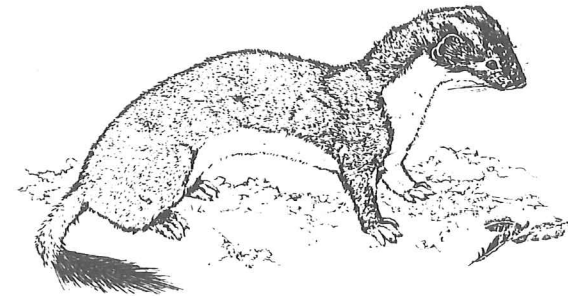


New Zealand Ecological Society

Programme and Abstracts



1996 Annual Conference

Lincoln University
Canterbury
New Zealand

30 June to 4 July 1996

Abstracts

New Zealand Ecological Society Conference

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Sponsored by: Department of Plant Science and Department of Entomology and Animal Ecology, Lincoln University. The Lincoln Foundation, Balivean Trust and Manaaki Whenua Landcare Research.

Compiled by: GH Stewart, JC Dale, Department of Plant Science, Lincoln University



PROGRAMME - ECOLSOC 1996

MONDAY CONTRIBUTED PAPERS H13 Lecture Theatre

8.30 - 10.00 Registration, H13 Foyer
10.00 - 10.30 **MORNING TEA**, H13 Upstairs Foyer
10.30 - 10.40 Conference Opening, H13 Lecture Theatre

Chair: Alan Mark

10.40 - 11.00 Day - The evolution of heteroblasty in New Zealand trees
11.00 - 11.20 Burrows et al - In the footsteps of Cook's axes: historical ecology from Dusky Sound
11.20 - 11.40 Heads - Regional patterns of biodiversity in New Zealand
11.40 - 12.00 Lord - Correlates of fleshy-fruitedness in the New Zealand flora and divergence in fruit traits between New Zealand and Australian congeners
12.00 - 12.20 Burns - Hot Boots! A gradient analysis of thermotolerant vegetation at Te Kopia

12.20 - 1.20 **LUNCH BREAK**

Chair: Steve Wratten

1.20 - 1.40 Frampton et al. - Meta-analyses: An approach for addressing ecological problems
1.40 - 2.00 Hardersen - Effects of Carbaryl exposure to nymphs of the Damselfly *Xanthocnemis zealandica* (Odonata: Coenagrionidae)
2.00 - 2.20 Whitmore & Huryn - Production and longevity of the freshwater crayfish (*Paranephrops zealandicus*) in a lowland bush stream
2.20 - 2.40 Schops - The ecology and population dynamics of an endangered weevil (*Hadramphus spinipennis*) on the Chatham Islands - a conservation approach
2.40 - 3.00 Bartholomew - An ecological restoration monitoring programme for the Karori Sanctuary, Wellington, New Zealand

3.00 - 3.20 **AFTERNOON TEA**, H13 Upstairs Foyer

Chair: Bruce Burns

3.20 - 3.40 Hunt & Buchan - Effects of clouds on UV radiation at a treeline site
3.40 - 4.00 Buckley et al. - Species richness in canopy gaps: the role of local and regional processes
4.00 - 4.20 Colin Burrows - Seed banks and their complexities
4.20 - 4.40 Alley et al - Factors contributing to the irruption of mouse populations in *Nothofagus* forests
4.40 - 5.00 Wells et al. Evidence of synchronous catastrophic disturbances in Westland
5.00 - 5.20 Ebbett - The ecology of lowland totara

- 5.30 DINNER
- 7.00 ANNUAL GENERAL MEETING, H13 Lecture Theatre
- 8.30 WINE & CHEESE FUNCTION, H13 Downstairs Foyer

TUESDAY -
SYMPOSIUM - THE ECOLOGY OF BIOLOGICAL INVASIONS
H13 Lecture Theatre

- 9.00 - 9.45 Vitousek - Biological invasion as a significant component of global environmental change
- 9.45 - 10.30 Lee - Perhaps Darwin was right: a new look at weed invasion in New Zealand
- 10.30 - 10.50 MORNING TEA, H13 Upstairs Foyer

Characteristics of Invaders
Chair: Ian Spellerberg

- 10.50 - 11.20 Townsend - Invasion biology of brown trout in streams of southern New Zealand
- 11.20 - 11.40 Bungard et al. - The response of *Clematis vitalba* L. to light and nitrate, and the invasion of forest remnants
- 11.40 - 12.00 Given - Invasive plants of the Chatham Islands - present occurrence and future prospects
- 12.00 - 12.20 Kean & Barlow - Modelling a potential invader - the Gypsy Moth in NZ
- 12.20 - 1.10 LUNCH

Factors that Influence Invasibility
Chair: Glenn Stewart

- 1.10 - 1.40 Hewitt - Marine biological invasions: community invasibility and invader success
- 1.40 - 2.00 Schreiber - Abiotic factors related to the distribution of a New Zealand freshwater snail in southern Victoria, Australia
- 2.00 - 2.20 Rose et al. - Factors influencing *Hieracium* invasion of short-tussock grasslands in the Awatere Valley, Marlborough, New Zealand
- 2.20 - 2.40 Wiser et al. - Invasibility of species-poor forest by a perennial herb over 25 years
- 2.40 - 3.00 Duncan - Avian community invasibility: the role of competition and introduction effort
- 3.00 - 3.20 AFTERNOON TEA, H13 Upstairs Foyer

Impacts, management and mitigation of plant and animal invasions
Chair: Graham Hickling

- 3.20 - 3.50 Williams & Halloy - A risk assessment system for screening plant imports into NZ
- 3.50 - 4.10 Kelly et al. - Impact of introduced birds and insects on pollination and dispersal in endemic mistletoes
- 4.10 - 4.30 Miskelly - The impacts of human visitors on forest birds on Kapiti Island
- 4.30 - 4.50 Parkes et al. - Commercial exploitation as a pest control tool for introduced animals in New Zealand
- 4.50 - 5.00 10 min break
- 5.00 - 5.20 West - Management of invasive plants - issues and time frames: a case study of Raoul Island, Kermadecs
- 5.20 - 5.40 Wratten et al. - Dynamics of invertebrate predator movement between cropped and uncropped farmland ecosystems
- 5.40 - 6.00 Townsend - Symposium synthesis
- 6.00 PRE DINNER DRINKS, Kauri Annex, Student Union
- 7.30 DINNER and DANCE to follow - the DEAD WETAS are the band!!!!!!! - Dining Room, Student Union

WEDNESDAY
CONTRIBUTED PAPERS
H13 Lecture Theatre

Chair: Richard Duncan

- 9.00 - 9.20 Syrett et al. - The psyllid *Arytainilla spartiophila* for biological control of broom in New Zealand
- 9.20 - 9.40 Lamoureaux - Space invaders: a field study and model of *Hieracium pilosella*
- 9.40 - 10.00 Gibson - Thresholds, community stability, and the invasion of *Hieracium* in New Zealand
- 10.00 - 10.20 Webster et al. - Vegetation changes, with particular emphasis on *Hieracium* species, after a decade of retirement from grazing. Results from a selection of sites in Marlborough, Canterbury, and Otago
- 10.20 - 10.40 MORNING TEA, H13 Upstairs Foyer

Chair: Kerry-Jayne Wilson

- 10.40 - 11.00 Jamieson et al. - Implications of inbreeding in New Zealand birds: new ideas and hypotheses
- 11.00 - 11.20 Armstrong & Ewen - The logic of follow-up translocations
- 11.20 - 11.40 Murphy & Bradfield - Poisoning rats: the impact on mustelids

- 11.40 - 12.00 Bowen et al. - The uptake and persistence of sodium monofluoroacetate (1080) in plants
- 12.00 - 12.20 Thomas et al. - Sodium monofluoroacetate (1080) bait-shyness in a wild brushtail possum (*Trichosurus vulpecula*) population

12.20 - 1.20 **LUNCH BREAK**

Chair: Rob Allen

- 1.20 - 1.40 Mark & Dickinson - Saltmarsh communities in Hapuka Estuary: patterns and processes in an intact coastal saltmarsh, Haast Ecological District, SW New Zealand, World Heritage Area
- 1.40 - 2.00 Shearer & Clarkson - Whagamarino peat bogs: does drainage make a difference?
- 2.00 - 2.20 Morgan - The ecology of *Thymus vulgaris* in central Otago: the role of competition
- 2.20 - 2.40 Riley & Vitousek - Hurricane disturbance effects on nitrogen trace gas flux in a montane rainforest
- 2.40 - 3.00 Wearing - Vegetation composition, landscape position, and change in semi-arid shrublands in central Otago

3.00 - 3.20 **AFTERNOON TEA, H13 Upstairs Foyer**

Chair: Dave Kelly

- 3.20 - 3.40 Wilson et al. - How well do VHF radios and satellites track Westland petrels?
- 3.40 - 4.00 Freeman - The offal truth: determining the importance of fisheries waste in the diet of Westland petrels
- 4.00 - 4.20 Sanders - Effects of fluctuating lake levels on black stilts
- 4.20 - 4.40 Dopson & Dickinson - Mistletoes in the central North Island
- 4.40 - 5.00 Markwell - Stable isotope study of seabird islands
- 5.00 - 5.20 MacLachlan - Density and diversity of spiders in agricultural fields and field margins in Canterbury, New Zealand.

ALLEY J, FITZGERALD BM, BERBEN PH, KNIGHTBRIDGE PI AND DUGDALE JS. Manaaki Whenua Landcare Research, Massey University Campus, Private Bag 11052, Palmerston North, New Zealand.

Factors contributing to the irruption of mouse populations in *Nothofagus* forests.

Mast seeding is a prominent feature of *Nothofagus* and a positive correlation between seedfall and mouse abundance has been recorded previously. However, the general assumption that beech seed is the food source responsible for the prolific breeding of wild mouse populations has not yet been proven. Research has shown that arthropods are an important component of the diet of mice and it has been proposed that arthropods contribute significantly to the irruption of the mouse population.

This paper presents results from a five year study carried out in the Orongorongo valley to investigate in detail the ecological processes underlying the mast seeding event. The focus is to determine how changes in quantity and composition of beech litter fall relates to the abundance of litter-dwelling invertebrates.

An increase in litter-dwelling caterpillars coincided with a dramatic change in litter production, this included a sudden shedding of leaves by *Nothofagus truncata* immediately prior to its prolific flowering.

In conclusion, this study supports the hypothesis that arthropods respond to changes in litter composition and contributes to the irruption of mice in *Nothofagus* forests of New Zealand.

ARMSTRONG DP AND EWEN JG. Department of Ecology, Massey University, Private Bag 11222, Palmerston North, New Zealand.

The logic of follow-up translocations.

Recovery programmes for New Zealand animals frequently involve translocations to new areas, particularly islands. It is also common, following an initial translocation, for additional animals to be released in the same location about a year later. The logic behind these follow-up translocations is often unclear, being based on vague notions such as "giving the population a boost". We argue that follow-up translocations are warranted only in special circumstances, and should not be done routinely. With an initial translocation, there's no data on how the species will perform at the release site, so it's very hard to make predictions. In contrast, with follow-up translocations, there are at least some data available to estimate population parameters. These data can be used, in combination with population viability analysis, to predict whether it will be beneficial to release further animals. These benefits need to be weighed against the cost to source population(s). We review cases of two bird species recently translocated to Tiritiri Matangi -- toutouwai, for which a follow-up translocation took place, and hihi, for which a follow-up translocation is currently being contemplated.

BARTHOLOMEW R. School of Biological Sciences, Victoria University, PO Box 600, Wellington, New Zealand.

An Ecological Restoration Monitoring Programme for the Karori Sanctuary, Wellington, New Zealand.

An integrated ecological management system is being established in the proposed Karori Wildlife Sanctuary. Supported by coordinated research, systematic monitoring and a comprehensive ecological database, this system aims to provide reliable relevant ecological information needed for effective management of the Sanctuary. Monitoring is targeted at key indicators of ecosystem health, processes that establish resource supply for fauna, and at indicators of succession within the valley.

Initial work has focused on development of common protocols, methodologies and *pro forma* for baseline ornithological, edaphic and floristic studies. This will facilitate the coordination of research done by a variety of agencies; and optimise the inclusion of research data into a comprehensive database. This database will be linked to a digitized base map through a geographic information system (GIS) at a later date.

Currently bird count data are being collated (OSNZ), a 1:5,000 base map has been produced and a soil survey conducted (author and VUW Research School of Earth Sciences). Vegetation monitoring now underway (author and VUW School of Biological Sciences) includes studies of phenology, vegetation unit mapping, seed-rain and seed-bank, establishment, basal area, canopy crown condition, vertical structure and plant distribution.

A species list linked to a voucher herbarium will provide a validated archival reference for monitoring species diversity and composition. Permanent photopoints and rapid inventory surveys will monitor gross changes to physiognomy and phenology. A network of permanent quadrats will provide detailed information on succession, structure and plant demography.

BOWEN LH, OGILVIE SC, AND EASON CT. Manaaki Whenua Landcare Research, PO Box 69, Lincoln, New Zealand.

The up-take and persistence of sodium monofluoroacetate (1080) in plants.

In New Zealand large-scale control of the introduced brushtail possum (*Trichosurus vulpecula*), and rabbit (*Oryctolagus cuniculus*) is based on aerial application of baits containing the toxin sodium monofluoroacetate (1080). The high solubility of 1080 has generated concerns about its fate and translocation within ecosystems, one concern is that herbivorous animals may be poisoned by consuming plants that have absorbed 1080. To address this concern we studied the up-take and persistence of 1080 in two representative species of terrestrial plant, the pasture ryegrass *Lolium perenne*, and the native broadleaf *Griselinia littoralis*. For both plant species, individuals were potted and a cereal bait containing 0.15% 1080 (w/w) was placed on the soil. At six time points up to 38 days whole plants were analysed for 1080 content by quantifying the dichloroaniline derivative using gas chromatography with a detection limit of 0.0015 ppm. Both plant species absorbed 1080 but showed different persistence characteristics. In the ryegrass, 1080 concentration reached a peak of 0.16 ppm after 4 days, which then declined below levels of detection after 7 days. Conversely, in the broadleaf 1080 concentration reached a peak of only 0.06 ppm after 10 days, but took 24 days to decline below levels of detection.

BUCKINGHAM R¹ AND ROBBINS L² ¹Wildlife Surveys, Mapua, Nelson. ²Get Real Productions, R.D.5, Springston, Canterbury, New Zealand.

Evidence of the continued existence of South Island kokako.

The South Island kokako (*Callaeas cinerea cinerea*) is the last endemic wattlebird likely to be remaining on the South Island mainland. Although over 150 reports of South Island kokako have been received in the last 30 years, none have been confirmed officially and the South Island kokako is now considered close to extinction.

Because South Island kokako are extremely rare, isolated and exceptionally elusive it is difficult to gather evidence as to their current existence. Yet evidence gathered since 1980 includes brief sightings of a furtive kokako like bird, which is associated with distinctive kokako-like calls and wingbeats especially in response to tape playback, and also with a characteristic moss grubbing sign. Kokako-like feathers have been found in association with the above indicators of South Island kokako presence. At the time of writing a DNA assay is being carried out on one of these feathers.

Although the situation deteriorates every year compelling recent evidence suggests that remnant populations of South Island kokako exist in diverse forest habitat in at least the Nelson lakes, North Westland and southern Stewart Island forests. Unless a concentrated effort is made to elucidate and manage the South Islands last remaining wattlebird in the next few years it will probably become extinct.

A management strategy based on the successful research and recovery plan for North Island kokako is a viable option which needs to be urgently investigated. Initially such a plan would necessitate improving techniques of detecting and/or attracting an extremely furtive bird.

BUCKLEY H, DUNCAN RP, URLICH S, STEWART GH AND GERITZLEHNER J. Department of Plant Science, PO Box 84, Lincoln University, Canterbury, New Zealand.

Species richness in FOREST canopy gaps: the role of local and regional processes.

In *Nothofagus* forest at Rough Creek in the Maruia Valley, northwest South Island, New Zealand, we measured in 32 permanently marked forest canopy gaps: 1) the proportion of forest floor that was covered in six substrate types (forest floor, log, stump, pit, mound, and exposed mineral soil), and 2) species richness at two spatial scales: the total number of species found in each canopy gap, and the number of species in 0.2m² quadrats on different substrates within each gap. We also determined gap age, area, shape, orientation, mode of formation (uproot, bole snap, standing tree death), and used the proportions of substrate types to construct an index of forest floor substrate heterogeneity for each gap.

Species richness in canopy gaps correlated with substrate heterogeneity, but not with any of the other measured gap characteristics; gaps with greater substrate heterogeneity contained more species. Twenty-two of the 42 species recorded in the quadrats showed a non-random preference for establishing on particular substrates, providing a mechanism for the increase in species richness with greater substrate heterogeneity. A greater diversity of substrates provides more opportunities for the recruitment of species with specific requirements for establishment and growth.

Variation in the number of species per quadrat was a function of local environmental conditions; quadrat species richness varied significantly with substrate type. After accounting for local environmental variation we found that quadrats located in species rich canopy gaps on average contained more species than quadrats located in species poor canopy gaps. Our results suggest that the availability of species in the region surrounding a local area may be a critical determinant of local species richness.

BUNGARD RA¹, DALY GT², McNEIL DL¹ AND MORTON JD³. ¹Department of Plant Science, PO Box 84, Lincoln University, Canterbury, New Zealand, ²Department of Landscape Architecture, PO Box 84, Lincoln University, Canterbury, New Zealand, ³Animal and Veterinary Sciences Group, PO Box 84, Lincoln University, Canterbury, New Zealand.

The response of *Clematis vitalba* L. to light and nitrate and, the invasion of forest remnants.

The deciduous perennial climber *C. vitalba* is an invasive weed species threatening the existence of lowland native forest remnants in New Zealand. In remnants, *C. vitalba* tends to establish in forest gaps and margins, particularly if these areas have been subject to recent soil disturbance. In these areas, rapid spatial and temporal variations in light level and soil nitrate concentration can be expected. We investigated the influence of light and nitrate on the germination, growth and light acclimation characteristics of *C. vitalba*. Seed germination increased following exposure to light and nitrate at levels that could be expected to occur following disturbance. Growth of seedlings under a range of light and applied-nitrate levels showed that maximum growth of *C. vitalba* should occur at full sunlight in soils with moderate to high levels of nitrate. The results also show that *C. vitalba* is capable of substantial growth at light levels as low as 10% full sunlight and can survive at light levels as low as 3% full sunlight. We argue that the substantial light-acclimation ability of *C. vitalba* is due to a combination of characteristics that are consistent with both low-light and high-light adapted species; we specifically suggest an important role for xanthophyll-cycle-dependent energy dissipation within the photosynthetic apparatus. We propose that the germination, growth and acclimation characteristics of *C. vitalba* can account for its success as an invasive weed species.

BURNS B. Manaaki Whenua Landcare Research New Zealand Ltd, Private Bag 3127, Hamilton, New Zealand.

Hot boots! A gradient analysis of thermotolerant vegetation at Te Kopia.

There are approximately 580 ha of geothermally heated ecosystems in 39 habitat islands within the Taupo Volcanic Zone. Most of these areas support a characteristic indigenous thermotolerant vegetation notable for a few geothermal endemics and the presence of disjunct fern and orchid species derived by long-distance dispersal from lower latitude sources. I analysed vegetation composition, structure and environmental relationships at the comparatively large and unmodified Te Kopia steamfield (95 ha). Soil temperatures ranged from 12 - 90 °C at 10 cm depth from non-heated peripheral soils to those almost devoid of vegetation. Communities change from secondary forest dominated by *Weinmannia racemosa* and *Pseudopanax arboreus* at the 'cold' end of the gradient to dominance on increasingly hot soils by *Leptospermum scoparium*, *Cyathodes juniperina*, *Leucopogon fasciculatus*, and *Kunzea ericoides* subsp. *microflora*, all with small needle-like leaves and shallow roots. Changes in vegetation composition and structure are strongly correlated with changes in soil temperature rather than other possible parameters. However, although pH is consistently low along the gradient, other soil parameters change in concert with temperature. With increasing temperature, soil Al, and SO₄²⁻ levels increase, while N, P, exchangeable cations, and Fe decrease. Also, as soil temperatures increase, ground surface bryophyte mats attain greater cover, while canopy height and plant species richness decrease. The presence of fruiting bodies of ectomycorrhizal symbionts on the hottest soils, including *Pisolithus tinctorius*, suggests a mycorrhizal role in sustaining vegetation on these highly infertile and stressed sites.

BURROWS C.J. Department of Plant and Microbial Sciences, University of Canterbury, Private Bag 4800, Christchurch, New Zealand.

Seed banks and their complexities.

Seed banks are populations of persistent, viable seeds maintained on parent plants, or on, or beneath the soil surface, and lasting weeks, months, or years. Germination delay mechanisms (hard seed coats, immature embryos, requirements for specific temperature and light conditions, biochemical blocks) permit seed bank development. Delays are often imposed to differing degree among individuals in a seed cohort.

Experiments with Banks Peninsula forest species are discussed. One series consists of exposure of trays of pasteurized soil in forest over the seedfall period, then monitoring of seedling appearance in an unheated, shaded glasshouse, until all seeds have germinated. Flushes of germination occur in autumn-early winter and again in spring-early summer of the first year. A few seeds persist and germinate in summer-autumn, or spring-early summer of the second year.

Other experiments examine germination of freshly collected seeds in conditions similar to those they could meet in nature (in fruit; and, with pericarp removed, - well lit; dried for a period; on soil; in the dark; buried in soil, then exhumed). Seeds from each species, germination-tested, in a cool, shaded glasshouse, respond differently, with major contrasts in well-lit, dried and buried treatments. Results indicate that seed banks for most common species could persist at, or near the soil surface for a few weeks or a few months. A few seeds from a cohort may persist into a second year. Buried seeds of some species germinate underground and seedlings die if the hypocotyl is short. Germination of others is inhibited by burial.

BURROWS L., HALL G., HUNT J., WISER S. AND VAN HERPT A. Manaaki Whenua Landcare Research, PO Box 69, Lincoln, Canterbury, New Zealand.

In the footsteps of Cook's axes, historical ecology from Dusky Sound.

Accurately dated forest clearances can provide a valuable means of measuring forest succession. In March 1773, Captain James Cook cleared 'more than an acre of ground' from the top of Astronomer Point. By comparing current composition on the Point with a reconstruction of the original forest, with an adjacent undisturbed forest stand, and with a modelled prediction of forest composition, it is possible to assess the rate and process of forest succession. Data was used to refine a model of forest succession (LINKNZ).

We measured the regenerated forest on Astronomer Point and on adjacent controls. Reconstruction of the original composition and structure was made by identification of stump wood samples and species descriptions by Cook's crew. These confirmed original large-diameter stems of *Dacrydium cupressinum* (rimu), *Prumnopitys ferruginea* (miro), other softwoods, and *Metrosideros umbellata* (southern rata). Measurement of increment cores is expected to provide age-size relationships and species appearance dates in the succession.

Almost all species presumed to have been present on Astronomer Point have re-established, with the exception of *Nothofagus solandri* var. *cliffortioides* (mountain beech), which is a dominant canopy species on the control plots. Rimu, southern rata and *Podocarpus hallii* (Hall's tara) were at higher density on Astronomer Point than controls. Basal area was comparable but mean canopy height and mean stem diameter was lower for Astronomer Point than for controls.

Preliminary refinements and simulations using the LINKNZ model have been run and give comparable species and structural results, as well as a possible explanation for the mountain beech absence.

DAY J. Department of Biochemistry, University of Otago, PO Box 56, Dunedin, New Zealand.

The evolution of heteroblasty in New Zealand trees.

Two species, *Elaeocarpus hookerianus* (pokaka) and *Pseudopanax crassifolius* (lancewood), were chosen as examples of the diverse architectures displayed by New Zealand's heteroblastic trees. It was assumed that if there was a common mechanism for the evolution of heteroblasty, then, using the concept of phylogenetic contingency, similarities in phenotype and function of these species might indicate that mechanism. The similarities during the transition from juvenile to adult in pokaka and lancewood suggest that light environment changes are of major importance. Juvenile pokaka plants display properties which have evolved to take advantage of a heterogeneous light environment. In contrast, juvenile lancewood have properties providing advantage in a stable light environment. Heteroblasty can only evolve if (1) there is a predictable change in environmental conditions during development, and (2) the different conditions are experienced for a reasonable portion of ontogeny. New Zealand's mixed forests have an upper and lower canopy. the height of the lower canopy is such that many species experience both understorey and forest canopy conditions. It is this change in light conditions which is likely to be responsible for the heteroblastic change in pokaka and lancewood. In the understorey both species display strong orthotropic growth to reach the forest canopy, and as adults both species demonstrate an increase in shade potential to establish them as part of the forest canopy.

DOPSON S AND DICKINSON K. School of Biological Sciences, Victoria University, PO Box 600, Wellington, New Zealand.

Mistletoes in the central North Island.

New Zealand has nine species of endemic mistletoe, belonging to the Viscaceae and Loranthaceae families. Due to factors such as the loss of habitat and the introduction of the Australian possum, *Trichosurus vulpecula*, mistletoes are now nationally threatened species, particularly in the North Island.

Five species of Loranthaceae mistletoe have been studied in the central North Island. Information has been collected on the phenology and reproduction of these species from five target populations for conservation management purposes.

Results of pollination, fruit development, and seed dispersal data, as well as the impact of possum browse on the reproduction of the mistletoes will be discussed.

DUNCAN RP. Department of Plant Science, PO Box 84, Lincoln University, Canterbury, New Zealand.

Avian community invasibility: the role of competition and introduction effort.

The record of passeriform bird introductions to the islands of Hawaii and St Helena show that introduced birds were more likely to successfully invade when fewer other introduced species were present. This finding has been interpreted as strong support for the hypothesis that interspecific competition influences invasion success. I tested the competition hypothesis, that invasions were more likely to succeed when fewer potentially competing species were present, using the records of passeriform birds introduced to four acclimatisation districts in New Zealand. In addition I tested if introduction effort, measured as the number of introductions and the total number of birds introduced, was a significant predictor of invasion success; a result previously established for all birds introduced to New Zealand. I found patterns consistent with both competition and introduction effort as explanations for invasion success. However, data supporting the two explanations were confounded so that it was difficult to statistically distinguish the effects of competition from introduction effort. Patterns in invasion success that have previously been attributed to competition could be partly an artefact of variation in introduction effort and initial propagule size rather than competition may be the critical determinant of invasion success in introduced birds.

EBBETT R. School of Forestry, University of Canterbury, Private Bag 4800, Christchurch, New Zealand.

The ecology of lowland totara in the South Island.

Lowland podocarp forest has been severely reduced in extent since human colonisation. *Podocarpus totara* dominated forest is now mostly restricted to small fragments throughout New Zealand, mainly on alluvial terraces in association with matai and kahikatea. Results of a three year PhD study to determine the ecology of this endemic forest giant and its future survival in a fragmented landscape will be presented.

Podocarpus totara colonises in high light environments in response to large scale disturbance events such as fire and floods. Seeds are dispersed locally by parent trees and further away by birds. Regeneration of lowland totara and associated species is restricted to a limited time period and seedlings are rare under a closed canopy. Within a dense mixed podocarp forest the absence of disturbance confines totara to optimal niches whereas repeated disturbance events promotes the dominance of totara, which lives to over 1,000 years old.

The future survival and conservation management of lowland totara dominated forest will be discussed using Banks Peninsula as an example. Agricultural practices have modified the environment and restricted lowland totara to such an extent that an integrated landscape management plan may be required to provide for the future regeneration of *Podocarpus totara*.

FRAMPTON C¹, DUNCAN RP², WRATTEN S³ AND KELLY D⁴. ¹Centre for Computing and Biometrics, PO Box 84, Lincoln University, Canterbury, New Zealand. ²Department of Plant Science, PO Box 84, Lincoln University, Canterbury, New Zealand. ³Department of Entomology and Animal Ecology, PO Box 84, Lincoln University, Canterbury, New Zealand. ⁴Plant and Microbial Sciences Department, University of Canterbury, Private Bag 4800, Christchurch, New Zealand.

Meta-analyses: An approach for addressing ecological problems.

It is only in the last five years that the possibility of solving many ecological problems through the synthesis of the statistical results from independent studies has become apparent. This procedure, Meta-analysis, has been widely used in the medical and social Sciences for the last ten years or so and in that time not only have the appropriate statistical procedures been developed but also the shortcomings of this approach have become apparent. I will outline the philosophy and statistical methods involved with the technique. Two ecological examples appropriate to a meta-analysis will be presented. One of these addresses a general ecological phenomenon, mast seeding, and shows how individual data-sets collected to show evidence of cyclic patterns are frequently inadequate for this purpose. The other example involves a manipulated experimental environment testing predator-prey associations, repeated independently on 3 occasions with inconsistent results.

FREEMAN A. Department of Entomology and Animal Ecology, PO Box 84, Lincoln University, Canterbury, New Zealand.

The Offal Truth: Determining the importance of fisheries waste in the diet of Westland petrels.

The Westland petrel (*Procellaria westlandica*) population is thought to have increased significantly over the last 30 years. It has been suggested that this increase is due to an increase in their food supply from offal and other waste discharged from fishing vessels, particularly in the hoki fishery which operates close to the Westland petrel's breeding grounds.

However, a survey of the proximity of Westland petrels to fishing vessels off the West Coast showed that although numbers of Westland petrels declined with increasing distance from fishing vessels, the small numbers of Westland petrels seen could account for only a small part of the population.

Diet analysis also indicates that fisheries waste is unimportant in the Westland petrel diet compared to wild caught fish and squid.

Diet samples obtained from the birds are partly digested. Fish waste in particular is usually devoid of any identifiable hard parts. Iso-electric focusing, a forensic tool used to identify unknown specimens by their protein fingerprints, is being used to identify fish species eaten by Westland petrels.

GIBSON R. Manaaki Whenua Landcare Research, PO Box 282, Alexandra, New Zealand.

Thresholds, community stability and the invasion of *Hieracium* in NZ.

Identifying appropriate future management strategies for sustainable management of rangeland vegetation requires an understanding of the present ecological condition, its stability and relationship to thresholds if any. In South Island high country of New Zealand a great proportion of the Tussock grasslands have been invaded by various species of the genus *Hieracium*. Opinions on the role of management to the invasion of these weed have tended to be polarised to either management (through overgrazing) is entirely responsible for this invasion or the opposite, management does not have any influence. Both opinions are backed up by actual observations of *Hieracium* invasion occurring irrespective of grazing management and invasion being strongly related to grazing management. The observations appear to directly contradict one another until the ecological status of the community and its position relative to a threshold prior to *Hieracium* invasion is established. Evidence for a threshold comes from an examination of times series data set showing the invasion of *Hieracium* over time, and from other existing scientific studies. Vegetation composition of sites that have not crossed the threshold is very strongly related to grazing management. Overgrazing can cause these to cross over a threshold of instability to a new domain of attraction where *Hieracium* invasion can then occur irrespective of current grazing management. In many cases sites have crossed the threshold as a result of historic management and *Hieracium* invasion is now taking place despite present light or non existent grazing pressure. However the overgrazing of communities that have not crossed the threshold can cause those communities to cross the threshold and for *Hieracium* invasion to take place. Understanding the position of a community relative to a threshold and whether current changes in vegetation composition is related to present or historic management is therefore critical in establishing what the outcome of particular management strategy may be and what may be an appropriate future management strategy for an area for achieving sustainable management.

GIVEN DR. Department of Plant Science, PO Box 84, Lincoln University, Canterbury, New Zealand.

Invasive plants of the Chatham Islands - Present occurrence and future prospects.

The Chatham Islands, an oceanic archipelago 800 km east of the New Zealand mainland, have an indigenous flora of approximately 330 species of which approximately 40 are endemic. The naturalised flora consists of approximately 200 species. Many naturalised plants are of limited occurrence, chiefly associated with cultivation and active human disturbance. The naturalised flora is analysed in terms of habitat, life form and reproductive potential, and briefly compared with naturalised floras of other temperate oceanic islands. A relatively small number of introductions are aggressively invasive. These include: *Leycesteria formosa*, *Rubus polyanthemus*, *Ugni molinae*, *Ulex europaeus*, several pasture grasses, and *Acaena novae-zelandiae*. Several indigenous New Zealand species have been proposed as introductions, in some cases by early Polynesian immigrants. Persistence and the long-term effects on island biota are discussed in relation to intrinsic characteristics of the invaders and extrinsic changes in habitat affecting both naturalised and indigenous species.

HARDERSEN S. Department of Entomology & Animal Ecology, PO Box 84, Lincoln University, Canterbury, New Zealand.

Effects of carbaryl exposure to nymphs of the damselfly *Xanthocnemis zealandica* (Odonata: Coenagrionidae).

In New Zealand, potential problems associated with the occurrence of pesticide residues in fresh water systems have become a concern in recent years. Here native aquatic 'non-target' organisms (e.g., damselfly nymphs) are at risk. Some of the pesticides with potential damage to the aquatic environment have been found in water bodies in the South Island of New Zealand. One of the compounds is carbaryl, but the effects of this insecticide on aquatic organisms native to New Zealand have not yet been examined.

The nymphs of *X. zealandica* (McLachlan) pass through thirteen instars before the terrestrial adult emerges. The LC₅₀ values of six instars (between 2nd and 13th) were estimated, to assess the range of susceptibility throughout the nymphal life of this species. The LC₅₀ (48 h) values ranged from 186.5 ppb to 760.0 ppb for the second and last instar respectively while the LC₅₀ (96 h) values for the same instars were 130.6 ppb and 352.6 ppb. This means that the susceptibility to carbaryl increased by a factor of up to 4.1 throughout the aquatic stages of this species.

Eggs of *X. zealandica* were exposed to a range of carbaryl concentrations during the 20-day development period. Hatching success was significantly different at 600 ppb from that at 0.6, 6, 60 ppb and control.

Nymphs of instar 12 were kept at different concentrations of carbaryl (1 ppb, 10 ppb, 100 ppb, control) until emergence. A significant reduction (> 90 %) in emergence success was found at 100 ppb.

HARMAN HM AND SYRETT P. Manaaki Whenua Landcare Research, PO Box 69, Lincoln, Canterbury, New Zealand.

A closer look at an accidentally-introduced biological control agent for broom.

The broom twigminer, *Leucoptera spartifoliella*, a host specific moth of European origin, is very common on broom (*Cytisus scoparius*) in New Zealand. It was first recorded in 1950 as an accidental introduction. Since then it has spread unaided to broom infestations throughout most of New Zealand. The rate of spread has been measured as 45 km over 7 years in Southland. Larval mining can kill branches and sometimes whole bushes. In the last few years we have received many reports of high levels of damage caused by the broom twigminer resulting in extensive areas of dead and dying broom. The accidental occurrence of the broom twigminer in New Zealand prompts us to ask the following questions: Where does the New Zealand strain of the broom twigminer come from? How does its biological performance compare with strains from other areas? Work is in progress to investigate these questions. Molecular techniques are being used to compare populations in New Zealand with others in Europe and North America. Fecundity is being compared among populations from within New Zealand and elsewhere.

HEADS M. Department of Botany, University of Otago, PO Box 56, Dunedin, New Zealand.

Regional patterns of biodiversity in New Zealand.

Regional patterns of biodiversity in New Zealand are illustrated using numbers of species per degree square. Maps of species number per degree square have been used extensively and to good effect by botanists in Australia and South Africa, and global studies of degree square biodiversity have recently been initiated in the United Kingdom. Units smaller than degree squares are subject to sampling error, while large area units such as faunal and floral regions are not generally agreed on by all biologists and may obscure smaller scale geographic trends in biodiversity. In this paper five speciose animal groups and two plant families are treated. Centres of biodiversity in Nelson, north Fiordland and east Otago are evident. Other groups would probably highlight Canterbury/north Otago and Northland. The different roles of location and environment in the origin and preservation of these patterns of biodiversity are discussed.

HEWITT CL. CSIRO-CRIMP, Castray Esplanade, GPO Box 1538, Hobart, Tasmania 7001, Australia.

Marine biological invasions: community invasibility and invader success.

The increasing effect of man on the environment is manifest in the recognizable deterioration of specific habitats due to global change and the loss of regional and global biota. One of the most pervasive and yet insidious mechanisms for this loss is the accidental and intentional transport of species from one biotic region to another. Examples of the devastating effects of non-indigenous species abound in terrestrial and freshwater systems, yet relatively little is known about marine invasions. Charles Elton proposed that communities would exhibit increasing resistance to invasion as the constituent food web became more tightly connected. This verbal hypothesis has risen to the level of paradigm in recent years and has received tacit support from several models of community assembly. I have empirically examined the encrusting communities of Coos Bay, Oregon, USA, with the intent of testing the paradigms accepted in invasion biology. Specifically, are species-rich, open coast communities less invisable (i.e., more resistant to invasion) by non-indigenous species than species-depauperate, estuarine communities. Two methods were pursued in this research: a bay-wide survey of the native and non-indigenous encrusting species; and a reciprocal transplant experiment between an historically invaded site and a non-invaded breakwater to test community invasibility and invader success. In summary, the native communities were susceptible to invasion in all instances, but to varying degrees. These differences in invasibility were due primarily to differences in native species cover at the onset of the experiment.

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Cloud induced fluctuations of UV-B radiation at a treeline site: implications for plants.

At a treeline site in Marlborough, New Zealand (lat. 41.75°S, long. 173.81° E, elevation above sea level 1366 m), measurements were made of shortwave irradiance and solar ultraviolet (UV) irradiance using an erythral-weighted sensor, during the period December 1993 to February 1995. Empirical functions were fitted to selected cloud-free days to determine the seasonal progression of clear-sky daily UV and shortwave radiant fluxes.

Under modelled clear-sky conditions, there is an annual course in daily UV dose from a summer high (7.1 kJ m⁻² d⁻¹) to a winter low (0.5 kJ m⁻² d⁻¹) as a consequence of changes in solar declination. Attenuation of UV by clouds resulted in the biosphere receiving 70% of the modelled, annual clear-sky dose of 1160 kJ m⁻² y⁻¹. On an annual basis, clouds reduced shortwave irradiance by a comparable amount. Clouds also affected the month in which the maximum daily UV dose occurred. On 17 days during summer, the daily dose of UV was higher than the modelled clear-sky dose expected at the equator.

Under both clear-sky and totally cloudy conditions, the UV to shortwave ratio increased to a maximum at mid-day, however, high cirrus and small clouds that obscured the solar disk increased the UV:shortwave ratio. Although changes in solar zenith angle dominated the annual cycle of clear-sky UV, changes in total ozone can seasonally displace the time of the maximum daily dose and alter its magnitude.

Variations in UV dose from one day to the next, due to clouds, can be as large as that found between clear-sky summer and winter daily doses. The maximum recorded reduction in the daily UV dose due to clouds was 92% of that expected under clear-sky conditions. The difference in measured UV dose from one day to the next (*UV) was calculated. The relative frequency of *UV was normally distributed, highly leptokurtic, and slightly left skewed (mean =4.3, standard deviation =1360, g₁ = -0.2, g₂ = 3.7, n=284). Due to the relatively infrequent cloud cover at this site, there is a greater than 50% chance that the daily UV dose will be within 0.5 kJ of the dose recorded on the previous day. The largest *UV was a positive increase of 4.5 kJ m⁻², while 25 days had an increase in *UV of >2 kJ d⁻¹. To assess the ability of plants to tolerate large step-wise changes in *UV, investigations are needed on the rates of synthesis and turnover of UV-B absorbing compounds.

JAMESON I, RYAN C AND BUNIN J. Department of Zoology, University of Otago, PO Box 56, Dunedin, New Zealand.

Implications of inbreeding in New Zealand birds: new ideas and hypotheses.

There is abundant evidence that inbred individuals show lower survival than outbred individuals. However, it has also been argued that inbreeding is less of a problem if it has occurred over several generations because deleterious recessive alleles should be purged as the population goes through a genetic bottleneck. The latter may describe the situation for many New Zealand birds that have small isolated populations and have persisted over time, and after management intervention, have been known to increase and recover despite intensive inbreeding (e.g. black robin). However, recent research overseas has indicated that the purging of deleterious alleles is environment-specific and that under different or new environmental stresses inbred individuals can still suffer greater mortality than outbred ones. Takahe transferred to lowland islands show significantly lower hatching success than Fiordland birds and pairs on islands that are closely related have lower hatching success than unrelated pairs. These data are consistent with the hypothesis of inbreeding depression mediated by a change in environment and may also account for poor hatching success of kakapo transferred to Little Barrier Island.

KEAN J AND BARLOW N. AgResearch PO Box 60, Lincoln, Canterbury, New Zealand.

Modelling a potential invader: the Gypsy Moth in New Zealand.

Accidental entry of the gypsy moth (*Lymantria dispar* (L.)) into New Zealand would be potentially devastating to commercial and conservation forests throughout the country. Recently, viable eggs and larvae have been intercepted on arriving ships. As part of a proactive response to this threat, population models are being developed to evaluate the use of microbial control agents both to eradicate founder populations and to give long-term control should the moths establish. Existing models of gypsy moth population dynamics deal with the European strain, whereas the Asian strain is seen to pose a greater threat to New Zealand. Consequently, the first step was to develop models for both strains in New Zealand and compare their behaviours.

Models of differing complexity were developed, ranging from simple analytical models to more complex simulation systems incorporating age structure and temperature-dependence. All were based on relationships reported in the literature, including development, mortality, predation, and resource interactions.

Preliminary results show that the models are able to reproduce observed gypsy moth outbreak cycles, and predict specific differences between the population dynamics of the Asian and European strains. In particular, they suggest that the Asian strain will undergo two generations per year, potentially causing twice as much damage as the univoltine European strain.

Further work will incorporate viral (NPV) and fungal (*Entomophaga maimaiga*) biocontrol agents, and identify optimal strategies for either control or eradication.

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Impact of introduced birds and insects on pollination and dispersal in endemic mistletoes.

All five extant endemic Loranthaceae mistletoes have bird dispersed fruits which must have the fruit pulp removed before germination can occur. Three species are bird pollinated and two of these (*Peraxilla colensoi* and *P. tetrapetala*) require the buds to be twisted by the pollinator before flower opening occurs explosively. A number of exotic birds and pollinating insects have become established in New Zealand. Here we ask: can introduced animals replace less common native animals for dispersal and pollination of mistletoes?

Introduced bird species do disperse mistletoe fruits but native birds are still far more important for dispersal because introduced birds are infrequent in forest and have a smaller gape than the native species. Data from 1995/96 show that native bees are able to open the flowers of *P. tetrapetala* (but not *P. colensoi*) if birds do not. Introduced honey bees and wasps are common flower visitors but do not open buds. Pollen deposition measurements and exclusion experiments show that effective pollination can occur through visitation by native and introduced insects once flowers are open.

Therefore, some pollen transfer takes place on introduced insects, and some fruit dispersal by introduced birds, but in neither case are introduced species substantially augmenting the services provided by native birds and insects. Native birds have a quantitative advantage for dispersal and native animals have a qualitative advantage for pollination. If native animal densities are reduced by competition with introduced birds or insects, mistletoe reproduction will suffer.

LAMOUREAUX S. AgResearch, PO Box 60, Lincoln, Canterbury, New Zealand.

Space Invaders: A field study and model of *Hieracium pilosella*.

The population and patch dynamics within a stand of *Hieracium pilosella* were investigated at Mt. John, Lake Tekapo. Soil fertility, grazing, moisture and herbicide/fungicide effects on phenology, growth and reproduction were followed during two growing seasons. The results from this and previous studies are being used to develop population models to predict both the spread of *H. pilosella* under different conditions and the impact of biological control.

To date, the reproduction and survival of approximately 3400 *H. pilosella* rosettes have been followed under different experimental conditions. Analysis suggests that vegetative reproduction is density-independent but mortality of rosettes is density-dependent. There are also significant relationships between the vital rates and % *Hieracium* cover as well as environmental factors such as fertiliser and moisture.

In addition to the field trials, two models have been constructed. The first simulates spatial patch dynamics on a per rosette basis using data from Makepeace (1980) and this study. The second simulates changes in total rosette density over time using a transition matrix applied half yearly.

LEE WG. Manaaki Whenua Landcare Research, Private Bag 1930, Dunedin, New Zealand.

Perhaps Darwin was right: a new look at weed invasions in New Zealand.

Nineteenth century naturalists, including Charles Darwin, considered that the indigenous flora of New Zealand would succumb to the ecological superiority of naturalised northern hemisphere plant species. Cockayne and others espoused the opposing view, that few indigenous communities or species were directly threatened by introduced plant species. Others believe that the development of communities comprising both indigenous and naturalised species represent a natural evolutionary progression. Currently there is a widespread perception that, after c. two centuries of interaction, a stable equilibrium exists between the indigenous and naturalised floras. This issue is reexamined in relation to the relative vulnerability of native plant communities in New Zealand, compared with communities elsewhere. Studies of New Zealand vegetation are reviewed to test several hypotheses regarding the critical factors facilitating weed invasion in natural ecosystems. Weed invasion in New Zealand is in its pioneer phase, but existing evidence of the interaction between native and naturalised species indicates that Darwin's view eventually may be proved correct.

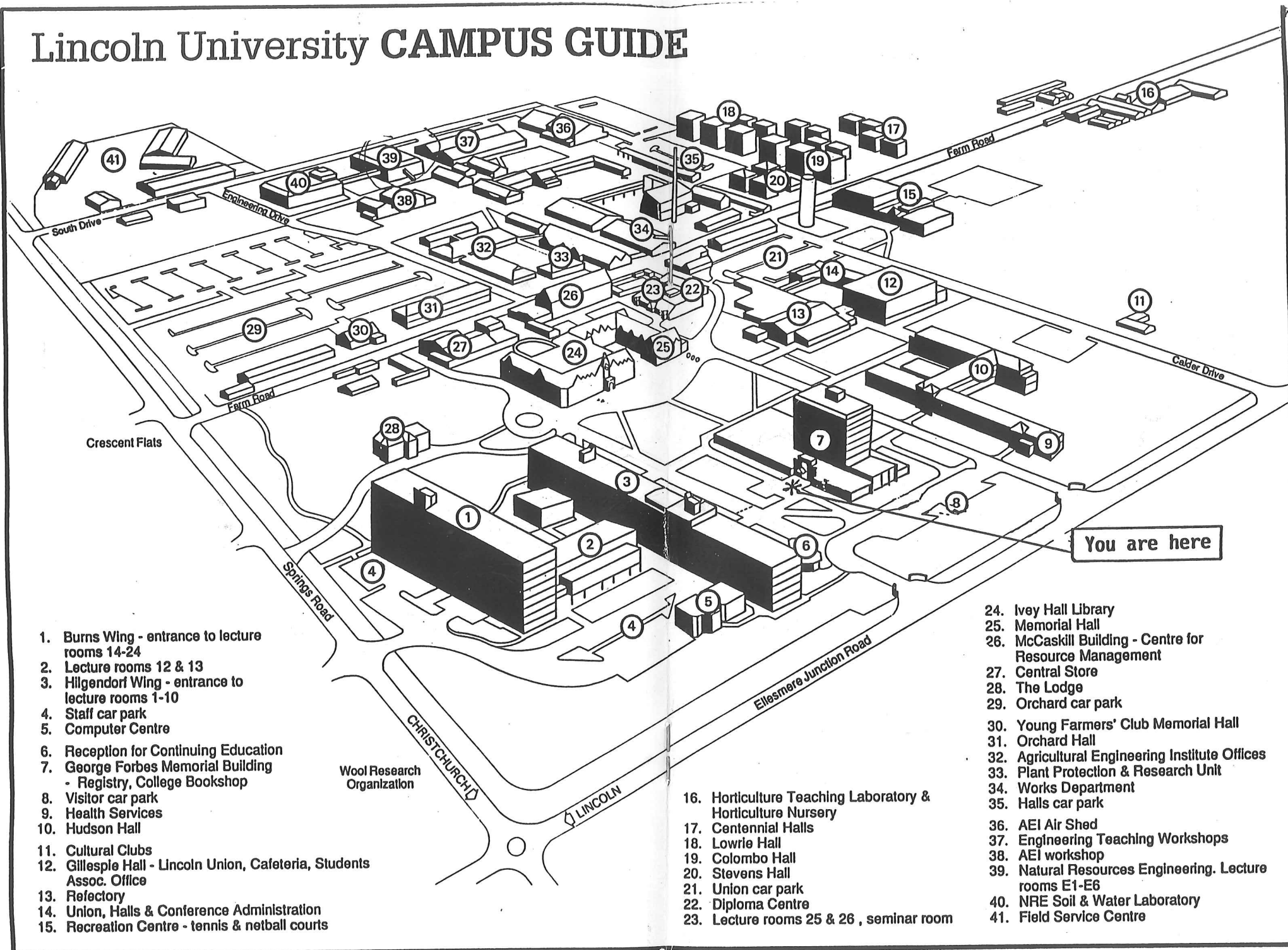
LORD J. Department of Botany, University of Otago, PO Box 56, Dunedin, New Zealand.

Correlates of fleshy-fruitedness in the NZ flora, and divergence in fruit traits between NZ and Australian congeners.

Roughly 25% of seed plant genera indigenous to NZ contain species with fleshy fruits; it has been suggested that fleshy-fruitedness is particularly common in NZ relative to other temperate floras. This paper examines traits associated with fleshy-fruitedness in NZ at two levels: analyses within the NZ flora and comparisons between NZ and Australia. Analyses within the NZ flora found that fleshy-fruitedness is not associated with increased diversification in NZ. The number of species in fleshy-fruited genera is not significantly different from the number of species in other genera, and endemic genera are no more likely to possess fleshy fruits than other types of fruits.

Of the c.95 fleshy-fruited genera indigenous to NZ, 67 also occur in Australia. Marked differences exist between NZ and Australia in the type of dispersers available; in particular NZ lacks arboreal mammals, and has a large number of frugivorous birds with gape sizes of less 10mm. When fruit traits of NZ and Australian species were compared it was found that NZ fruits became more elongated with increasing size than Australian fruits, as would be expected if bird gape size was a stronger constraint on fruit size in NZ than in Australia.

Lincoln University CAMPUS GUIDE



1. Burns Wing - entrance to lecture rooms 14-24
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3. Hilgendorf Wing - entrance to lecture rooms 1-10
4. Staff car park
5. Computer Centre
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7. George Forbes Memorial Building - Registry, College Bookshop
8. Visitor car park
9. Health Services
10. Hudson Hall
11. Cultural Clubs
12. Gillespie Hall - Lincoln Union, Cafeteria, Students Assoc. Office
13. Refectory
14. Union, Halls & Conference Administration
15. Recreation Centre - tennis & netball courts

16. Horticulture Teaching Laboratory & Horticulture Nursery
17. Centennial Halls
18. Lowrie Hall
19. Colombo Hall
20. Stevens Hall
21. Union car park
22. Diploma Centre
23. Lecture rooms 25 & 26, seminar room
24. Ivey Hall Library
25. Memorial Hall
26. McCaskill Building - Centre for Resource Management
27. Central Store
28. The Lodge
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30. Young Farmers' Club Memorial Hall
31. Orchard Hall
32. Agricultural Engineering Institute Offices
33. Plant Protection & Research Unit
34. Works Department
35. Halls car park
36. AEI Air Shed
37. Engineering Teaching Workshops
38. AEI workshop
39. Natural Resources Engineering. Lecture rooms E1-E6
40. NRE Soil & Water Laboratory
41. Field Service Centre

McLACHLAN ARG. Department of Zoology, University of Canterbury, Private Bag 4800, Christchurch, New Zealand. Present address: Department of Entomology and Animal Ecology, P.O. Box 84, Lincoln University, Canterbury, New Zealand.

The distribution and abundance of *Spelungula cavemicola* (Araneae: Gradungulidae), a New Zealand cave-dwelling spider.

Spelungula cavemicola, New Zealand's largest native spider (13 cm legspan) and only protected species of spider is restricted to a few limestone caves in Nelson, N.Z. Populations in several caves (500 m of passage in total) near Karamaea were visually surveyed 20 times in 13 months. Spiders numbers varied between 111 and 42 during the year, mostly when spiderlings emerged from eggsacs. Most spiders were found within 20 m of cave entrances, but can be found much deeper into the caves. It is not known whether *Spelungula* is an obligate cave-dweller or not.

Multiple logistic regression of 84 randomly chosen sites showed that *Spelungula* presence was best predicted by presence of cave weta, a prey of *Spelungula*, but not by the presence of any other invertebrates, nor light level, presence of water, distance to nearest entrance, nor relative humidity.

Spelungula appears to be long-lived (at least 3 to 5 years to reach mature size) and reproduces only slowly. The consequences of human visitation to the caves are discussed.

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Saltmarsh communities in Hapuka Estuary: Patterns and processes in an intact coastal saltmarsh, Haast Ecological District, South-West New Zealand World Heritage Area.

Eight plant communities are described from a pristine but small (c. 11 ha) saltmarsh and adjacent podocarp-broadleaved rain forest association at Hapuka estuary, Haast Ecological District, South Westland. Eight of the nine environmental factors measured at the 74 sample sites along five transects across the marsh were shown to be significantly related to the vegetation pattern through vector analysis.

Despite being located c. 2.0 km up-river from the current northern location of the outlet of three rivers (Tumbull, Okuru, Hapuka of which the Hapuka is much the smallest), across a highly dynamic barrier beach, the water which irrigates the saltmarsh at high tide reaches 15-19‰ on calm days but may be much less saline when moderate to strong southerly winds counter the tidal influence. Northerly winds, or a southern outlet through the barrier beach, by contrast, are likely to enhance salinity of the tidal waters across the saltmarsh.

The highly popular interpretive boardwalk through the Hapuka saltmarsh and adjoining rain forest make it a very significant if minute component of the South-West New Zealand World Heritage Area.

MCLACHLAN ARG. Dept of Entomology and Animal Ecology, P.O. Box 84, Lincoln University, Canterbury, New Zealand.

Density and diversity of spiders in agricultural fields and field margins in Canterbury, New Zealand.

The spider fauna in agricultural land in N.Z. is poorly known with the species diversity and the proportion of native and endemic species not well studied. This work has surveyed spider species composition and density in arable pasture land as well as adjacent field boundaries. Introduced European spider species dominate the open-field fauna with densities of up to 24 m⁻². In less disturbed field margins, densities can reach up to 890 m⁻² with a higher proportion of endemic species. The movement into the field of spiders from field margin refugia appears to be limited. In replicated field experiments, spider density was related to vegetation height and disturbance, but not apparently to pasture plant species. The prospects for enhancing the contribution of spiders to biological control in farmland are discussed.

MARKWELL T. School of Biological Sciences, Victoria University of Wellington, PO Box 600, Wellington, New Zealand.

Stable isotope study of seabird islands.

The use of stable isotopes to study feeding patterns is becoming an increasingly important area of ecology. Stable isotopes of carbon and nitrogen undergo fractionation during biochemical reactions so that different ecosystem components have their own unique stable isotope signature. These signatures can be used to analyse feeding habits of animals and study transport of organic material through an ecosystem. Isotope studies can be used in range of different applications, from looking at atmospheric pollution, to changes in human diets over time, to determining whether or not polar bears eat strawberries in summer. Data will be presented showing the use of stable carbon and nitrogen isotopes to study island ecosystems and how nutrient addition by colonial seabirds provides resources that are available to other members of the island ecosystem.

MISKELLY C. Wellington Conservancy, Department of Conservation, PO Box 5086, Wellington, New Zealand.

The impacts of human visitors on forest birds on Kapiti Island.

Five-minute bird counts along the Trig and McKenzie Tracks on Kapiti Island were used to assess whether differing levels of public use had any detectable impact on the ten most frequently recorded forest bird species. Counts conducted by OSNZ members in 1983-84, when both tracks were open to the public, were used to identify those species that appeared to use the two tracks in similar ways. Counts of weka, kereru, whitehead, tomtit, robin and tui were strongly correlated between the two tracks, whereas counts of kaka, kakariki, fantail and bellbird showed little or no correlation; these latter four species were excluded from further analyses.

The McKenzie Track was closed to the public in October 1990, concurrent with the opening of the Wilkinson Track. Counts conducted by OSNZ members between April 1991 and July 1993 were used to determine whether any forest bird species had been affected by closure of the McKenzie Track. Expected count values for the McKenzie Track were calculated by assuming that the same percentage change in bird counts as recorded on the Trig Track between 1983-84 and 1991-93 would have occurred on the McKenzie Track if it had not been closed to the public.

The maximum number of permitted visitors to Kapiti Island was increased from 150 per week to 250 per week in September 1993. However, the maximum number of permitted visitors per day remained at 50. Counts conducted by the Department of Conservation and OSNZ between October 1993 and April 1996 were used to determine whether any forest bird species had been affected by this increase in permitted visitor numbers. Expected count values for the Trig Track were calculated by assuming that the same percentage change in bird counts as recorded on the McKenzie Track between 1991-93 and 1993-96 would have occurred on the Trig Track if birds there had not been affected by the increased number of permitted visitors. The results presented for this aspect of the study are provisional as final count session will not be completed until July 1996.

MORGAN RK. Department of Geography, University of Otago, PO Box 56, Dunedin, New Zealand.

The ecology of *Thymus vulgaris* in Central Otago: the role of competition.

This paper describes a growth trial experiment designed to test certain ideas about the influence of competition from grasses on the distribution of *Thymus vulgaris* (common thyme) in the landscape of Central Otago.

Although thyme can grow successfully in well-watered conditions, moister south facing slopes, with grass cover, often support sparse thyme. North-facing slopes have extensive, but poorly performing, thyme; this might be seen as a competition-free habitat but towards the edge of the tolerance range for thyme. Terrace tops have both grasses and thyme, but their relationship seems complex and may be dependent on land use factors.

The growth trial, using established seedlings of thyme and *Agrostis capillaris*, comprised three composition treatments (100% thyme, 100% grass, 50:50% both species); three density levels (12, 6 and 2 plants per pot), and three watering regimes (described here as "dry", "medium" and "wet"). There were three replicates of each combination of treatments; the growth trial period was 8 weeks.

Some of the main findings are:

1. at high densities, thyme productivity is reduced by competition from the grass;
2. thyme does not benefit from growing with the grass under any of the experimental conditions/treatments;
3. the grass plants are not inhibited by the thyme plants.
4. thyme productivity in the trial appears to be independent of moisture conditions; density and competition seem to be the important influences;

While by no means definitive, the results suggest that thyme can grow reasonably successfully in grassy communities where density is kept low by drier conditions or by management practices that reduce the grass component of the community.

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Poisoning rats: the impact on mustelids.

Large-scale poisoning by aerial application or bait stations is used routinely to control brushtail possums in New Zealand forests. A side effect of these operations is that ship rats are also controlled in the short term. The indirect effects of these operations, particularly on other predators are not well understood.

The diet of stoats caught at Mapara, a central North Island forest, was determined over six years. Before widespread rodent control, the diet of stoats was mainly rat with very few bird or mouse remains. After two partially successful aerial 1080 operations for rodents, rats remained the main prey of stoats year-round with few bird or mouse remains. After a successful aerial rat control operation, birds became the most frequently occurring prey item in stoats for six months afterwards, with fewer rodent remains.

During two years of rat control using brodifacoum in bait stations over spring and summer, the most frequently occurring prey items in stoats caught in the following summer and autumn were birds and mice, with few rat remains. Thirty of 40 stoats, 10 of 14 weasels and 9 of 16 ferrets caught throughout the year had lethal or sub-lethal levels of brodifacoum in their livers. Implications and questions for conservation management will be discussed.

PARKES J, NUGENT A AND WARBURTON B. Manaaki Whenua Landcare Research, PO Box 69, Lincoln, Canterbury, New Zealand.

Commercial exploitation as a pest control tool for introduced mammals in New Zealand.

This paper examines the factors that determine whether commercial exploitation of introduced mammals in New Zealand provides a useful method for reducing their densities and therefore their impacts on native biota. We describe the history of commercial harvesting of three introduced species, red deer (*Cervus elaphus*), Himalayan thar (*Hemilragus jemlahicus*), and possums (*Trichosurus vulpecula*). We then assess why the conservation outcomes of this harvesting have differed for these three species and attempt to define some general rules about where and when commercial exploitation is a useful pest control tool. Commercial harvesters of red deer for game meat and byproducts have harvested over 2 million deer since 1960 and reduced the national population from over 1 million to a current population size of c. 250 000 deer, a 75% reduction overall. Current annual harvests average c. 20 000 deer, with annual variations explained largely ($r^2=0.89$) by the price of venison. Commercial harvesting of thar for game meat between 1971 and 1982 killed at least 38 000 thar and reduced the population by over 90% to <5000 animals. After the peak harvests before 1976, low annual harvests of only a few hundred animals were able to be sustained as thar were killed as bycatch of the deer industry - but the harvest was stopped between 1983 and 1994 because of pressure from recreational hunters. Commercial exploitation of possums for fur began in 1921, with over 56 million skins being exported. The annual harvest is correlated with the price of furs. Compared with deer or thar, the prices paid per possum are low, and possums are much more abundant (c. 70 million) and ubiquitous pests. The annual harvests of possums have therefore been variable and never sufficient to have more than locally significant effects on population densities.

REDDIE B AND HICKLING GJ. Department of Entomology & Animal Ecology, PO Box 84, Lincoln University, Canterbury, New Zealand.

Through the looking glass: mirror image stimulation for assessing dominance in brushtail possums.

Mirror image stimulation (MIS) has promise as a method for evaluating the effect of experimental treatments (e.g., the effects of proposed biological control agents) on possum dominance behaviour. To validate the technique MIS was used to assign dominance scores to 14 brushtail possums (*Trichosurus vulpecula*) in an outdoor arena. Both sexes responded to their image in a mirror with increased vigilance and a variety of approach and retreat behaviours, with males being more likely than females to retreat. A principal components analysis of 16 behavioural categories was used to generate an MIS dominance score for each possum. The within-pair difference in possums' MIS scores was highly correlated with the pairs' observed dominance relationship ($r_s = 0.91$, $P < 0.02$). Female possums, which typically dominate males in the field, had significantly higher MIS scores than did males ($P = 0.005$). MIS was particularly successful in generating data on subordinate animals, which tend to be unresponsive in stressful social settings and thus difficult to score using traditional dominance ranking procedures.

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Hurricane disturbance effects on nitrogen trace gas flux in Hawaiian montane rainforest.

Biogenic gas emissions from soils have been shown to be sensitive to some ecosystem disturbances. Steudler et al. (1991) suggest that patterns of N-cycling and nitrogen trace gas emissions recover relatively quickly after natural disturbances in forests accustomed to these disturbances. Tropical storms and hurricanes have historically been a regular component of Hawaiian weather. Natural disturbance effects on patterns of nitrogen trace gas emissions and soil nitrogen flux were compared between pre- and post-hurricane studies in Hawaiian montane rainforest. This site had been studied for one year prior to Hurricane Iniki and was revisited 3 months after Iniki. Both N_2O and NO emissions with respect to soil water-filled pore space were also similar to pre-Iniki emissions, consistent with a model of soil water control over relative emissions of N gases. The damage sustained at the kauai site is less than or comparable to damage sustained in a Puerto Rican forest studied by Steudler et al. (1991). In contrast to their results, we did not observe a significant decline or increase at 3 months post-Iniki in either N_2O or NO emissions using a more extensive pre-hurricane data set.

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Factors influencing *Hieracium* invasion of short-tussock grasslands in the Awatere Valley, Marlborough.

Environmental and management factors influencing grassland composition and *Hieracium pilosella* abundance were investigated on 182 vegetation plots in two sub-humid catchments in the Awatere Valley, using classification, ordination, generalised additive models (GAMs), and generalised linear models (GLMs).

H. pilosella was present on >80% of plots, but is in the early stages of invasion in one catchment (< 5% cover) and is dominant in the other (25% cover). *H. pilosella* was absent in a community characteristic of wet, fertile soils. On drier sites, there were strong between-catchment vegetation differences. *H. pilosella* was less abundant in the catchment with higher rainfall, historically low rabbit numbers, and spring rather than winter spelling from sheep. In this catchment, *H. pilosella* was least frequent on sheep camps with dry, fertile topsoils. For individual plots, topographic position and slope explained 33% of the variation in *H. pilosella* cover. In the catchment at the later stage of invasion, *H. pilosella* was abundant in all communities, with greatest cover on oversown and top-dressed sites. *H. pilosella* cover was more predictable than at the earlier stage of invasion: individually, 12 site factors explained 19-33% of the variation and topsoil sulphur, slope, and topsoil calcium together explained 52%.

Rainfall, soil moisture and fertility, and grazing influence grassland composition and *Hieracium* abundance. However because such factors interact, they individually provide only partial explanations for *Hieracium* success. Further, relationships vary with the scale of investigation and stage of invasion, and differences in grassland composition can be partly a consequence of the stage of invasion itself. Environment, disturbance, species and community attributes, and the availability of propagules are all predisposing influences on invasion. Therefore, single-factor models are unlikely to prove adequate for interpreting or managing *Hieracium* in tussock grasslands.

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Possum impacts and threats to conservation values in Nelson/Marlborough conservancy.

A comprehensive regional assessment of present possum impacts and conservation values threatened by possums in Nelson/Marlborough conservancy was undertaken in three phases. In phase 1 all available information on possums, and possum-vulnerable species throughout the Conservancy was reviewed and gaps in current knowledge were identified. To fill the gaps recognized in phase 1, in phase 2 aerial and ground surveys were used to evaluate the distribution of possum-vulnerable forest canopy species and to assess the extent of possum-induced damage to the forests. In phase 3 all information was integrated to develop a framework for protecting a representative range of possum-vulnerable ecosystems and species and to identify priority areas for possum control. The information-review identified the Wakamarama and Seaward Kaikoura ecosystems as the most susceptible to possum damage; those in Nelson Lakes, South Wairau and Matakaitaki are the least susceptible. The review also indicated that knowledge of present possum impacts on forests was insufficient to develop control strategies. The subsequent aerial and ground surveys showed that although forests are beech dominated, there is conspicuous dieback of possum-preferred species in 70% of the study area. The overall impact of possums appears to be a process of progressive attrition, rather than the synchronous collapse observed elsewhere. Within each of 13 biogeographic units, priority areas for possum control were identified that best represented the range of species, communities and ecosystems vulnerable to possums, thus integrating protection of both "unusual" and "common" species/communities/ecosystems.

SANDERS M. University of Canterbury, Private Bag 4800 Christchurch, Current Address: Department of Conservation, Private Bag, Twizel, New Zealand.

Effects of fluctuating lake levels on black stilts.

During the 1992 electricity crisis, concern was expressed about potentially detrimental effects of low lake levels on black stilts, one of New Zealand's most endangered birds. I investigated the relationship between lake levels and black stilt food supplies, foraging behaviour, and foraging habitat on 4 deltas of the Upper Waitaki Lakes, during winter, 1992 - 1994. I also used a 10 - 13 year data set to investigate whether changes in lake levels were associated with changes in the abundance of black stilts on 6 lake deltas. Changes in lake levels affected these variables differently on different lake deltas. When lake levels declined, aquatic invertebrate biomass (food) and feeding rates increased on the Ahuriri Delta of Lake Benmore and decreased on the Tasman Delta of Lake Pukaki, but did not change on the Tekapo/Ohau Delta of Lake Benmore or the Godley Delta of Lake Tekapo. As lake levels declined, the area of available habitat increased on all deltas, although the formation of steep banks may have made some lake-edge habitat unsuitable for black stilts on the Tasman and Godley Deltas. Multiple regression suggested that the abundance of black stilts on lake deltas could be influenced by lake level and/or time of year and/or total population size. Declining lake levels were associated with increases in numbers of black stilts on the Ahuriri and Tekapo/Ohau Deltas of Lake Benmore, and decreases in numbers of black stilts on the Cass Delta of Lake Tekapo. The management implications of these findings are discussed.

SAWYER J. Department of Conservation, PO Box 5086, Wellington, New Zealand.

Plant Conservation in Wellington Conservancy.

People conserve plants for many reasons. In New Zealand efforts to conserve indigenous plants are directed at a large variety of plant taxa. Plants of conservation concern in the Wellington Conservancy of the Department of Conservation include:

- Plant taxa whose national presence is threatened and are in danger of national extinction.
- Plant taxa whose presence in any particular region of New Zealand is threatened.
- Plant taxa that are rare (either found at only a few locations or widespread but never abundant).
- Plant taxa for which limited information exists about their geographical distribution or their current status in the wild.
- Plant taxa that are only found in one particular region (a local endemic plant).
- Plant taxa whose occurrence at a particular place or in a particular region is believed to constitute an important genetic resource.
- Plant taxa that are important for the survival of other plant or animal taxa.
- Plant taxa that are important to people.

SAWYER J. Department of Conservation, PO Box 5086, Wellington, New Zealand

Biogeography: its application to plant conservation in Wellington conservancy.

Biogeography is the study of the geographical distribution of plants and animals and other organisms in space and time.

The geographical distribution of native vascular plant taxa has been used as a basis for the design of species recovery programmes for nationally and regionally threatened plant taxa that occur or were formerly known to occur in the Wellington Conservancy.

Information about the geographical distribution of all native vascular plant taxa in the Wellington Conservancy has been obtained from:

- Herbarium records at all national herbaria
- 380 published and unpublished vascular plant checklists compiled for various localities in the Wellington Conservancy
- Published and unpublished botanical reports
- Data compiled during Protected Natural Area surveys
- Species record sheets completed by botanists working in the region.

Several case studies will be used to show how the geographical distribution of a plant taxon can be used as a basis for the design of a strategy for its conservation.

Conclusions

Biogeography has important applications in the development of strategies for plant conservation.

The geographical distribution of a plant taxon can be used:

- To develop research projects that seek to provide ecological explanations for observed distribution patterns (ecological biogeography)
- To determine whether populations of that taxon occur on legally protected land. This may allow priorities to be determined for negotiations concerning the legal protection of private land upon which nationally threatened plant taxa now occur.
- To identify sites that supported populations of that plant taxon in the past. A survey may be required to determine the current status of the plant at that site. If the plant is no longer present it may be possible to re-introduce the plant as part of a species recovery programme.
- To provide baseline information for comparative analysis of future changes in the distribution of the taxon.

SCHÖPS K. Department of Entomology and Animal Ecology, PO Box 84, Lincoln University, Canterbury, New Zealand.

The ecology and population dynamics of an endangered weevil (*Hadramphus spinipennis*) on the Chatham Islands - a conservation approach.

H. spinipennis belongs to a small genus of large, flightless weevils (family Curculionidae). Its distribution is restricted to two predator-free outlying island of the Chatham Islands group but it is believed that the weevil had a much wider distribution before rodents and cats were introduced. The phenology, ecology and population dynamics of *H. spinipennis* have been investigated in the summers of 93/94, 94/95 and 95/96 during five visits to Mangere Island. The adult weevils reach at least two and a half years of age and feed on foliage of *Aciphylla dieffenbachii*, Apiaceae. The larvae develop on the roots. The impact of the feeding weevils and larvae has caused the disappearance of *Aciphylla* patches in the past, leading to a fragmental, but interacting metapopulation of weevils. One subpopulation was chosen for an intensive mark-recapture study. The plants in one patch were mapped annually and a total of over 9000 weevils were marked individually. The number of weevils in the patch increased rapidly from just over 2000 individuals in the summer of 93/94 to over 6000 in the summer of 95/96 causing a decline in the number of host plants from 625 adult plants to 250. For the adult weevil population death and survival rates were calculated as well as the dispersal rates within the patch. The future demographic development of the studied weevil subpopulation, its interaction with the population dynamics of the host plant and its dispersal ability are discussed. By using the results of this study a management plan for this endangered weevil species will be developed.

SCHREIBER S. Cooperative Research Center for Freshwater Ecology, Department of Ecology and Evolutionary Biology, Monash University, Clayton, 3168, Australia.

Abiotic factors related to the distribution of a New Zealand freshwater snail in southern Victoria, Australia.

In this study the relationship between the presence of a snail introduced to Australia from New Zealand (*Potamopyrgus antipodarum* (Prosobranchia: Hydrobiidae)) and 12 environmental factors was investigated. Seventy-three stream sites, distributed over 16 catchments, were sampled in southern Victoria, Australia, and *P. antipodarum* was found to be present at 22 of these sites. Water temperature, pH, conductivity and calcium concentration of the water were also measured. The sites selected for this study were all close to sites used by the 'State Water Laboratory of Victoria' as part of the 'Victorian Water Quality Monitoring Network', and data on stream flow, dissolved oxygen, turbidity, type of human impact affecting the catchment upstream of a particular site, as well as some data on nutrients, were available. Logistic regression was used to investigate the relationship between the distribution of the snail and these environmental factors. It was found that *P. antipodarum* was most likely to be present at sites that were affected by more than one type of human impact, such as agricultural and urban runoff. Other environmental factors, such as conductivity, temperature and calcium content of the water, were found to be relatively less significant in explaining the distribution of *P. antipodarum* in southern Victoria.

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Whangamarino peat bogs: does drainage make a difference?

At Whangamarino Wetland, two adjacent bogs, separated by low hills of Island Block Road and bounded by rivers at the opposite extremities, were sampled along north-south trending transects. Distinct changes were apparent in the state of the peat, pH, [conductivity?], water table levels and vegetation patterns, some of which may be related to lowering of water tables in the surrounding area. Both bogs there is a zone of degraded peat with increasing pH levels towards the river margin, for up to nearly 1 km. These rivers have been lowered by up to 1 m over the past 30 years and the breakdown of peat may be related to the lowered water table. Another influence on the northern transect may be introduction of nutrients in groundwater from the causeway that has been built adjacent to the river.

In Island Block North, the northern part (up to 900 m from the causeway and 1100 m from the river) has depressed ground water levels, raised pH and degraded peat in the top 0.25m. In addition this area has *Baumea* sedge-dominated vegetation, indicative of higher nutrient status than the *Empodisma minus*-dominated southern part of the transect.

In the southern transect both margins display higher pH, relatively high peat degradation in the top 0.25 m, and relatively tall vegetation containing high proportions of manuka (*Leptospermum scoparium*) and sedge (mainly *Baumea* species). This character extends about 300 m into the northern side of the transect and up to 900 m from the southern side, adjacent to the river). In contrast, the centre of the bog has lower pH, less degraded peat and *Empodisma*-dominated vegetation with occurrences of *Epacris pauciflora* indicating lower nutrient status.

SHEAT JJ, HARMAN HM AND SYRETT P. Manaaki Whenua Landcare Research, PO Box 69, Lincoln.

The broom seed beetle, *Bruchidius villosus*, in New Zealand

Broom (*Cytisus scoparius*) is a leguminous shrub weed native to Europe that already occupies extensive areas of New Zealand and has the potential to invade much further. A seed-feeding beetle, *Bruchidius villosus*, has been introduced to reduce its rate of spread. Two factors have been identified as critical to successful rearing of beetles: synchrony of beetle reproductive development with flowering and pod production of broom, and achieving high rates of adult emergence from seeds. The efficiency of rearing methods was increased 4-fold by allowing beetles to emerge from seeds while these were still in the pods. Broom seed beetles have been released at 41 sites, and have established at 7 so far. Twenty five of the sites have not yet been assessed for beetle establishment. At one site that has been sampled regularly beetle numbers are increasing, from an infestation rate of seeds of 5% in 1994/95 to 20% in 1995/96. Parasitism was low (0.5%) in 1994/95. Four species of hymenopteran parasitoid has been recorded: *Pteromalus sequester*, *Macroneura vesicularis*, *Dibrachys ?cavus*, and *Trichomalopsis* sp. Studies on the survival of broom seed in the soil, the fate of fallen seed, and seedling survival are in progress to assist in determining the impact of *B. villosus* on broom populations.

SMALE M AND MCLEOD M. Manaaki Whenua Landcare Research, Private Bag 3127, Hamilton, New Zealand.

Rates of vegetation and soil recovery on landslide scars on soft sedimentary rock, east cape, North Island.

Primary successions on landslide scars on mudstone were modelled using slips of different ages in extensively grazed pasture north of Gisborne. Teatree - mostly kanuka (*Kunzea ericoides*) with some manuka (*Leptospermum scoparium*) - is the dominant vegetation everywhere. Teatree stands on slips develop along similar lines to those on intact pasture, growing just as quickly. A range of adventive pasture plants colonises the slips along with teatree and persists until the canopy closes at 10-15 years. Twigg coprosma (*Coprosma rhamnoides*) begins establishing in the first 10 years and persists for at least 70 years. Native hook-sedges (*Uncinia* spp.) and meadow rice grass (*Microlaena stipoides*) establish from about 20 years, and native ferns such as ponga (*Cyathea dealbata*) from about 30 years. Although all the slips are close to patches of pre-European forest, seedlings of tall tree species are very rare in teatree stands on slips, probably being eliminated by grazing. Soil develops more quickly on soft mudstone than on harder sandstone, the depth increasing rapidly for the first 20 years before slowing down.

SVAVARSDÓTTIR K AND PALMER JG. Department of Plant Science, PO Box 84, Lincoln University, Canterbury, New Zealand.

When has a plant species completed its invasion?

The invasion of *Hieracium* species into the native tussock grasslands of New Zealand was investigated using the patterns of *Hieracium pilosella* and *H. praealtum* in the Ashburton Lakes area as a case study. The specific objectives of this paper are to compare the distributions of *Hieracium pilosella* and *H. praealtum*, and to relate the differences in distributions to stages of invasion.

Species cover was assessed, site variables recorded, and soil cores analysed for nutrients. The distribution of *Hieracium* species was related to environmental variables using a stepwise-regression. The final model for *Hieracium pilosella* consisted of total phosphorus in the soil ($r^2=0.24$; $p<0.01$) and elevation ($r^2=0.07$; $p<0.05$). The species cover was lowest at the highest elevation and it increased as soil phosphorus increased. Soil phosphorus was the only contributor to the final model of *Hieracium praealtum* ($r^2=0.07$; $p<0.05$), and the response showed the same pattern as for *H. pilosella*.

A vegetation survey had also been carried out in the area by Henry Connor in the 1960s. Although the current survey did not revisit Connor's original sites, a qualitative comparison gives an indication of changes in distribution of these species in the area over time. The frequency distribution of cover classes was used in the comparison. Both species occurred infrequently and at low abundance in the 1960s. Thirty years later the distribution patterns of these species were very different. *Hieracium pilosella* had become common and its abundance showed a log-normal distribution with the peak at 5-25% cover. On the other hand *Hieracium praealtum* had not changed its distribution pattern. These differences can be related to different stages of invasion these species are at.

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The psyllid *Arytainilla spartiophila* for biological control of broom in New Zealand.

Arytainilla spartiophila is one of two psyllid species and a complex of other specialised insects that feed on broom (*Cytisus scoparius*) in Europe. This psyllid has only a single generation a year, but frequently attains sufficiently high populations to cause substantial damage to broom plants in spring and early summer. Experimental tests and field records have demonstrated that it is highly specific to broom, and does not develop on other plants. Psyllids were first released in New Zealand for biological control of broom in 1993, and are established at Lincoln. Under a nationwide cooperative programme with Regional Councils and other organisations, in 1994 1000 psyllids were released at each of four sites, and psyllids have been recovered from two of these sites so far. Releases were made at a further 16 sites in 1995 and the fate of these has yet to be determined. Experimental releases have been made in Otago to test how many psyllids are necessary for establishment. For releases of 270 individuals, psyllids were recovered the following year from 80% of releases. Psyllids have been recovered the following year from a release of only two individuals. When our experimental predictions have been tested more widely, we may modify our recommendations on the numbers of individual insects to release at a site, thus improving the efficiency of our release programme.

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Sodium monofluoroacetate (1080) bait-shyness in a wild brushtail possum (*Trichosurus vulpecula*) population.

Bait-shyness was investigated in wild possums by comparing the consumption of diced carrot with consumption of non-toxic cereal bait before and after the population was poisoned with the same cereal bait containing 0.04% sodium monofluoroacetate (1080). Before poisoning, 64% of the total bait consumed was cereal, whereas after poisoning cereal bait consumption declined to 3-4%. To determine whether any individual component of the cereal bait cues possum avoidance, the consumption of plain cereal bait, cereal bait with green dye, and cereal bait with cinnamon lure were also measured. Possums remained shy of the cereal bait even when the dye and lure were absent. Ways to overcome bait-shyness are discussed in light of these new findings.

TOWNSEND CR. Department of Zoology, University of Otago, PO Box 56, Dunedin, New Zealand.

Invasion biology of brown trout in streams of southern New Zealand.

Brown trout were introduced to New Zealand in 1867. Successful establishment was broadly predictable in terms both of the characteristics of brown trout and of the receiving community. There is evidence of impacts of brown trout on the abundance of some native fish and invertebrates, and brown trout have been responsible for the local extinction and fragmentation of certain species. An intensive study of the Taieri River has revealed that several native galaxiid fishes are now restricted to headwaters above large waterfalls that prevent the upstream migration of brown trout. Brown trout may profoundly affect the functioning of stream communities, reducing the abundance of grazing invertebrates and altering their grazing behaviour so that algal biomass increases. A trophic cascade was predictable on the basis of the attributes of the invader and of the stream community. Brown trout seem to have been responsible for the evolution among invertebrates of novel anti-predator behaviours with far-reaching community consequences. The ecological and evolutionary consequences of the introduction of brown trout to New Zealand are probably reversible.

WEARING A. Department of Geography, University of Otago, PO Box 56, Dunedin, New Zealand.

Vegetation composition, landscape position and change in semi-arid shrublands in Central Otago.

The relationships between landscape position and vegetation, and possible trajectories for change, were investigated in some kanuka (*Kunzea ericoides*) dominated tall shrublands in semi-arid pastoral lands on the lower slopes of the north-western Dunstan mountains, Central Otago. The prime study area was a small catchment near a permanently marked 20 X 10 metre quadrat established in 1963, and resurveyed in 1968 and 1994. All woody and tussock plants rooted inside the quadrat were listed and mapped. Vegetation changes within the quadrat are reported and possible consequences assessed. How far beyond the quadrat these conclusions apply is considered with respect to floristic composition, vegetation patterns and landforms adjacent to the quadrat, and in the adjoining catchment. Even allowing for the small pool of indigenous species, the pace and trajectories of vegetation change are likely to be variable and patchy in nature, reflecting a complex interplay of topography, aspect, moisture and site accessibility to species, which are then subsumed in land management practices. It is argued that the small size and scattered distributions of many native plant populations in the modified low rainfall environments of Central Otago can be best assessed by an approach based on physiographic derived units.

WEBSTER R, JENSEN C AND CARTER D. Knight Frank (NZ) Ltd, 76 Cashel Street, Christchurch, New Zealand.

Vegetation changes, with particular emphasis on *Hieracium* species, after a decade of retirement from grazing. Results from a selection of sites in Marlborough, Canterbury, and Otago.

Vegetation changes were investigated on 42 permanent transects in the South Island high country, established between 10 and 13 years ago. All sites were in retirement areas controlled by the Department of Conservation, and most had a prior history of sheep grazing and tussock burning. Sites ranged in altitude from 650 to 1870 metres above sea level and encompassed a gradient of vegetation communities from modified lower altitude short tussock grassland to tall tussock grassland and, at the highest sites, alpine herb and cushion communities. Despite the altitudinal and geographic range, some common trends were observed which could be regarded as indicative of a slight and very gradual recovery under reduced grazing pressure. Bare ground tended to decline slightly on most sites, and tall tussock *Chionochloa* species generally increased slightly. Short tussock species *F. novae-zelandiae* and *Poa colensoi* showed a decline on most transects. Many herbs, both native and exotic, declined, including a notable decline in the exotic flatweed *Hypochoeris radicata*. The only exotic species to increase significantly were *Hieracium pilosella* and *Hieracium lepidulum* which increased in occurrence on virtually all sites on which they were found. Any predictive models for *Hieracium* based on management gradients must allow for the advance of the species under retirement recovery conditions.

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Study on rodent monitoring efficiency.

Eradication of rodent species on some offshore islands have been proved to be an effective means of saving native animal and restoring native ecology. A correct estimate of which species are present and relative density of rodent species is essential for a successful eradication programme. Are the conventional methods the best? This study trialed different ways of monitoring rodents. The experiment, which has been conducted on Browns Island from June to July 1995, included variations in trap lay out, trap covers and baits.

Two species of rodents, *Rattus norvegicus* and *Mus musculus* have been known to be present on the island. Two different trapping designs, conventional trapping lines and trapping grids, were carried out in June and July respectively. The traps were set for 10 nights for trapping lines and 8 nights for the grids. The corrected trapping rates are 9.03% rat and 0 mouse for trapping line, 5.25% rat and 0.2% mouse for trapping grids. Although trap lines have been used in most studies, trapping grids proved to be the better method to detect the presence of rodent species when two species coexist and one is subordinate to the other. The highest trapping rate appears after the third day: the sixth day for trapping. Therefore, three-day trapping, conventionally used by most researchers, is not enough for testing the density of Norway rats.

Of five different baits tested for monitoring rodents after the eradication, chocolate; cheese; soap; wax and oiled wood were preferred in that order by Norway rat. The efficiency of covers made of different materials, tin, plastic and wire netting was tested also. The wire netting cover had highest trapping rate and tin cover had lowest ($F=5.57$, $p=0.009$, $df=2.27$). However, wire netting covers have the highest possibility of catching birds.

WELLS A, DUNCAN R AND STEWART GH. Department of Plant Science, Lincoln University, PO Box 84, Lincoln, Canterbury, New Zealand.

Evidence of Synchronous, Catastrophic Disturbances in Westland.

The temporal occurrence of disturbance in Westland conifer forests was investigated to look for evidence of synchronous catastrophic disturbances. The dates of establishment of 64 published stands of conifer tree species that regenerated following disturbance were determined from tree-population age structures or an estimation of the age of the oldest tree in a population from age-diameter relationships; these dates were assumed to approximate the time of stand-initiating disturbances. Disturbance history was also determined at a local scale for Welcome Flat, Copland valley. A major region-wide peak in stand establishment occurred at 250-350 years ago, resulting from catastrophic flooding, landslipping and treefall. During this time over 40 % of all conifer trees aged in Westland established. The timing of this peak period of disturbance corresponds with major rockfall activity along the Southern Alps and with fault movement; this provides compelling evidence of forest establishment following a massive earthquake in the early part of the period. Further peaks in regional disturbance were found at 200-250, 400-450 and 500-600 years ago, and are best attributed to periods of increased storminess. Disturbance history at Welcome Flat was similar to the regional pattern. The recognition of these synchronous catastrophic disturbances in the recent past is fundamental to understanding forest pattern in Westland.

WEST CJ. Department of Conservation, PO Box 743, Invercargill, New Zealand.

Management of invasive plants - issues and time frames: a case study of Raoul Island, Kermadecs.

The weed eradication programme on Raoul Island provides clear illustration of the time it takes to eradicate different plant species, the types of effort that are required and the methods which might be employed. The biology of each plant species varies but three critical features must be considered: propagule longevity, dispersal mechanism and time to first flowering and/or propagule production.

Time: the Raoul Island eradication programme which originally targeted 10 species has been running for 20 years. Currently 17 species are listed for eradication and the programme is predicted to run for at least another 20 years.

Effort: For all species the effort is initially aimed at knocking back obvious populations. The second phase of dealing with a species involves searching for individuals or small groups of plants and destroying them. The third phase is surveillance and destruction of any individuals found. In each phase plants are located then destroyed but the amount of effort expended in searching increases with each phase whereas the effort of destruction decreases.

Methods: In the first phase of eradication, many methods are employed and on Raoul application of herbicide from helicopters and from the ground using individual knapsacks and a motorised unit have been used. Some areas of Mysore thorn were burnt to kill the plants present and hasten germination from the seed bank. Herbicide prills are also used. In the second and third phases most plants are hand pulled or prilled.

To date, on Raoul, only one species is identified as having been eradicated: a single plant of ragwort which was pulled out before it flowered! This species is still under surveillance.

WHITMORE A AND HURYN A. Department of Zoology, University of Otago, PO Box 56, Dunedin, New Zealand.

Production and longevity of the freshwater crayfish, *Paranephrops zealandicus* in a lowland bush stream.

Production and longevity were assessed for a population of crayfish *Paranephrops zealandicus* in Powder Creek, a headwater stream draining a catchment of regenerating coniferous-broadleaf forest within Otago. Annual production was derived from size-specific growth rates, population structure and biomass density. Longevity was estimated with an iterative bootstrap model based on annual growth increments. Three reaches of stream were sampled, each reach consisted of a single pool and 20m riffle. Growth rates were obtained by monitoring 1440 individually tagged crayfish between January 1994 and June 1995. Crayfish density was estimated by depletion runs in pools, and quadrat sampling in riffles. Crayfish occurred at relatively high densities (3-4 individuals m^{-2} in riffles and 4-13 individuals m^{-2} in pools). Production was high (up to 11 g AFDW $m^{-2}y^{-1}$) because of high biomass rather than high rates of growth and population turnover. Production was greater in pool sections than riffles. Individual crayfish were found to be slow growing and long lived in comparison to other crayfish species. Crayfish of 16+ years were not uncommon. Female crayfish were not reproductively active until 5+ years. Recruitment of juveniles was low. Fewer than 4% of all females carried eggs, and the young remained attached to the female for a minimum period of 14 months. The effect of this large, stable population on the benthic community is currently being investigated experimentally.

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A risk assessment model for screening plant imports into New Zealand.

Weeds are a major cost to agriculture, forestry, and the environment. The Biosecurity Act requires that all plants proposed to be brought into New Zealand, that are not prohibited entry and which are not already here, must be evaluated for their potential weediness. This requires an objective, credible, relatively quick, and publicly acceptable risk assessment system to screen large numbers of potential new entries. A computer based weed risk assessment system was developed in Australia that uses a scoring system to assign each prospective import into one of three numerical classes which are then converted to a recommendation. 1) Accept: the plant is allowed in, 2) Reject: the plant is not allowed in, 3) Evaluate: more information is required either to re-run the model, or from such methods as field trials, before a decision can be made. The model also has some capacity to detect which sector is likely to be effected.

The questions on which the model is based are in three main sections: Biogeography, Undesirable traits, and Biology and Ecology. These were modified to suit New Zealand conditions. The model was tested on some 200 plant species presently in New Zealand, which were scored as if they had not yet arrived in the country. To verify the model, 11 people in various occupations were asked to rank the species for weediness on a three point scale: major weed, minor weed, and non-weed. The ranks were averaged and the species assigned to the three classes. These averaged rank scores were compared with the scores from the model. Virtually all plants (98 %) ranked as major weeds were rejected, including all species currently classed as Noxious Plants in New Zealand, and the majority of minor weeds were either rejected (65 %) or required further evaluation (27 %). Most (64 %) non-weeds were accepted.

The variance for the weediness scores from the respondents was high, which was to be expected and related largely to perceived usefulness. In contrast, a major benefit of the weed risk assessment system is that it is unbiased as to potential usefulness. It has potential for use in New Zealand in combination with other systems for evaluating weediness and undertaking cost benefit analysis.

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How well do VHF radios and satellites track Westland petrels.

During recent decades Westland petrels (*Procellaria westlandica*) have increased in numbers, presumably due to their use of offal discarded from fishing vessels. In order to determine how much time petrels spent foraging near fishing vessels we tracked birds using VHF radios and satellites. VHF radio tracking was logistically demanding but clear signals were obtained and plotting positions by triangulation was straightforward. However, the birds mostly foraged beyond our 100km range.

In 1995 we trialed the new generation NANO satellite transmitters on Westland petrels. The petrels were less mobile than albatrosses for which satellite tracking is a well established technique. The smaller distances travelled and the petrels 'circular' tracks within a small area of ocean posed unexpected problems of data interpretation.

The ARGOS satellite tracking system provides data in seven accuracy categories, four of known accuracy, <1>km, and three where accuracy is not estimated. We present our data in three ways and discuss the strengths and weaknesses of each in meeting the objectives of our study. Satellite tracking is a high tech, gee-whiz method that can instantly produce computer generated maps that intrigue media and ecologists alike. These sensational maps present some fundamental problems of interpretation. We suggest that the interpretation difficulties we experienced are probably similar to those future users will face as even smaller transmitters are used on less mobile animals.

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Community structure and invasibility of species poor *Nothofagus* forest by a perennial herb over 25 years.

Community structure, dispersal limitation, disturbance, and site characteristics can influence invasion of habitats by exotic plant species. We examined these factors in relation to invasion of South Island mountain beech forest by an exotic perennial herb, *Hieracium lepidulum*. *H. lepidulum* occurred on 11%, 43% and 57% of 250 randomly located permanent plots (400 m²) in 1970, 1985 and 1994 respectively. In 1970, *H. lepidulum* was more common on plots near the forest margin with tussock grasslands, but this relationship disappeared later in the invasion. The occurrence of *H. lepidulum* in 1985 and 1994 was greater on plots showing a marked decline in forest biomass between 1970-1985, but was unrelated to more recent biomass change. In 1994, *H. lepidulum* was also more common on plots having high soil fertility (exchangeable cations, total N), partly reflecting a feedback between soil fertility and canopy disturbance. In all years, *H. lepidulum* occurrence was greater on plots and subplots (0.75 m²) with a high proportion of species in the *H. lepidulum* guild and relatively greater species richness. This contradicts suggestions that species-poor sites are most easily invaded. We show that 1) the ability to predict *H. lepidulum* occurrence increased over time, 2) *H. lepidulum* frequency in subplots was strongly related to the length of time present on plots, and 3) that, in any given year, community structure parameters (species richness and proportion of species in the *H. lepidulum* guild) accounted for considerable variation unrelated to the other measured factors. This invasion of species rich stands, within relatively species poor forests, is somewhat counter-intuitive, yet supports the view that the greater diversity of microsites and more rapid species turnover of species rich habitats enhances their invasibility.

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Dynamics of invertebrate predator movement between cropped and uncropped farmland ecosystems.

The move towards integrated farming systems, with their greater reliance on natural processes, will benefit from a better understanding of how beneficial organisms use, or are impeded by landscape features. Vegetated and relatively undisturbed field boundaries, for instance, can harbour a community of potentially beneficial arthropods. However, unless these animals' dynamics leads to their periodic or seasonal invasion of the adjacent crop, their actual role in biological control of pests may be limited.

The dispersal process itself may, however, be impeded by landscape features and even relatively strongly-flying insects may be restricted by hedges, shelterbelts etc.

This paper will review some recent experimental work (including time-lapse video analysis) in New Zealand and Norway, covering invertebrate groups such as harvestmen (Opiliones), hoverflies (Syrphidae), spiders and ground beetles (Carabidae). The extent to which the field margin is a dynamic source, a 'static' refuge or an impediment in the landscape dynamics of these and other groups will be explored.