that mammals can become 'trap shy' over successive trapping nights and the probability of capture can be influenced by intra-specific competition for traps. Our analysis of 64 monitoring exercises (using leg-hold traps) indicates that the probability of capture substantially increases following a major control operation. We believe that the lower probability of capture pre-control is caused by greater intra-specific competition for traps. As a consequence, leg-hold trapping underestimates possum abundance when the population density is highest and, therefore, underestimates the efficacy of control operations. Our analysis did not detect any evidence of gender bias with a similar ratio of males and females trapped pre-and post control. Finally, we did not find any evidence of trap-shyness post-control, however, this issue requires further field investigation.

Community involvement in an urban kereru assessment

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Recently, increased emphasis has been placed on bridging the communication gaps between scientists and the public, to prevent repeating past alienation of stake-holder groups. On Auckland's North Shore such an attempt was made to involve the community in the collection of data for a large-scale assessment (2000+ observations) of urban kereru (*Hemiphaga novaeseelandiae*). The study used 44 local observers for collecting data to determine kereru densities, local phenology and variation in behaviour over the period December 1997 to January 2000. Specific analytical problems encountered included pseudo-replication of observations, zero-errors (confounding between non-response and no observations), the changing layout of the data sheet over the 2-year period, with problems abbreviating species names and problems differentiating changes in total counts between increased kereru activity or increased observer effort. By refining the data collection methods it is possible to overcome these problems and from this guidelines for future studies, including a more optimal data collection sheet, are made. In this context the Urban Kereru Study acts as a "pilot study" for future community involved research projects.

Preparing a strategy to guide the Department of Conservation's ecological management programmes.

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A strategic intent has been declared to manage ecosystems as well as species and genes in order to conserve what's left of New Zealand's native biodiversity. Some progress has been reported towards ecosystem goals at offshore islands and, more recently, at mainland sites. Preliminary outcomes reported at "Mainland Islands" are particularly important in that they indicate that preventing further biodiversity loss and restoring damaged ecosystems may be possible on the New Zealand mainland. A more proactive approach to addressing the major challenges in managing ecosystems has been proposed involving integrated and coordinated science-based management activities. In recognising the potential benefits of Mainland Islands, and their significant associated costs and risks, the Department of Conservation is moving to identify the part such projects should play in its activities overall. An ecological management strategy is being drafted which will provide a basis for departmental resource allocation decisions. Some principles underpinning this strategy are discussed and important questions raised.

Restoration approaches for mined restiad peat bogs.

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In the Waikato more than 75 % of the original restiad peat bogs have been converted to agricultural use. Other restiad bogs have been mined for peat and interest in their restoration is increasing. We established a restoration trial on a mined bog with a full factorial of 4 fertiliser additions (nitrogen, phosphorus, nitrogen plus phosphorus, and control), 3 seed additions (*Leptospermum scoparium*, restiad– *Sporadanthus ferrugineus*, and control) and 3 cultivation techniques (lightly–tilled, deeply–tilled and raised). All combinations were duplicated in 5 m by 5 m plots. Our first restoration goal was to establish a vegetation cover rapidly, and all plots in the raised cultivation treatments exceeded 88 % cover by two years whereas the other cultivation treatments ranged between 1 and 75 % cover. The best combination within the raised plots was nitrogen and phosphorus addition with Leptospermum seed (100% cover of *Leptospermum*, 222 cm high). A second goal was to establish Restionaceae and the best treatment was raised peat with 70 % cover of *Sporadanthus*. We found that nutrient status of the peat had returned to background levels within 2 years of fertiliser application.

Between the devil and the deep blue sea: nest site selection in the Chatham Island oystercatcher (*Haematopus chathamensis*)

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Tidal flooding is a major cause of nest losses among the endangered Chatham Island oystercatcher (CIO), a coastal nesting shorebird. This raises the question as to why CIO select the sites they do and why they do not choose sites less vulnerable to flooding.
Major changes have occurred along the coastline of the Chathams since the arrival of humans, especially on the two main breeding islands of Chatham and Pitt where 85 - 90% of CIO breed. Establishment of the European sand binding species Marram grass (*Ammophila arenaria*) has changed dune structure, and numerous predators have been introduced, the most significant being cats (*Felis catus*) as they are known predators of eggs, chicks and adult oystercatchers.

These changes to the Chatham Islands have probably reduced nesting habitat for CIO and increased the risk of predation, especially for incubating adults, so that CIO are now caught in a dilemma: nest too close to the ocean and risk clutch losses, or nest too close to vegetation and risk predation on the incubating adult (especially from cats). Are oystercatchers trapped between the devil and the deep blue sea?

To breed successfully CIO must find suitable nest sites, and any conservation management attempts to increase the population must consider the factors which affect nesting success and survival of incubating adults.

Predator-mediated apparent competition between an introduced grass (*Agrostis capillaris*) and a native fern *Botrychium australe* (Ophioglossaceae) at Cass, inland Canterbury

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This study shows how invasive plant species may indirectly affect native species through apparent competition by altering the local invertebrate community. The native New Zealand fern *Botrychium australe* (Ophioglossaceae) is thought to benefit from disturbances such as fire, because this species is generally found in disturbed habitats with low shade and high competition. However, a mapped population of *B. australe* at Cass experienced a marked decrease in survival and reproduction after an accidental fire in May 1995. Mortality was not due to the direct effects of fire; in the year following the fire, survival was normal and reproduction was higher than in previous years. However, an introduced grass (*Agrostis capillaris*) became common in the area from 1997. *B. australe* survival in years 2-4 after the fire (1996-1999, 59.63%) was significantly lower than survival before the fire (94.9%), and plants did not produce spores at all during this 3-year period. From 1997 onwards, *B. australe* plants suffered heavy defoliation by a herbivore, and exclusion experiments in 1999 and 2000 showed that the introduced slug *Deroceras reticulatum* was responsible for the damage. The slug probably increased after the fire because the spread of *Agrostis* created a suitable habitat.

Fluxes of Water Vapour and CO_2 at a Waikato Peat Bog.

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Moanatuatua peat bog is a remnant of a Waikato peatland that once occupied 75km^2 but now has an area of 1.1km^2. Valued for its diverse flora, the raised peat bog is now a protected scientific reserve requiring improved knowledge of processes governing peat production for management purposes. Previous research during summer months on Waikato raised peat bogs showed hydrological and vegetation feedbacks exist which create conditions favourable for peat production. Plant physiology and canopy structure are believed to be effective in limiting evaporation from the moist peat surface of Moanatuatua.

Aims of this study include the identification of controls and feedbacks of peat production at Moanatuatua peat bog. Fluxes of CO_2 measured with an eddy covariance system are used to estimate rates of peat production through carbon balance estimates.

Accelerating rehabilitation of native ecosystems: successes and failures of the direct transfer technique

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Direct transfer is the salvage and replacement of intact 'sods' of vegetation with underlying soil. Variations of the technique have been used in Britain to conserve high-value heath and chalk grassland, and in Canada to enhance diversity of tailings ponds and introduce native plant under-storey species to rehabilitated areas. In New Zealand, direct transfer, using one to six m^2 sods with up to 0.7 m depth of soil, has been used to rehabilitate indigenous plant and invertebrate communities after open-cast mining. To illustrate the key principles, this paper gives examples of successes and failures of the method.

In New Zealand successes have occurred with a range of communities, from pakihi fernland and sub-alpine tussock to 5 m tall scrub and beech forest under-storey, and in a range of climates from temperate to sub-alpine. Success includes translocation of large, flightless beetles and wetas. Failures are attributed to inadequate soil depth, placement of sods on hostile sites, and overly-rough handling of sods. Change in plant species composition has occurred where sods are too far apart, shifted plants were too small, or the ecosystem is sensitive to an altered water table.

Invasion by *Tradescantia fluminensis* increases decomposition rate and alters nutrient cycling in a New Zealand lowland forest remnant

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The biggest ecological threat posed by plant invaders is alteration of ecosystem-level properties. We determined the impact of the ground smothering weed, *Tradescantia fluminensis*, on litter decomposition and nutrient cycling in a New Zealand lowland podocarp-broadleaf forest remnant. Using litter bags, we found that litter beneath mats of *Tradescantia* decomposed at almost twice the rate of litter placed outside the mat. The impact of *Tradescantia* on decomposition was evident through the reduced quantities of standing leaf litter in *Tradescantia*-affected areas relative to non-affected areas, despite similar quantities of leaf litterfall to both habitats. Moreover, *Tradescantia* alters nutrient cycling, as indicated by increased soil available nitrogen and phosphorous in affected relative to non-affected areas of forest. This is the first published example of an invasive herb altering ecosystem-level properties.

Ecological processes controlling the range distribution of *Ulex minor* and *Ulex gallii*

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A study system where the geographic distribution strongly indicates the presence of a controlling factor is provided by two species of gorse, *Ulex gallii* Planch. and *Ulex minor* Roth., present within heathland communities of the United Kingdom and France. These perennial shrub species exhibit almost disjunct geographical distributions. Within the United Kingdom *U.gallii* occupies a westerly range, whereas within eastern areas of Britain this species is replaced by *U.minor*. The ranges overlap within Dorset (southern England) where the species co-exist. The principle aim of this work is to determine the ecological factors controlling the distribution pattern, in particular interactions occurring at the range boundaries of the two species.

Population dynamics have been monitored to establish differences in demographic parameters between populations of each *Ulex* species at the center and margins of their range, thus distinguishing those demographic parameters most influential in determining differences in population abundance between regions. Field-based competition experiments have investigated the ecological processes creating these demographic differences. The methodology applied within this project should emphasize those areas of the life cycle of each species most vulnerable towards population decline or extinction.

How a sapling specialist shoot-boring insect alters the population dynamics of a Costa Rican tree

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How a species of insect herbivore alters the population dynamics of its host plant usually has little to do with how much tissue is eaten. Of far more importance are what tissue is eaten and which individual plants in a population experience the most damage. This is well illustrated by the large detrimental effects that a tree sapling shoot-borer, *Cromarcha stroudagnesia* (Lepidoptera, Pyralidae), has on the population dynamics of its host tree, *Tabebuia ochracea* (Bignoniaceae), in the tropical dry forests of the Area de Conservación Guanacaste, Costa Rica. Just one 10 mm long larva tunnelling in the single top shoot of a canopy gap *T. ochracea* sapling reduces the annual rate of annual height increment by on average 77.9% and causes branching. Repeated herbivory of the top shoot (on average once every 2.5 years) increases the probability that a canopy gap sapling is overshaded by neighbouring vegetation, and the probability of prereproductive death from falling debris. *Cromarcha stroudagnesia* and other shoot-borers typically attack the tops of the most vigorously growing tree saplings, and are therefore likely to have disproportionately large impacts on the population dynamics of their host trees.

Establishment of *Arytainilla spartiophila* (Hemiptera: Psyllidae) for biological control of broom in New Zealand

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Psyllids (*Arytainilla spartiophila*) were first released for biological control of broom (*Cytisus scoparius*) in New Zealand in 1993, and are now established at 31 sites, from Lawrence (Otago) in the south, to Upper Atiamuri (Rotorua) in the north. The recorded rate of spread has been slow, but from releases made in 1994 psyllids have now been found at least 150 m from the original release point at several sites. Twenty-two percent of all releases of psyllids have established, 33% have failed, and for the remainder it is either too soon to tell, or sites have not yet been checked. The rate of establishment was greatest for larger releases (270+ individuals), but at least two populations have established from releases as small as just a single male and female. Smaller releases took longer to reach high populations than larger releases, but they achieved the same rate of increase as larger releases. Although broom plants have been severely damaged by psyllid feeding when the insects are reared under controlled conditions, so far no appreciable damage has been noted on broom plants growing in the wild.

Identifying sources of nitrogen in primary succession on Mt Tarawera, NZ.

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Plant colonisation on Mt Tarawera has been continuous since its eruption in 1886. Primary succession is still proceeding on the summit but is nitrogen limited because the soil parent material is of volcanic origin. Sources of nitrogen for the early colonisers in these communities have been identified as nitrogen fixation, mainly by *Coriaria arborea*, and atmospheric deposition.

We have identified a vast difference between the ^{15}N signatures of *Coriaria* and non-N_2-fixing plants. Nitrogen in *Coriaria* has a ^{15}N near zero while non-N_2-fixing plants isolated from *Coriaria* have ^{15}N values of –15 to –20. The same species of non-N_2-fixing plants collected along transects away from *Coriaria* have been found to have intermediate ^{15}N values, falling between these two extremes, relative to their distance from *Coriaria*. The ^{15}N signature of non-N_2-fixing vegetation on Mt Tarawera reflects the proportional input of nitrogen from fixation by *Coriaria* and atmospheric deposition. Once calibrated stable isotope methodology will act as a tool to measure the contribution of nitrogen from these two sources to the total nitrogen pool.

Berries and birdpoo – the ins and outs

☺ Amy Trass & Alastair Robertson
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The consumption of fleshy fruits by vertebrate dispersers is a well-known mutualism in which the disperser obtains a meal and the plant gets an opportunity to disperse its seeds. A key question is whether seeds germinate better after passage through the digestive system of a disperser. All species examined had very low germination percentages of seeds within fruit, and much greater germination of seeds that were cleaned either by passage through birds or by hand. The rate of germination was less affected by different treatments than the absolute percentage germinating, but was generally faster in bird-voided compared to hand-cleaned seeds. Seeds in both of these latter treatments germinated considerably faster than seeds within fruit.

Practical application of an ecosystem-based framework to address land degradation in the Canterbury high country: an evolving concept

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Under the Resource Management Act (1991) regional councils have a responsibility to promote sustainable land management through the conservation of soils and ecosystems.
It is not sufficient to develop land management policies by focusing on soils alone: by the time changes in soil quality and/or erosion become apparent, vegetation is often already in an advanced stage of degradation which may be difficult to reverse. A wider ecosystem approach is required to understand the relationship between soils and vegetation, and to use changes in vegetation as an early warning indicator of soil degradation.

Land degradation is identified as a significant issue for the Canterbury high country, with many areas showing advanced stages of loss or degradation of vegetation cover and accompanying erosion. However, there is no existing ecosystem framework available for the high country that has direct application to planning for sustainable land management.
This paper follows the development of a practical ecosystem framework for the Canterbury high country, from identification of sub-regional ecosystem groups to the delineation of ecosystem processes at a local scale. The process culminates in a set of objectives and policies which identify specific targets for achieving and maintaining sustainable land use.

Are native leafroller moths affected by possum control?

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We sampled leafroller moths (fam: Tortricidae) in patches of native forest at four locations in the North Island and one site in the South Island for two years to investigate how moth capture rates varied with possum control. We used pheromone lures for *Planotortrix octo, P. excessana, Ctenopseustis obliquana* and *C. herana* because the polyphagous larvae of these species have been recorded on host plants consumed by possums. Two traps for each species were set up in a cluster of 8 traps. Three clusters were installed in forest receiving sustained possum control, and three clusters were also set out in nearby forest patches not under possum control. At one location, Hurunui Mainland Island, we had a further 3 clusters in an area in which possum control had only recently commenced. We captured 2332 moths in the 1998/9 season and 2751 in 1999/2000. *C. herana* was rare or absent in the North Island forests we sampled. Seasonal patterns of emergence appeared similar between years for each species except at Hurunui, where moths emerged earlier in 1999/2000. Sites differed in relative abundance of moth species, so we analysed each species separately. Binary logistic regression to predict presence or absence of moths in traps showed that moth presence was related to year, site and possum control.

How useful is the plant functional type concept? A comparison of morphological characters and responses to nutrients, water, and the cessation of grazing in semi-arid New Zealand grassland.

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A primary motivation for the classification of plants into functional types is to simplify predictions of vegetation response to perturbations such as climate change and land management practices. However, the predictive power of functional types has rarely been tested. We tested the utility of functional types for predicting responses to perturbation at two field sites in semi-arid grassland in central Otago, southern New Zealand. Functional types were defined using multivariate techniques (Cluster Analysis and Principal Components Analysis) to group plants on the basis of plant morphological and reproductive characters. Twenty characters, measured on species from two different sites, were used for this analysis (87 plant species in total). Multivariate analyses were also used to define syndromes of response to perturbations at each site (i.e. species response guilds). We defined guilds of response to fertiliser, irrigation and grazing cessation treatments at one site, and to grazing-cessation across a environmental gradient at the second site. There was differentiation between native and exotic species in both classifications, indicating that morphology and treatment response reflect species origins and historic factors. However, from comparisons of functional types and response guilds, we conclude that functional types may not be a reliable tool to predict short-term responses of plant species to perturbations in semi-arid central Otago.

Exotic plant invasions and invasibility: pattern, process and community changes in alluvial grasslands.

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Evidence for predictable processes in exotic plant invasions is difficult to obtain from data collected at one point in time. Novel analyses are here used to examine invasion processes and invasibility in grassland communities on alluvial surfaces throughout eastern South Island, using a database of comprising species presence and rank abundance in 993 quadrats. Evidence is assembled towards answering the following questions:

1. Can invasibility be predicted from environmental factors? Does invasibility differ between native communities?
2. How does the native component of a grassland change as greater numbers of exotic species invade? Are there consistent changes in the composition, diversity, and evenness of taxonomic groups or life forms?
3. Is the sequence of invasions by exotic species or life-forms predictable? Do certain taxonomic groups or life-forms invade first, or is invasion a random process? Are there "keystone invaders" which arrive first, and which might either (i) facilitate the invasion of other exotic species, or (ii) displace native taxonomic groups or life-forms? Do we see any evidence for Simberloff's "invasion meltdown"; i.e. an abrupt increase in the exotic fraction triggered by the invasion of a particular species or life-form?

Are there significant environments within New Zealand that are vulnerable to invasion by introduced trees, but beyond the ecological potential of native trees?

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Most ecologists would give at least a qualified "yes" to this question, which has implications for biological conservation. Recent flood plains, frost flats, and semi-arid regions are all colonised more readily by certain introduced trees than by native trees. The status of environments above the altitudinal tree limit seems more contentious, and will be discussed through comparisons with similar environments in other regions. In New Zealand, tall tussock grassland extends from the upper limit of evergreen *Nothofagus* forest to short alpine vegetation at higher altitudes, whereas in the southern Andes comparable grassland occurs where the upper limits of deciduous *Nothofagus* forest have been depressed by volcanic eruption. The New Zealand tall tussock grasslands also have similarities to vegetation on high tropical mountains, and it has been suggested that the 'megaherbs' in the former are equivalent to the 'megaphytes' in the latter. However, the tropical mountain grasslands lie in the same altitudinal belt as forest remnants, and therefore are below the climatic forest limits. The New Zealand tall-tussock grasslands also lie below a potential forest limit, as shown by the ability of introduced trees to establish within them.

Effects of vertebrate pests on recovery of New Zealand forests after disturbance: a planned experimental study

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"Healthy, diverse and resilient ecosystems" are a target outcome of New Zealand's investment in research. Ecologists define resilience as the rate at which a disturbed ecosystem returns to its equilibrium state. Introduced mammalian herbivores are expected to affect the resilience of forest ecosystems, since by consuming native plants they may alter the rate at which plant populations recover from natural disturbance. According to various ecological theories, the resilience of an ecosystem may be related to species richness, diversity, functional types of species present, number of trophic levels, and rates of nutrient or energy turnover. Vertebrate herbivores may affect all these ecosystem characteristics in complex ways, and needless to say, the different theories make conflicting predictions about resilience. To test the theories, we must experimentally perturb systems away from their equilibrium states, and record their recovery over time. But like many ecosystems, New Zealand's forests vary on multiple temporal scales, and cannot be assumed to be at equilibrium. This means that perturbed forests may never return to their pre-perturbation state. We describe pilot and proposed experiments to compare the trajectories of recovery of forest plots when different combinations of pests are excluded.

The impact of hydro-electricity generation developments on the extent of braided rivers and adjoining wetlands in the Upper Waitaki Basin, South Island, New Zealand.

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The formation of four new lakes, and lake level modification of two natural lakes, has inundated 22 250 ha of land and riverbed in the Upper Waitaki Basin (UWB). The inundated area included 16% (7 400 ha) of the original braided river habitat and 20% (3 900 ha) of the original wetlands. Formation of hydro-lakes and modification of existing lakes almost doubled the area of open water (an additional 22 250 ha) and more than doubled the length of lake shoreline (an additional 290 km). Approximately 9% (4 200ha) of the original braided river bed in the UWB has had the main source of flow diverted into hydro-power canals, reducing the natural functioning and dynamics of the rivers and making the river channel more vulnerable to weed encroachment. Up to 25% of braided river and associated wetland habitat in the UWB has been has been altered, however the effect on wading and shorebirds remains unquantified. Populations of some threatened and endangered bird species have declined but the importance of loss of habitat through Hydro-Electricity Generation is confounded by loss of habitat through weed encroachment and predation by introduced mammalian predators.

Prion problems. Early breeding and non-breeding season colony visits enable broad-billed prions to exclude endangered Chatham petrels.

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The endangered Chatham petrel *Pterodroma axillaris* now breeds on a single island where up to 70% of breeding failures are caused by interference from the locally abundant, broad-billed prion *Pachyptila vittata*. The prions visit the island between breeding seasons when the petrel chicks are left alone in their burrows while their parents forage at sea. The prions kill the petrel chicks when taking over burrows for their own use. Few species of Procellariiformes visit breeding islands outside the breeding season and non-breeding season behaviours are little studied. In this paper we report on the activities of broad-billed prions during non-breeding season visits. Competition for burrows was intense and site tenacity was low. Up to 79% of prions banded in study burrows were not recaptured in subsequent breeding or non-breeding seasons. Up to 10 prions were banded in a single burrow during a non-breeding season and up to 4 during a breeding season. 14% of banded prions were captured in more than one study burrow, a few up to 100 m from the burrow in which they were banded. We discuss whether burrow competition between these two native species is a natural or a human induced phenomenon.

Intensive Non Toxic Multi Pest Control. A Viable Alternative To Brodifacoum, The Te Urewera Experience

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The effectiveness of intensive rat trapping as a control technique was investigated in a replicated trial carried out in Te Urewera National Park in 1999. Snap traps were placed within tunnels on a 25metre x 150metre grid within two 200-hectare study areas. Rat densities were monitored with tracking tunnels. Rat tracking indices were reduced from 100% to 2% and from 86% to 0%. A total of 5195 rats and 41 stoats were killed. Two other areas (200ha and 800ha) were treated with Pindone poison in cereal pellets, a previously successful technique, both these areas failed to achieve the target of less than 5% tracking index. Intensive rat trapping provides an alternative to Brodifacoum in some situations. It is effective, targeted, toxin free, has high public support and is expected to be sustainable. The Northern Te Urewera Ecosystem Restoration Project (a 'mainland island' project) encompasses 50 000 ha of high conservation value forest habitat within Te Urewera National. Sustained possum control throughout is achieved with contract trappers. Intensive integrated pest control, including the control of rats, stoats, possums, pigs and deer, is undertaken in four 'core breeding areas' within this greater area. Rat trapping will take place in all 'core areas' in 2000/2001, an area totalling 1400ha, indicative results should be available by the conference date. The Northern Te Urewera Ecosystem Restoration Project is now toxin free apart from limited cyanide use.

Frugivory and seed dispersal by the common gecko *Hoplodactylus maculatus*

☺ Debra Wotton
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I investigated the effectiveness of *Hoplodactylus maculatus* as a seed disperser of fleshy-fruited native plants in a coastal habitat on Mana Island, New Zealand. An exclusion experiment was set up on *Coprosma propinqua* plants to measure the level of lizard frugivory. Seed dispersal quantity was measured by pitfall trapping geckos and removing seeds from droppings collected. Minimum dispersal distances were measured from traps where seeds were collected to the nearest fruiting plant. Germination success of *Coprosma propinqua* seeds ingested by geckos was compared with seeds collected from plants, both with the flesh removed and from intact fruit. The effect of gecko seed deposition patterns on germination success was investigated by placing pots containing *C. propinqua* seeds in four microhabitats on Mana Island. Lizards appeared to be the major frugivore of *C. propinqua* fruit, removing large quantities. Exclusion of birds had no effect on fruit removal rates, and birds were seldom observed in the study site. Forty percent of gecko droppings contained seeds, 95% of which were from *C. propinqua*. Common geckos are capable of dispersing seeds well beyond the canopy of the parent plant, with *Coprosma propinqua* seeds dispersed up to at least 9.3 m. Ingestion of *C. propinqua* seeds by common geckos had no effect on germination success, with 72% of seeds germinating. Geckos deposit seeds beneath rocks, and these microhabitats appear to be suitable for germination of *Coprosma propinqua*, with high levels of mean seed germination (73%). These results provide evidence that fruit is an important component of the diet of *Hoplodactylus maculatus*, and that common geckos provide effective local seed dispersal for *Coprosma propinqua*.

Trends in vertebrate pesticide contamination of wildlife

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Vertebrate pesticides are used throughout New Zealand in both wild animal control and threatened species management. Non-target impacts has always been of concern with the use of these pesticides and much research has been conducted on the environmental impacts of 1080. However, during the last two years, the focus of vertebrate pesticide concern has centred on the persistence of brodifacoum in the environment, so that it now rivals 1080 for the number of samples tested in the vertebrate pesticide testing laboratory. During this period, 690 samples were tested for brodifacoum, while 430 were tested for 1080, including 361 water samples from the monitoring of 1080 pest control operations. Data now exists for brodifacoum concentrations in 28 bird species with the highest concentrations found in morepork (3.4 mg/kg), wÿka (2.3 mg/kg), and chaffinch (2.3 mg/kg); and 12 mammal species, where the highest concentrations were found in rat (14.7 mg/kg), ferret (2.43mg/kg), and pig (2.4 mg/kg) tissues.