New Zealand Ecological Society

Annual Conference

Blenheim, New Zealand
29 June – 2 July 1999

PROGRAMME & ABSTRACTS

Compiled and edited by Alan B. Rose
Landcare Research
Blenheim

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Hosted by:

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Student Conference:

Ben Reddiex (Lincoln University)

Registration and Finances:

Alan Rose and Cherryl Fitzgerald

Field Trip Coordinators:

Alan Rose, Mike Harding, Richard Hunter, Cathy Jones, David Butler

TUESDAY, 29 JUNE

0830 REGISTRATION, BLENHEIM COUNTRY LODGE FOYER

Contributed papers:

1030 ☺Grant Blackwell: Calibration of ship rat trapping and non-lethal indexing.
1050 ☺Craig Morley: Using acoustically sensitive transmitter systems on elusive species.
1110 ☺Josh Kemp: Nest predation and adult female survivorship in kea.

1130 OFFICIAL OPENING

1200 Lunch

SYMPOSIUM: "SUSTAINING TUSSOCK GRASSLANDS FOR CONSERVATION AND PRODUCTION"

1300 Amy Austin: Visions of the Patagonian steppe: ecology and management.
1330 Alan Mark: The history of New Zealand's tussock grasslands.
1400 Mike Dodd: What makes a grassland? North American perspectives.
1425 Colin Meurk: Biodiversity and conservation management of tussock grasslands.
1450 Colin Boswell: Nutrient cycling in tussock grasslands.

1515: Tea break

1530 Richard Duncan: Models for understanding *Hieracium* invasion.
1555 Chris Frampton: Methods for analysing long term vegetation changes.
1620 John Parkes: Rabbits, RHD, and the future.
1645 Bruce Allan: The role of pastoral farming in the tussock grasslands.
1710 Ockie Bosch: Integrating research and management.

1830 POSTER SESSION AND TASTE MARLBOROUGH

WEDNESDAY, 30 JUNE

Contributed papers:

0830 Roger Gibson: Long term changes of soil and vegetation induced by pastoralism.
0850 Bob Webster: Declining species richness in tussock grasslands.
0910 David Scott: Fertiliser rejuvenation of fescue tussock
0930 John Hunt: Fluxes of CO_2, water and energy from a tussock grassland.
0950 ☺James Griffiths: Katipo abundance and distribution in duneland.

1010 Tea break

SYMPOSIUM: "MAINLAND ISLANDS IN THEORY AND PRACTICE"

1025 Alan Saunders: Towards an ecosystem focus for conservation management.
1050 John Innes: Adaptive management and the kokako project.
1120 Rosemary Barraclough: Performance measures for mainland restoration.
1145 Peter Bellingham: Ecosystem change: can we restore mainland communities?

1210 Lunch

1310 David Choquenot and Clare Veltman: How many mainland islands?
1335 John Craig: Whither mainland conservation in New Zealand?

Contributed papers:

1400 Nod Kay: Macroecology: island rats.
1420 Bruce Burns: Gap and non-gap understorey responses to reducing a goat population.
1440 Charles Eason: Toxicokinetics of anticoagulant rodenticides for mainland islands.

1500 Tea break

1515 Sam Ferreia: The likely outcome of ecosystem-based restoration programs.
1535 Mary McIntyre: Interim effects of ecological change on Mana Island.
1555 Chris Ward: Mainland islands - an east coast Hawke's Bay perspective.
1615 Brenda Greene: Alternative strategies for mainland islands.
1635 David Kelly: Pollen and dispersal limitation in *Fuchsia excorticata.*
1655 Richard Maloney: Black stilts increase following releases of captive-reared birds**.**
1715 Mark Sanders: Quantifying causes of mortality at nests of braided river birds.

1800 AGM

1930 Annual Dinner

FRIDAY, 2 JULY

Contributed papers:

0830 ☺Julia Davey: Are native Lepidoptera protected by Protected Natural Areas?
0850 ☺Margaret Stanley: Avian frugivory in an Australian eucalypt woodland.
0910 ☺Adrian de Groot: Regional and environmental variation in peatland communities.
0930 ☺Clayson Howell: Moa myths: photoinhibition in New Zealand's divaricate shrubs.
0950 ☺Souzi McGill: Use of the gall fly to suppress Californian thistle in pea crops.

1010 Tea break

1025 ☺Matthew Prebble: Phytolith analysis as a paleoecological tool in the Taieri Basin.
1045 ☺Wendy Sullivan: Minimising burrow competition between prions and petrels.
1105 ☺Deborah Wilson: How much does predation affect lemming population dynamics?
1125 Claire Newell: Regional variation in forest species richness patterns.
1145 Murray Efford: Modelling the fate of west coast beech forests.

1205 Lunch

1305 Mathew Vujcich: The evolution of Wenderholm Regional Park.
1325 Dianne Brunton: Artificial nestbox use by North Island saddleback.
1345 Craig Miller: Home range of stoats in podocarp forest.
1405 David Kelly: Role of weather and El Niño-southern oscillation in mast seeding.
1425 Harald Steen: Effects of climate fluctuations on blue penguin breeding.

1505 Finish and tea break

Abstracts

✉ denotes a poster presentation.
☺ denotes a student paper or poster.

Bruce Allan. Wattie Bush, Peel Forest, RD 22, Geraldine. (watibush@voyager.co.nz).
THE ROLE OF PASTORAL FARMING IN THE TUSSOCK GRASSLANDS

Even in their natural state the tussock grasslands were varied and dynamic. Despite man's influence the present state remains so, although large areas are ecologically depleted and threatened. Pastoral farming still dominates land use but pressure for more 'conservation areas', particularly through tenure review, is increasing. Farming impact is now better understood. Detrimental effects of overstocking, use of inappropriate types of stock, inflexible stock polices, and grazing too soon after burning are recognised. Beneficial effects of fertiliser and selected seed input, controlled mob grazing, and pro-active decision making have also been identified. We now have some practical management options to fight *Hieracium*. The benefits of RCD introduction are undeniable. The ideal would achieve ecological goals (eg - maintenance of soils, tussocks, forests, biodiversity), as well as financial (eg - viable enterprises), and social wellbeing (eg - sustainable communities). The land will be under 'viable stewardship' - that is a mix of enterprises including pastoral farming that, through control, meet identified resource protection and other public expectations. Pastoral farming will still dominate, but practices must continue to respond to market forces (eg - diversification and amalgamations), and better understanding. Plans for resource protection must be fair, practical and workable, and there should be more use of alternatives such as QEII covenants and community initiatives. Effective monitoring is essential.

Amy T. Austin, Osvaldo E. Sala, Martín R. Aguiar, y José M. Paruelo. University of Buenos Aires, Department of Ecology and IFEVA, Buenos Aires, Argentina.
VISIONS OF THE PATAGONIAN STEPPE: ECOLOGY AND MANAGEMENT OF GRASSLANDS IN ARGENTINA

The Patagonian region of southern Argentina and Chile encompasses an area of over 600,000 km^2 in temperate South America. The climate pattern is dominated by constant winds from the Pacific that drop abundant rainfall on the western side of the Andean mountain chain and result in progressively drier conditions approaching the eastern coastline. Rainfall is asynchronous with growing season, with maximum precipitation occurring in fall and winter. The tussock grassland steppe is a dominant ecosystem in much of the region. One of the most striking aspects of the ecology of this system is the intrinsic heterogeneity seen at many levels of study. The marked spatial heterogeneity of vegetative cover is seen in a patchy distribution of shrubs and grasses, with consequent variation in soil texture, organic matter, and nutrient content. In addition, there is vertical heterogeneity in the use of limiting water resources due to a difference in root distribution of shrubs and grasses, and resulting in differential water-use efficiency. The combination of seasonal variation in rainfall and of the differential response of the two functional types constrains the primary production of the steppe. Sound management of these grasslands requires an understanding of the various aspects of heterogeneity present at multiple scales.

Rosemary K. Barraclough. School of Environmental and Marine Sciences, University of Auckland, Private Bag 92019, Auckland. (rk.barraclough@auckland.ac.nz)

PERFORMANCE MEASURES FOR MAINLAND RESTORATION

The selection of methods by which to monitor the performance of a mainland restoration project can only be effectively made if the goals and objectives of the project have been clearly defined. This requires a clear appraisal of the limits to our knowledge regarding the outcomes of mainland restoration work, and the subsequent creation of short-term and long-term objectives. Furthermore, the reason for monitoring has to be clarified before an effective monitoring strategy can be constructed. Of course, within this strategy choices also have to be made based upon cost-effectiveness, practicality, suitability and, overall, one has to be realistic regarding the scope and quality of the information that is able to be collected. The above issues will be briefly discussed and illustrated with the examples of specific sampling techniques and applications. There will also be some focus on how distance-sampling techniques could fulfil these criteria and their potential application in mainland restoration monitoring.

Bellingham, P.J.[1]; Wardle, D.A [1].; Allen, R.B.[1]; Barker G.M.[2];Yeates, G.W.[3]
Landcare Research, [1] Lincoln, [2] Hamilton, [3] Palmerston North.

ECOSYSTEM CHANGE: CAN WE RESTORE MAINLAND COMMUNITIES TO INITIAL CONDITIONS?

Using current research as case studies, we will address whether it is possible to define "initial conditions" in dynamic ecosystems. We will then address whether the consequences of changes in ecosystems brought about by humans are understood sufficiently, let alone able to be reversed. What is known about changes in indigenous ecosystems is often over-simplified because there is insufficient knowledge to build a complete picture, or too short a period of time to disentangle agents of change. Because components of some ecosystems are long-lived (e.g. forest trees) we do not know what are the consequences of various life-history processes that may have been disrupted for many centuries (e.g., dispersal limitation or seed predation). While effects of some introduced biota are known to be detrimental, in most systems their roles are poorly understood and need to be evaluated before setting restoration targets. Finally where whole ecosystem studies have been conducted, we argue that the effects of human-induced change are often idiosyncratic rather than predictable, so simple models for what will be the consequences of attempting to reverse change will not necessarily yield expected results. We plead for recognition of complexity in ecosystem function when setting restoration goals.

☺Blackwell, G. L. Ecology Group, Institute of Natural Resources, Massey University.

CALIBRATION OF SHIP RAT TRAPPING AND NON-LETHAL INDEXING METHODS: DO THEY TELL THE SAME STORY?

Footprint tracking tunnels are a widely used rodent indexing technique in New Zealand. They are assumed to bear a linear relationship with true density, and accurately reflect changes in animal numbers. Following the recommendation of Brown *et al* (1996), I investigated the relationship between kill-trapping and footprint tracking tunnel indices on both an intensive trapping grid, and along a trap-line through the same habitat. On the 17 ha trapping grid, 121 rats were caught over five nights of trapping, giving an estimated density of 8.2 rats ha $^{-1}$. A linear regression of footprint tracking rate against rats remaining on the grid explained 86 % of the variation. On the trapping line, the regression of the trapping rate against rats caught in a trapping period was significant, and explained 57 % of the variance, but the relationship between footprint tracking rate and rat captures was not significant. I propose several explanations for the lack of correlation between the density indices calculated from the trapping line, and suggest that the relationships between density estimates of small mammals in New Zealand should be investigated more closely.

Bosch, O.J.H[1]; Allan B.[2].; Allen, W.J.[1;] Boswell, C.[3]; Saggar, S[4]; Parkes J.[5]
[1]Landcare Research, Alexandra; [2] Peel Forest, 22 RD, Geraldine; [3]AgResearch, Invermay;
[4]Landcare Research, Palmerston North; [5] Landcare Research, Lincoln.

INTEGRATING RESEARCH AND MANAGEMENT IN THE TUSSOCK GRASSLANDS

Sustaining solutions to the environmental and economic challenges in New Zealand's tussock grasslands requires that the many stakeholders participate in a decision-making process to (a) develop a better understanding of different points of view, (b) take ownership of outcomes, and (c) see these implemented. Good decision making when stakeholders have different (and sometimes conflicting) views depends on the availability of sound supporting information, and on careful management of the process. These conditions apply equally to gathering information and developing the systems for managing it as they do to the decision making itself. Ongoing research by scientists forms an important source of new information, but land managers and policy makers involved in the day-to-day implementation and evaluation of management strategies or policies, can also serve as an extremely valuable source of information. Bringing these two groups together to share information enables science and management to be more closely linked. This paper describes how the creation of a collaborative learning environment is helping researchers and end-users of research in the tussock grasslands to work more closely together in our quest for more sustainable land-use.

C.C. Boswell. AgResearch, Invermay Agricultural Centre, Private Bag, Mosgiel.
NUTRIENT CYCLING IN TUSSOCK GRASSLANDS

Tussock grasslands are complex ecosystems. They occupy terrain that is infinitely variable with respect to altitude, slope, aspect, soil cover, and its vegetative cover. Nutrient cycling calculations for the tussock grasslands are difficult. They have to take account of pulses of nutrient inputs; of nutrient uptakes affected by hugely variable annual rainfalls; different periods of accumulation of nutrients in standing tussock and litter pools; different utilisations of vegetation by grazing animals; and various losses from the system. Thus they have to account for seasonal variabilities affecting cycling at the ecosystem scale. But they also have to take account of variabilities within local parts of the ecosystem. For example, the variability in natural inputs of nitrogen through fixation by micro-organisms is dependent in the distribution of plant/s with which the organisms are associated, and their frequency. Tussock grasslands are mostly grazed extensively by sheep and in drier regions have historically been plagued by rabbits. Animals are the agents of uneven cycling of nutrients within tussock grasslands. They are agents of net nutrient removal from hillsides and net accumulation at stock camps. The current joint Landcare/Agresearch South Island High Country research programme should provide the information to develop a model nitrogen cycle in dry tussock grassland.

✉Helen Braithwaite and Susan Timmins. Science & Research, Department of Conservation, PO Box 10-420, Wellington. (hbraithwaite@doc.govt.nz, stimmins@doc.govt.nz).
WEED SURVEILLANCE - HOW TO DO IT?

At the New Zealand Department of Conservation we are developing a weed surveillance plan to facilitate the early detection of invasive weeds of conservation concern. Early detection improves the chances of achieving effective control for least cost and minimises the impact of new weed incursions on conservation values. Certain places will warrant special attention; it is important to catch weeds as early as possible in valuable sites before the biodiversity values are damaged. In contrast, weeds are more likely to turn up in areas vulnerable to weed invasion. Weed surveillance should also focus on particular species, including species that are a problem elsewhere. In addition, it is crucial to be alert for any new, unexpected species; these unidentified intruders are harder to find because the observers do not have the benefit of a search image. The Surveillance Plan will accommodate both planned surveillance and fortuitous observations made while people are engaged in other activities. Currently there is no active surveillance system and casual observations are often not captured, for lack of a system. Weed sightings need to be processed to verify the observation and to decide on the appropriate action. Surveillance facilitates early intervention and thus minimises biodiversity loss.

Dianne Brunton and Rosalie Stamp. Ecology, Evolution & Biostatistics, School of Biological Sciences, University of Auckland.

ARTIFICIAL NESTBOX USE BY NORTH ISLAND SADDLEBACK

The provision of nestboxes is a commonly used management tool when dealing with the conservation of secondary cavity nesting birds. Saddlebacks are cavity nesters and nest in holes and clefts in pohutukawa, hollow trunks, ponga crowns, flax bushes and even in the leaf litter. When saddleback were first released on Tiritiri Matangi Island in 1984, the island was predominantly regenerating bush. Consequently there was a shortage of natural cavities, so nestboxes were attached to trees in the different bush patches over the island. This current study examines three aspects of nestbox use: a) preference for different nestbox designs, b) breeding success as a predictor of future nestbox use, and c) the impacts of ectoparasites. The results of this study suggest that saddleback nestboxes on Tiritiri Matangi are more likely to be used if the opening faces north, they have a volume of between 0.005 and 0.01 m^3, and if the height of the opening is between 140 and 160 mm. Two species of skin mites were discovered; the fowl mite and an new species. We found that mites have little if no effect on saddleback breeding success. Mite number was not correlated with fledgling number or chick weight at 10-12 days.

Bruce Burns[1]; Peter Sweetapple[2]; John Parkes[2]. Landcare Research, [1]Private Bag 3127, Hamilton, [2]P.O. Box 69, Lincoln.

GAP AND NON-GAP UNDERSTOREY RESPONSES TO REDUCING A GOAT POPULATION TO RARITY IN A NORTH ISLAND INDIGENOUS FOREST

Feral goats are regarded as serious pests of forests because they eliminate or reduce certain understorey plants and curtail regeneration of canopy trees. The impacts of goats within treefall gaps may be critical to forest health as these are key regeneration sites for many trees and attract disproportionately high goat use. Within indigenous forest at Tawarau, North Island, we compared understorey dynamics over 4 years in gap and non-gap plots. Both plot types were located within areas with undisturbed goat populations (G), areas where goats were almost eliminated by hunting (H), exclosures (E), and an area where goats had been maintained at low levels for ten years (LTH). Over all plots, the density of large (> 30 cm tall) woody seedlings was on average three times higher in gaps compared to non-gaps. In G areas, numbers and heights of large seedlings remained static or decreased over the monitoring period regardless of plot type. However, in H, E and LTH areas, many more large seedlings were recruited, and those already present grew substantially faster, in gaps than in non-gaps. This suggests that goat influence on forest structure and composition can be concentrated within gaps and has implications for monitoring and management.

✉D. Butler; D. Peters; N. Etheridge; M. Maitland; G. Taylor. Department of Conservation, Private Bag, St Arnaud Area Office

INITIAL RESULTS FROM THE ROTOITI NATURE RECOVERY PROJECT: ST ARNAUD'S HONEYDEW BEECH MAINLAND ISLAND

The Rotoiti Nature Recovery Project was established in 1996 with the aim of restoring a typical piece of beech forest containing honeydew through integrated pest control. Initial control programmes have focussed on possums, rodents, mustelids and common wasps. Extensive monitoring of populations of these pests and of native species expected to benefit from their control has been carried out in the treatment area, 825 hectares on the slopes of the St Arnaud Range, and two nearby non-treatment areas. Results are presented showing effective ongoing control of possums; two seasons of increasingly successful summer wasp control; and increased mustelid and rodent activity in response to beech seeding. Enhanced productivity has been demonstrated for kaka and robins, vegetation responses are becoming evident and the honeydew supply for native fauna has been increased.

✉Dianne Carter, Bob Webster, and Carol Jensen. Knight Frank (NZ) Ltd, Land Resources Division, PO Box 142 Christchurch.

WITHER HILLS VEGETATION MONITORING PROGRAMME

The Wither Hills Farm, owned by the Marlborough District Council, covers 1046 ha on the north facing hill slopes behind Blenheim township. The Council's primary objectives for managing the property are to minimise soil erosion, downstream siltation, and flooding of Blenheim township. The Council leases the farm for grazing, promoting recreational values and sustainable pastoral production in accordance with the primary soil and water conservation objectives. This poster describes the vegetation monitoring programme undertaken by Knight Frank (NZ) Ltd, Land Resources Division, which samples the vegetation cover and composition in each of the property's four catchments or blocks to determine whether the management objectives are being achieved. Vegetation cover is primarily Danthonia grasses (*Rytidosperma* spp.), annual clovers, and annual grasses. Since 1993, vegetation cover has been well maintained at near 100% cover in the three catchments upstream of the township. The fourth catchment has poorer vegetation cover, and alternative management strategies may be more suitable for parts of this block.

David Choquenot[1] and Clare Veltman[2]. [1]Landcare Research, P.O. Box 69, Lincoln; [2]Science & Research Unit, Department of Conservation, P.O. Box 10-420, Wellington.

HOW MANY MAINLAND ISLANDS: MANAGEMENT OR EXPERIMENT?

A collection of reserves like mainland islands is not a large-scale management experiment. It is simply a large management experience. Whereas a traditional experiment is comparative in nature, the existing mainland island programme, at best, compares each site against itself over time. We will explain the difference between large-scale experiments and large-scale management done experimentally. We will show these are not incompatible. The same tools used to predict ecosystem responses to management are used to predict experimental responses to treatment, i.e. replication and controls. What managers do can elicit changes over at least two and usually three trophic levels. Ecological theory is playing catch-up with many of these situations, and empirical research lags behind theory. The Kluane experiment (Krebs et al. 1995) is perhaps the most probing exploration of how trophic interaction shapes vertebrate communities. We will review the results of that large-scale experiment from the perspective of science, management and conservation results to illustrate what could be done in New Zealand.

John Craig[1] and David Norton[2]. [1]School of Environmental and Marine Sciences, University of Auckland; [2]Conservation Research Group, School of Forestry, University of Canterbury.

WHITHER MAINLAND CONSERVATION IN NEW ZEALAND?

While the conservation of indigenous biodiversity is easier on islands than on the mainland, especially with respect to managing introduced species, islands cannot protect all of New Zealand's indigenous biodiversity. Mainland conservation is therefore an essential component of New Zealand's conservation efforts. Many mainland sites are also more accessible than islands to the public and therefore provide much better opportunities for public involvement in conservation. Mainland islands have been advocated as a key tool in restoring mainland ecosystems and some are located in areas with high public use. However, selection of sites for mainland islands has been largely ad-hoc with little systematic consideration given to either ecological or social values. We suggest that mainland islands have the potential to be a key component in New Zealand mainland conservation, both for restoring our ailing indigenous biodiversity and as sites for active public participation in conservation. However, to approach this, decisions on which of the full range of ecosystem types present in New Zealand, including aquatic systems, as well as what degree of public use, from high usage to those that are relatively remote, need to be made. Additional issues such as the priorities for action and the degree of co-management also require debate.

☺Julia Davey. Plant and Microbial Sciences, University of Canterbury, Private Bag 4800, Christchurch.

ARE NATIVE SPECIES OF LEPIDOPTERA PROTECTED BY THE PROTECTED NATURAL AREAS PROGRAMME?

Are areas identified as worthy of protection by vegetation features also beneficial to insect conservation? It is often assumed that areas of high native plant diversity have correspondingly high native animal diversity, and that native-dominated vegetation contains more native animal species than modified, exotic-dominated vegetation. The Protected Natural Areas Programme contains these assumptions as it identifies areas of high conservation value (Recommended Areas for Protection, or RAPs) primarily by vegetation and landform features. I examined these assumptions in relation to native moths. Sampling sites were chosen in shrub/grassland vegetation at six RAPs in Cass Ecological District. At each site moth and vegetation samples were taken in native-dominated and exotic-dominated vegetation, inside and outside of the RAPs. No significant differences were found in moth species richness between the four site categories, despite significantly higher native plant species richness in the native-dominated category. Time of year, wind speed and night light levels had the strongest effect on moth species composition. Vegetation around the trapping site and location relative to RAP boundaries had little, if any, effect. The RAP sites include 78% of all moth species found but this is not significantly different from that included in the outside sites.

☺Adrian J. de Groot and J. Bastow Wilson. Botany Department, University of Otago, Dunedin.

REGIONAL VARIATION IN PEATLAND PLANT COMMUNITIES AND ITS RELATIONSHIP TO ENVIRONMENTAL GRADIENTS IN SOUTH-EASTERN, SOUTH ISLAND, NEW ZEALAND

South-eastern New Zealand has a wide variety of different peatland types. These peatlands were studied to determine whether the differences were in response to regional environmental gradients, particularly peatland water chemistry. Relationships between vegetation and water chemistry are well documented in Northern Hemisphere where water chemistry is often used to distinguish between bog and fen types. New Zealand has many unique peat-forming plant species but the peatland vegetation/environment relationship has rarely been studied in New Zealand. This study found that the distinctly different plant communities on different peatlands in south-eastern South Island can be characterised by environmental parameters. Peatlands with *Empodisma minus*, a plant of west coast pakihi that is also found in coastal Otago, are different from other peatlands in the region in having deeper peat, and higher sodium levels. Among the other peatlands, cushion bogs have a lower pH and calcium levels, and higher magnesium levels than Sphagnum-dominated peatlands, indicating less groundwater influence. Inland peatlands tend to have more humified peat than more coastal peatlands, perhaps indicating a slower peat accumulation rate.

[1]M.B. Dodd and [2]W.K. Lauenroth. [1]AgResearch Grasslands, Ruakura Research Centre, Private Bag 3123, Hamilton; [2]Department of Rangeland Ecosystem Science, Colorado State University, Fort Collins, CO 80523, USA.

WHAT MAKES A GRASSLAND? NORTH AMERICAN PERSPECTIVES ON THE SUSTAINABILITY OF NATURAL GRASSLANDS

When posing questions about the sustainability of New Zealand grassland systems, useful lessons may be learned from examining the structure and function of large-scale, evolutionarily stable natural grasslands overseas. The varied grassland ecosystems of North America provide a useful study resource because of the mosaic of grassland types that interact with influential environmental variables - climatic, edaphic, botanic and anthropogenic. Historically, most examinations of the stability of grassland systems have focussed on climatic variables, and there is no doubt that these are of great significance. However, non-climatic factors are also significant influences on ecosystem structure, and more recent studies have considered the importance of soil texture, alien species invasions, fire suppression and grazing management. In the shortgrass steppe of the western Great Plains, the climatic and edaphic conditions have produced vegetation structured in such a way that the replacement of bison with cattle as the dominant grazer does not appear to have affected ecosystem stability. By contrast, changes in fire regimes are leading to woody species invasions in the tallgrass prairie, overgrazing is altering the structure of the southwestern desert grasslands, and species invasions are threatening the sagebrush steppe. The increasing evidence of the effects of climate change indicate that it has the potential to alter the current state of grassland ecosystems, although some claims to this effect that have already been made are probably premature.

Richard Duncan[1] and Alan Rose[2]. [1]Ecology and Entomology Group, P.O. Box 84, Lincoln University, Canterbury. [2]Landcare Research, Private Bag 1007, Blenheim.

MODELS FOR UNDERSTANDING *HIERACIUM* INVASION

Hieracium species (hawkweeds) are unevenly distributed throughout grasslands of the dry eastern ranges of South Island. Understanding why some areas are particularly prone to infestation by hawkweeds, while other areas are less so, is central to managing the problems associated with hawkweed spread. Traditional explanations for the uneven distribution of hawkweeds have emphasised: (1) differences in the ecology of the *Hieracium* species, (2) spatial variation in environmental conditions, and (3) spatial variation in past management, particularly variation in grazing, burning and fertilising history. Nevertheless, these factors have proved inadequate as explanations for the observed patterns; variation in *Hieracium* species abundance rarely shows consistent relationships with particular management or environmental variables. We suggest these inconsistencies arise from a failure to consider three additional factors: (1) vegetation structure, which appears to be a key factor influencing susceptibility to hawkweed infestation, (2) variation in the rate at which hawkweed propagules arrive at sites (propagule availability), and (3) interactions between factors, which are likely to account for many of the apparently contradictory relationships between *Hieracium* species abundance and management or environmental variables. We present examples illustrating the importance of each of these factors and their interactions, to show that they need to be incorporated in any comprehensive model that attempts to explain the patterns of hawkweed spread in South Island grasslands.

C.T.Eason[1] and E. Murphy[2]. [1]CENTOX (Centre for Environmental Toxicology) Landcare Research, P.O. Box 69, Lincoln; [2]Department of Conservation, Private Bag, Christchurch.

TOXICOKINETICS OF ANTICOAGULANT RODENTICIDES, IMPLICATION, AND SAFER PRODUCTS FOR MAINLAND ISLANDS

There are a large number of anticoagulant toxicants. Potency is linked to receptor binding in the liver and it is unfortunate that the most potent second-generation anticoagulant rodenticides are also the most persistent, with elimination half-lives in the liver of 3.5 to 5 months. One of the most potent of these compounds, brodifacoum, has found increasing favour for sustained rodent and possum control and mainland New Zealand. Concurrent with the increased field use of brodifacoum, secondary poisoning, and contamination of a range of wildlife from native birds (including kiwi) and game species, have been reported. Use of an alternative second-generation anticoagulant rodenticide (e.g., bromadiolone, difethialone, or flocoumafen) or some of the first-generation anticoagulants, e.g., diphacinone) would not significantly reduce the risks of secondary poisoning or wildlife contamination. Only warfarin and pindone are comparatively rapidly excreted (i.e., cleared from the liver in 2–5 weeks), but are considerably less potent. Coumatetralyl has greater potency and has a half-life in the liver of 55 days, and is probably less persistent than diphacinone. Novel strategies for mainland islands are needed for making greater use of fast-acting non-anticoagulant toxicants (e.g., cholecalciferol) integrated with anticoagulant rodenticides with relatively short retention in the liver, and the use of traps, to reduce wildlife contamination and the development of resistance to anticoagulants.

✉C.T. Eason[1]; C. Bailey[1]; E. Murphy[2]. [1]CENTOX (Centre for Environmental Toxicology), Landcare Research, P.O. Box 69, Lincoln; [2]Department of Conservation, Private Bag, Christchurch.

NON-INVASIVE METHODS FOR ASSESSING EXPOSURE AND DETERMINATION OF ANTICOAGULANT EFFECTS

During the last 12 to 18 months there has been an increasing detection of brodifacoum residue in a range of target and non-target wildlife species. Linked to this is the concern with regard to untoward effects on non-target wildlife and the generation of anticoagulant resistance. Currently we are establishing blood clotting methods from measuring the changes induced by exposure to anticoagulants on small blood samples (20 µl – 100 µl). We are evaluating the duration of anticoagulant effects in rats following single and repeat exposure to brodifacoum, and developing protocols for resistance monitoring in rats, and exposure in bird species through non-invasive blood sampling and monitoring for changes in blood clotting. Current methods for measuring exposure of wildlife involve analyses of liver samples for brodifacoum.

✉Rachel Ebbett. TerraForma, P.O. Box 3395, Richmond, Nelson.

SUCCESS AND FAILURE OF COMMUNITY ECOLOGICAL PROJECTS

TerraForma is an ecological consultancy service in the Tasman and Waiheke Island areas. Services range from integrated landscape design to native forest management and revegetation. Two recent community initiated projects are presented - one considered a success, one a failure. Both involve the community and local Council, and primarily involve Council land. Weed control in the Graham Valley, Motueka is a project involving the formation of a Trust body to administer funds. After several public meetings, and a questionnaire showing 75% support for the scheme, this project has stalled due to a small but vocal community opposition. Reasons for opposition include mistrust of the instigators' motivations and resentment of Council involvement. A streamside restoration project involved a popular Waiheke Island Beach Reserve in an area where the Local Council already has plans for development. This project aims to restore the streamside environment and re-establish a colony of pingao. A "Beach Care" group will plant trees this winter and monitor the pingao colony. Pingao seeds are being collected for propagation and a revegetation plan has been produced. This project is considered a success due to a high level of community environmentalism and strong Council support.

✉D.C. Eckery; W. Ng Chie; L.E. Colbourne; D.A. Heath; S.B. Lawrence; S. Lun; L.J. Whale; E.G. Thompson[1]; P.M. Mahoney[1]; J. Wen [1]; J.L. Juengel; A.E. Fidler; L.G. Moore; B.J. McLeod[1]; K.P. McNatty. AgResearch, Wallaceville Animal Research Centre, Upper Hutt, New Zealand; [1]AgResearch, Invermay, Mosgiel, New Zealand.

THE POSSUM RESEARCH PROGRAMME OF THE WALLACEVILLE AGRESEARCH REPRODUCTIVE BIOLOGY GROUP

Possums are vectors of bovine tuberculosis and predators of nesting native birds, and they cause destruction of native vegetation. Research aimed at disrupting reproduction in possums has been undertaken by government agencies and universities to provide long term solutions for the control of possum populations. The Possum Research Programme of the Reproductive Physiology Group at Wallaceville Animal Research Centre has its focus in two areas: fertility control and survival of pouch young. More recently we have expanded our programme to include the development of controlled breeding strategies and systems of delivery. Although basic research remains an integral part of our research programme, several potential targets for biocontrol have now been identified and we have begun developing and testing these reagents. Some reagents developed for the control of possums could be adapted for mustelid fertility control in the future.

Murray Efford. Landcare Research, Private Bag 1930, Dunedin

MODELLING THE FATE OF WEST COAST BEECH FORESTS

This paper considers the long-term prospects for West Coast *Nothofagus fusca* forests subjected to low intensity logging. The largest trees in these forests are over 400 years old, and most of the wood volume is in trees over 200 years old. The plan for logging asserts that a timber harvest of 1-2 trees/ha/year may be taken in perpetuity without appreciable long-term change in the existing old-growth character of the forest. The validity of the claim rests on a tree demographic model which has been shown to be inadequate (Efford 1999 J Roy Soc NZ 29(2) in press). An improved model with both density-dependent recruitment and density-dependent radial growth rates is presented. It shows that the present size structure will change over time under the proposed regime, with the progressive loss of large trees. While the volume yield of timber may be sustained from the smaller size classes that increase in abundance, the old-growth character of the forest will be lost. The only possibility for retaining the status quo structure under wood harvesting would seem to be in restricting logging to the salvage of dead trees. These results emphasise the critical role of modelling when assessing the likely outcomes from competing scenarios for population management.

Sam Ferreira. Department of Conservation, Auckland Conservancy, PO Box 68908, Newton, Auckland.

DIVERGENCE WITHIN CONVERGENCE: A CASE STUDY ON THE LIKELY OUTCOME OF ECOSYSTEM-BASED RESTORATION PROGRAMS.

Ecosystem-based restoration will be most successfully achieved by minimising undesirable disturbances and initiating/mimicking ecological succession. An obvious limitation is understanding succession itself. However, describing and therefore understanding succession is difficult primarily as a result of the time period involved in successional changes. Ecologists have, as a result, often resorted to describing differences in simultaneously available stands of different age (chronosequence), and relating these to ecological succession. This approach is constrained by the underlying assumption of chronosequence which simply states that younger stands should converge to older stands in a similar fashion. I use tree-, millipede-, small mammal - and bird community data collected on stands of rehabilitating coastal dune forests in South Africa to evaluate this assumption. The results illustrate a divergent trajectory of succession during early successional stages, followed by convergent patterns of later stages on mature stands of forest. I conclude that ecosystem-based restoration programs may appear unsuccessful at early stages as a result of divergent patterns within convergent patterns during successional development.

Chris M. Frampton. Cenre for Computing and Biometrics, P.O. Box 84, Lincoln University.
METHODS FOR ANALYSING LONG-TERM VEGETATION CHANGES

There are many different statistical and mathematical models available to analyse temporal vegetation data. Key elements in determining the appropriate technique for a specific scenario include: the spatial and temporal arrangement of the sampled units, the type of data collected, and the key objective(s) of the research. In this talk I will outline the readily available analysis approaches including Repeated Measures ANOVA, Markov processes, non-parametric hypothesis testing, and ordination, and their assumptions. I will show how each technique is specifically appropriate to different scenarios with varying objectives.

Roger Gibson[1]; Allan Hewitt[2]; Graham Sparling[3]; Ockert Bosch[1]
Landcare Research, [1]Alexandra, [2]Dunedin and [3]Hamilton. (Gibsonrs@landcare.cri.nz).
LONG TERM CHANGES OF SOIL AND VEGETATION INDUCED BY PASTORALISM IN CENTRAL OTAGO TUSSOCK GRASSLANDS.

Soil properties and grassland composition were sampled in the Ida Valley. Sites were chosen to minimise the effects of environmental variation, while maximising differences in vegetation and soils as a consequence of long term (100+ years) pastoralism (e.g either side of fence lines). Gradient analysis was used to order the sites and the principal gradient was identified by correlation with site factors and management information. Dense red tussock was present where long term grazing intensities had been lowest and *Hieracium pilosella* was dominant where such intensities had been highest. Mixed short tussock and adventive grasses occupied intermediate positions. All soils were classified as Brown soils. Labile soil carbon (hot water extraction), total porosity, and macro porosity and water (by volume) were lowest and bulk density was highest where long term grazing intensities had been highest. Soil Na and N (anaerobic N) decreased with higher intensity grazing, although the pattern for N was not consistent. We conclude that *Hieracium pilosella* domination was not a direct result of current grazing intensities. Rather, invasion was faster and more complete into vegetation that had been previously induced under high grazing intensities. Long term high grazing intensities led to loss of desirable soil properties, however it should be noted that a reversal of this trend has been reported under *Hieracium pilosella*.

Brenda Greene. Auckland Regional Council, 21 Pitt Street, Auckland.

ALTERNATIVE STRATEGIES FOR MAINLAND ISLANDS

In 1992 Auckland's first mainland island at Wenderholm Regional Park was established. In 1994, five 20 ha kokako territories within 20 000 ha of forest within the Hunua Ranges marked the start of a mainland island project which now covers 500 ha. Rats, possums and goats were targeted. In 1998, 4 female kokako from Mapara were transferred to the area. Another mainland island is proposed at Tawharanui, covering 600 ha. Possums and mustelids will be targeted. The different approaches of each of the mainland islands are compared and contrasted, and fitted into a wider strategic vision of stepping stones from the Hauraki Gulf Islands onto the mainland.

☺James Griffiths. Ecology & Entomology Group, Soil, Plant & Biological Sciences Division, P.O. Box 84, Lincoln University, Canterbury. (Griffith@tui.lincoln.ac.nz).

KATIPO ABUNDANCE AND DISTRIBUTION AT KAITORETE SPIT AND PEGASUS BAY

Katipo (*Latrodectus katipo*) abundance has declined in some areas. The cause of this decline is poorly understood. I investigated the presence and absence of katipo at 18 randomly selected plots (50 m x 100 m) spaced as evenly as practicable, between Kaitorete Spit and the northern end of Pegasus Bay (≈ 100 km excluding banks peninsula). At each site wind, temperature, slope, aspect, habitat type, relative lay, habitat density, substrate type and substrate fluidity were sampled along 6 transects (50 m long) spaced at intervals parallel to the hightide mark. The presence/absence of katipo and other spider genera were recorded. Chi-square tests revealed significant differences in the wind, slope, aspect, habitat type, relative lay, habitat density, and substrate fluidity between sites where katipo were present and sites where they were absent. Preliminary findings show most katipo were found in sparse to medium habitat densities in marram on the upper section of steeply sloping sand dunes (20-35^{o}) that face north-east to west. Dune vegetation and structure has changed markedly on the New Zealand coast within the last 100 years. Results of this study suggest this change may affect katipo presence/absence.

☺Clayson Howell, Dave Kelly and Matthew Turnbull. Department of Plant and Microbial Sciences, University of Canterbury. (c.howell@botn.canterbury.ac.nz).

SHEDDING NEW LIGHT ON OLD MOA MYTHS: PHOTOINHIBITION IN NEW ZEALAND'S DIVARICATE SHRUBS

Divaricate shrubs are a characteristic and abundant feature of New Zealand's flora. There is debate over whether climate (frost protection) or moa browsing is responsible for the convergent evolution of the divaricate form. Here, cold induced photoinhibition of photosynthetic carbon fixation is discussed, as the primary factor for this uniquely New Zealand feature. Chlorophyll fluorescence has been used to measure photochemical efficiency (dark-adapted Fv/Fm), in three species (*Aristotelia fruticosa*; *Coprosma propinqua* and *Corokia cotoneaster*) at a sub-alpine site at Cass. Photochemical efficiency of internal leaves exposed to the North dropped 22-30% within 14 days, while leaves exposed but artificially shaded and control leaves showed no reduction. These measurements, in conjunction with gas exchange measurements, seem to indicate severe photoinhibition in exposed treatments, despite a comparatively mild winter. The network of interlacing branches thus position leaves within the volume of the shrub where partial shading provides net benefits, particularly under chilling temperatures. These findings strongly support the climate hypothesis and provide a mechanism that has applicability under a wide range of ecological conditions, most of which have been common since the early Pleistocene. Morphological features of the chosen species allow limited comparisons with other divaricate shrubs and divaricate juvenile stages.

J.E. Hunt; F.M Kelliher; J.N. Byers; T.M. McSeveny. Landcare Research, P.O. Box 69, Lincoln.

FLUXES OF CO_2, WATER AND ENERGY FROM A TUSSOCK GRASSLAND DURING A DRYING CYCLE

Measurements were made to quantify the role of climate in the dynamic fluxes of carbon dioxide (CO_2), water vapour and energy between a tussock/hieracium grassland and the atmosphere. We present data from near Twizel, starting from the last frost in October 1998 until a major rainfall event in January 1999. During this 84 day period only 47.5 mm of rainfall fell. The ecosystem was a carbon sink at the beginning of the study period, taking up 5.0 g m^{-2} d^{-1} but as the soil dried it became a carbon source releasing 2.4 g m^{-2} d^{-1}. These are a about 1/3 of the rates reported from US prairie ecosystems. The change over from source to sink occurred at day 351. With a small rainfall event (5 mm) the ecosystem reverted to a carbon sink for a short period. A shift in energy partitioning was reflected in the Bowen ratio (sensible heat/latent heat) changing from 0.3 to 9.0. Bare ground and dry soils increased the soil heat flux and soil surface temperatures. A low shoot : root ratio makes the soil a major component of ecosystem carbon balance. Changes in management or environmental factors that affect the soil environment may have a large effect on the annual carbon balance.

John Innes[1], Ian Flux[2], Philip Bradfield[3]. [1]Landcare Research, P. Bag 3127, Hamilton; [2]Dept Conservation, P.O. Box 10-420, Wellington; [3]Dept Conservation, P.O. Box 38, Te Kuiti.

ADAPTIVE MANAGEMENT AND THE KOKAKO PROJECT

Under adaptive management, alternative models or hypotheses about how natural systems work are tested using routine management as an experimental manipulation. The models are then refined and tested again. Pest mammal control for kokako recovery has been undertaken in such a framework (then called 'research-by-management'; RbM) since 1989. This approach enabled researchers and managers to investigate the cause of kokako decline and to increase populations simultaneously. An 8-year trial concluded that predation was a more immediate cause of current declines than competition, and that ship rats and possums were key pests. It also identified pest control targets at which kokako populations should recover. Ongoing research and management ('post-RbM') is mainly exploring options for sustaining kokako management, focusing on pulsed pest control. Adaptive management projects can be difficult to co-ordinate and interpret, but we suggest that they are the best or only option for answering some key questions in New Zealand ecosystem management.

M. Kay. Forest Research, Private Bag 3020, Rotorua.

MACROECOLOGY: ISLAND RATS

New Zealand's island biota is unique. It has a high level of endemism and many unique features reflecting its long isolation and depauperate fauna. Demographic studies of the flora are moving towards evolutionary explanations for component communities. Although the principles of immigration and extinction on islands have been repeatedly confirmed no comprehensive predictive theory of invasive ecology has emerged. Most predictions rely on statistical probabilities to estimate how many species will arrive, establish, or perish. All else being equal those organisms most likely to arrive will be *r*-selected generalists and most will arrive without their regulatory 'predators'. Resource Allocation Theories (RATs) predict trade-offs between reproductive, growth and defence strategies for both plants and animals. For plants, resource allocation to defence of reproductive and growth tissue is considered to affect many morphological and chemical characters. Although islands are considered inherently invasible it is postulated that without 'top-down' regulation of herbivores by 'predators' plants will allocate resources for a 'bottom-up' deterrence. Evidence presented here suggest that the dominant elements of the New Zealand endemic flora will be resistant to invading invertebrates because as island plants they have evolved defences to combat resident and immigrant invertebrates in the absence of complex trophic webs.

Dave Kelly[1], Jenny Ladley[1], Alastair Robertson[2], Paul Peterson[3], and Merilyn Merrett[4].
[1]PAMS, University of Canterbury, Private Bag 4800, Christchurch; [2]Ecology, Massey University, Private Bag 11222, Palmerston North; [3]Landcare Research, P.O. Box 11008, Palmerston North; [4]Landcare Research, Private Bag, Hamilton.

POLLEN AND DISPERSAL LIMITATION IN *FUCHSIA EXCORTICATA* ON THE NZ MAINLAND

Conservation of ecosystems requires that interactions such as mutualisms are maintained. Recent work suggests that reduced densities of bird pollinators and dispersers may be negatively affecting reproduction in some native plants. Here we describe pollination experiments on *Fuchsia excorticata*, tree fuchsia, in 1998/99 at 6 mainland sites. Fuchsia is gynodioecious and self-compatible, and pollinated by bellbirds and tui when these birds are present. Female flowers bagged to exclude all pollinators never produced fruits. Bagged hermaphrodite flowers gave low fruit set (0-32%). Hand pollination with cross or self pollen gave high to very high fruit set (56-96%) except at Ruahine (31%). The difference in fruit set between hand pollinated flowers and naturally pollinated flowers accessible to birds gives an index of the adequacy of the pollination mutualism. Natural pollination varied from excellent (Mokoia Island, Nelson Lakes, Opepe), through moderately reduced (Banks Peninsula, Ohakune) to poor (Ruahine). Female plants were much more susceptible to failure of natural pollination than hermaphrodites, which may self-pollinate. Dispersal was also only partly effective. Overall, low bird densities on the mainland are limiting reproduction in fuchsia in some areas, as has been previously shown for *Peraxilla*.

Dave Kelly[1], Eric M. Schauber[2,3], Peter Turchin[2], Chris Simon[2], William G. Lee[4], Robert B. Allen[5], Ian J. Payton[5], Peter R. Wilson[5], Phil E. Cowan[6], and R. E. Brockie[7]
[1]Plant and Microbial Sciences, University of Canterbury, Christchurch, NZ.; [2]Department of Ecology and Evolutionary Biology, University of Connecticut, Storrs, Connecticut, USA; [3]Institute of Ecosystem Studies, Millbrook, New York, USA; [4]Landcare Research, Private Bag 1930, Dunedin, NZ; [5]Landcare Research, P.O. Box 69, Lincoln, NZ; [6]Landcare Research, Private Bag 11052, Palmerston North, NZ; [7]Biological Sciences, Victoria University, P.O. Box 600, Wellington, NZ.

MULTI-TAXON SYNCHRONY BY NEW ZEALAND MAST SEEDING PLANTS: ROLE OF WEATHER AND EL NIÑO-SOUTHERN OSCILLATION.

Masting (the synchronous fluctuation between years in seed production by members of a plant population) can also be synchronised within and among genera across continental spatial scales. Here, we demonstrate high intra- and intergeneric synchrony in masting across >150,000 km^2 by 16 species of New Zealand plants from four families (*Chionochloa*, Poaceae; *Nothofagus*, Fagaceae; *Phormium*, Phormiaceae, and *Elaeocarpus*, Elaeocarpaceae). Fruiting by the synchronised species was associated with high temperatures the summer before seedfall. Such temperature anomalies are consistent across New Zealand during the La Niña phase of the El Niño-Southern Oscillation. In the one species unsynchronised with the others, *Dacrydium cupressinum*, fruiting was correlated with low temperatures two summers before seedfall. Models of temperature-driven masting produced simulated time series with a similar pattern of cross-correlation to the observed pattern. Interspecific masting synchrony may be adaptive if species share seed predators. However, this selective factor does not explain the multi-taxon synchrony in New Zealand; we conclude that it is the nonadaptive result of a shared environmental cue linked to the Southern Oscillation. Global climate change may alter this cue, with negative effects on communities where masting is important.

☺Josh Kemp[1] and Graeme P Elliott[2] . [1]Department of Zoology, University of Otago, P.O. Box 56, Dunedin; [2]549 Rocks Road, Nelson.

NEST PREDATION AND ADULT FEMALE SURVIVORSHIP IN KEA (*NESTOR NOTABILIS*), 1993 -1999

To gauge the extent to which predators threaten kea (*Nestor notabilis*) population viability, we studied kea nest survival and adult female survival in southern-beech (*Nothofagus spp.*) forest in Nelson Lakes National Park, from 1993 to 1999. The nest survival rate was high (67%, n = 39) compared to 10% for kaka (*Nestor meridionalis*) in similar habitat (Wilson *et al.* 1998, n = 20). We investigate relationships between nest survival, nest site characteristics and landscape processes. We conclude that the low nest predation rate is likely to result from 1) breeding in early spring (before stoat numbers rise in January) and 2) often nesting at high altitude and/or in steep places. We found no evidence of nest predators killing adult females, but the sample size was small. Our results agree with a previous study at Arthur's Pass (Jackson 1963). We believe that these results can be legitimately extrapolated to most kea habitat and conclude that kea are less threatened by introduced predators than New Zealand's other hole-nesters. We recommend that low-key monitoring of adult female survival occurs in the future.

Richard Maloney and Dave Murray. Department of Conservation, Private Bag, Twizel.

BLACK STILT NUMBERS INCREASE FOLLOWING SUCCESSFUL RELEASES OF CAPTIVE-REARED BIRDS

Through intensive wild management and captive-breeding imminent extinction of black stilts has been prevented, but numbers remain low. There are now 40 wild and 20 captive adults. Pair formation is limited by low recruitment of wild chicks (6% survive to breeding age). From 1993, to circumvent wild chick mortality, eggs were captive-reared for release. By 1999, 160 sub-adults (9 months old) and 10 juveniles (3 months) had been released using three methods. (1) soft-released = released near the site where they were raised (N = 88), (2) hard-released = transported to a new site and immediately released (56), (3) hard+suppl+iodine. = given iodine before release to prevent goitre, hard released, then given supplementary food for 4 weeks post-release (16). Overall, 20 – 45 % of hard and soft-released sub-adults survived to breeding age. Most deaths were in the first 50 days after release. In comparison, sub-adults and juveniles released using hard+suppl+iodine had high initial survival (no losses of 6 sub-adults and 10 juveniles in the 50 days following release). Causes and timing of mortality, and survival, movements and likelihood of breeding by captive-reared and released birds are compared to wild-raised juveniles. Benefits and risks associated with the release programme are discussed.

Alan Mark. Botany Department, University of Otago, Dunedin.

THE HISTORY OF NEW ZEALAND'S TUSSOCK GRASSLANDS: EVOLUTION AND MANAGEMENT

Information is reviewed from the time grasses first appeared in New Zealand's fossil record, in the Eocene, to the present. Grassland became widespread in the late Tertiary, as a result of the Kaikoura Orogeny and associated climatic deterioration, and was most extensive during the late Otiran Glacial. Contracting through the Holocene, it was restricted by 2500 yr BP largely to the alpine zone and the interior basins of the South Island. Grassland expanded 2500-1500 yr ago through natural fires at 500-2000 yr intervals in the drier areas of the South Island and locally in the North Island, and again largely waned until fires lit by the first Polynesians increased about ten-fold. Grassland thus expanded rapidly in the South Island rainshadow region about 700 yr ago and periodic, perhaps accidental, fires maintained them until European settlement.

Initiated in the 1860's, pastoral farming began with an "eruptive phase" of heavy grazing by mammalian stock, a new phenomenon, plus frequent uncontrolled burning that adversely impacted on the grassland ecosystems. From an early concern for the pastoral practices of burning and grazing (Buchanan 1865), there have been frequent reiterations by scientists and others, up to the present, all to little avail in terms of condition and trend of the less responsive tussocklands. These concerns will be briefly outlined: 1910 (AH Cockayne; Commission on Canterbury Pastoral Runs Classification); 1912 (Petrie); 1919 (L Cockayne); 1920 (Commission to Report on the Southern Pastoral Runs); 1922 (Thomson): 1938 (Zotov); 1940 (Sheep-farming Industry Commission); 1945 (Gibbs & Raeside; Cumberland; Royal Commission to Inquire and Report on the Sheep-farming Industry in New Zealand); 1954 (Tussock Grasslands Research Committee); 1956 (L Moore). The last two were largely instrumental in initiating a series of overdue autecological studies of the dominant species which clarified the important distinction between tolerances to the separate practices of burning (several positive effects revealed) and grazing (generally detrimental), plus the two combined (usually highly detrimental) (O'Connor & Powell 1963; Mark 1965a b c, 1968; Payton & Brasch 1978; Payton & Mark 1979; Payton et al. 1986).

The degrading effects of pastoral management continued to receive attention (Wraight, 1963; Connor 1964,1965; Scott 1979; O'Connor 1981,1982; O'Connor & Harris 1991; McKendry & O'Connor 1990; Basher et al. 1990; Treskonova 1991, 1992; Mark 1994; Floate at al. 1994), culminating with the "South Island High Country Review" for the Ministers of Conservation, Agriculture and Environment, which confirmed the generally deteriorated condition of the rangelands (Martin 1994).

Legislative responses: the 1941 Soil Conservation and Rivers Control Act established catchment boards which arranged subsidised assistance for lessees to implement run conservation plans; the 1948 amendment to the Land Act gave pastoral lessees greater security of tenure; the 1991 Resource Management Act aims to promote sustainable management of natural and physical resources; the 1998 Crown Pastoral Lands Act facilitates lessees freeholding "productive" land while allowing land with high conservation/recreation values to revert to Crown ownership/management. It also allows some discretion by the Crown in relation to conservation values on pastoral land. The effectiveness of this legislation will be discussed.

Souzi McGill[1], Richard Harris[2], and Eric Scott[1]. [1]Entomology & Ecology Group, Soil, Plant & Ecological Sciences Division, Lincoln University. [2]Landcare Research, Private Bag 6, Nelson.

USE OF THE GALL FLY, *UROPHORA CARDUI,* FOR SUPPRESSION OF CALIFORNIAN THISTLE FLOWERING IN PEA CROPS

Californian thistle is a pest to the organic pea industry because flower buds may be accidentally harvested and are difficult to remove during processing. The Californian thistle gall fly *(Urophora cardui* L.), a biological control agent introduced from Europe, is capable of suppressing thistle flowering, but its effectiveness in pea crops has, to date, not been investigated. To prevent flowering, galls need to form in the terminal region of the thistle stem, which requires attack of young stems. We investigated factors relating to augmentative releases of the fly in patches of young thistles in pea crops. Factors included release intensity, dispersal from the release site, and food requirements for adult flies. The flies don't require supplementary food and they remain in the crop when released. Laboratory testing showed that between 0.09 and 0.8 pairs/stem could produce galls on most stems, and that one pair of flies could produce up to 21 galls. However, field results showed flies produced fewer galls, and the number of flies required to achieve adequate control is nearer 2.5 pairs/stem. This equates to over 27 000 pairs for some fields, and is not practical because it would require considerably more effort than conventional methods of control.

M. McIntyre[1] and F. Kell[2]. [1]School of Biological Sciences, Victoria University; [2]Box 41072 Eastbourne.

SOME INTERIM EFFECTS OF ECOLOGICAL CHANGE ON MANA ISLAND

The monitoring of vegetation, lizards (*Oligosoma nigriplantare, O. zealandicum)* and ground weta *(Hemiandrus bilobatus)* at two sites in an old grassland community on Mana Island highlights some interim effects of community change associated with ecological restoration. Succession in the grass species, and temporary overbundance of grassland lizards and both types of weta date from the removal of cattle (large grazers) in 1986 and mice (small seed and insect eaters) in 1989. Ngaio (*Myoporum laetum*) planted as 20 cm seedlings at one site has reached about 12% cover but does not yet have detectable influence on the animal species. The data were accumulated mainly by graduate students as part of a class project begun in 1994. Data for giant weta (*Deinacrida rugosa)* from a third site in mixed scrub and grassland date from 1991.

Colin D Meurk. Landcare Research, PO Box 69, Lincoln 8152. (meurkc@landcare.cri.nz)

BIODIVERSITY AND CONSERVATION MANAGEMENT OF NEW ZEALAND TUSSOCK GRASSLANDS

Tussock grasslands in New Zealand encompass herbaceous vegetation actually or potentially dominated by graminoid tall, short or bunch tussocks. Natural, steady state grasslands occur above timberline and on lowland shallow or toxic soils. Natural seral and induced, secondary grasslands are now ubiquitous and are largely dominated by exotic plants. Grassland patterns may be understood in terms of the balance between stress and disturbance regimes. Stress imposes limits on potential vegetation structure and composition, whereas frequency and severity of disturbance dictates the seral status of the vegetation within the stress-defined constraints. Conservation of the natural attributes of New Zealand grasslands is complicated by the introduction of many continentally evolved species that are better adapted than indigenous species to human-induced disturbances. But successional grasslands, even with a high exotic load, have conservation value. They may be the only places where some native species demonstrate their ecological limits. Conservation management must therefore balance or regulate stress (although irrigation, fertiliser and shelter will generally be detrimental to indigenous species), disturbance (fire, grazing, weeding, soil stripping), and control of exotic species, and be integrated with production. All grassland reserves should be large enough (>75 ha) to accommodate a range of management treatments that cumulatively sustain the natural attributes of the ecosystem. Conservation of any ecosystem must be carried out at a landscape scale. This means temporal stages within the spatial complex (the full Clementsian sere) are preserved. Multiple conservation and production benefits may come from managing grassland environments towards their natural woodland condition.

Craig Miller. Department of Conservation, Private Bag 701, Hokitika. (cmiller@doc.govt.nz).

HOME RANGE OF STOATS IN PODOCARP FOREST: IMPLICATIONS FOR A STOAT CONTROL PROGRAMME.

The spatial characteristics of stoat (*Mustela erminea*) home ranges were determined as part of a programme to protect Okarito brown kiwi chicks (*Apteryx australis* 'Okarito') from predation. Stoats were fitted with radio transmitters and tracked in two podocarp (Podocarpaceae) forests, in south Westland, New Zealand, from July 1997 to May 1998. Home range was determined by minimum convex polygons and restricted edge polygons, and core areas were determined by hierarchical cluster analysis. The mean male home range across all seasons calculated by minimum convex polygon (210 ± 28 ha) and restricted edge polygon (176 ± 29 ha) were significantly larger than the mean female home range across all seasons (89 ± 14 ha and 82 ± 12 ha). The mean male home range calculated by minimum convex polygon during the breeding season (256 ± 38 ha) was significantly larger than the mean home range pooled across the non-breeding seasons (149 ± 16 ha), whereas that calculated by restricted edge polygon was not significantly different. The mean female home range during the breeding season was not significantly different from that in the non-breeding seasons when estimated by either method. The results of this study and the implications for stoat control to protect kiwi chicks at Okarito are discussed.

☺C. Morley. Department of Zoology, University of Canterbury, P.O. Box 4800, Christchurch.

THE ECOLOGICAL BENEFITS OF USING ACOUSTICALLY SENSITIVE TRANSMITTER SYSTEMS ON ELUSIVE NOCTURNAL SPECIES

Many ecological aspects of ferret behaviour are poorly understood. Acoustically sensitive transmitter systems (ASTS) make it possible to listen to an animal's activities so that its natural behaviour can be studied. After calibration in an observation enclosure, a male ferret wearing an ASTS was released into a large semi-natural enclosure with several females. All activities and behaviours were recorded for 72 hours/month over the six month breeding season. My observations show that the ferret was often active during the day but that most activity occurred underground. Such behaviour would normally have not be seen by an observer but by using an ASTS system, behaviours such as eating, mating, moving and sleeping could be measured. The length of time and, number of activities varied depending upon the time of day and season. ASTS can provide important information for ecological models on time, activity and energy budgets, and on reproductive behaviour and communication between conspecifics. These results show that ASTS can open up the way to understanding many elusive and nocturnal species.

✉Elaine Murphy[1] and Craig Gillies[2]. [1]Science & Research Unit, Department of Conservation, Private Bag 4715, Christchurch. [2]Science & Research Unit, Department of Conservation, PO Box 10420, Wellington.

STOATS AS CONSERVATION PESTS IN NEW ZEALAND

Stoats, ferrets and weasels were introduced to New Zealand in the 1880s in an attempt to control rabbits. Although stoats were quickly implicated in the decline of native birds, the extent to which they still contribute to the decline of native species is only now becoming clear. Their impacts on threatened and endangered birds are of particular concern. Kiwi, endemic to New Zealand and the smallest of the ratites, have declined significantly since human settlement. Predation of young kiwi by stoats is thought to be the most important factor in the continuing decline of mainland populations. Stoats have a detrimental impact on endemic hole-nesting birds such as the yellowhead, kaka and parakeet. Mustelids are believed to have been the major cause of the decline of an endangered shorebird, the southern New Zealand Dotterel, and stoats have also been shown to have a dramatic local impact on the northern subspecies. Stoat control in New Zealand will have to be ongoing if some endemic species are to survive on the mainland. Currently, control relies largely on labour-intensive trapping. Trapping techniques are being refined and other techniques, such as poisoning and biological control will be investigated.

Claire L. Newell and Robert B. Allen. Landcare Research, P.O. Box 69, Lincoln.
REGIONAL VARIATION IN FOREST SPECIES RICHNESS PATTERNS

Regional plant species diversity patterns bear the imprint of geographical and historical events, and it has been suggested that high diversity in New Zealand forests is associated with old, tectonically stable land surfaces. We used data from ten mountainous landscapes, five old, tectonically stable (stable) and five young, unstable (unstable) landscapes (total >2600 relevés), to examine whether there is a close link between species diversity, landscape age and stability. We addressed the question proposed by Ogden (1995): does high regional diversity result from more species per site (richness) or greater compositional change along a major environmental gradient (turnover)? Turnover was measured along the elevation gradient in each landscape because of consistently strong associations between elevation and vegetation composition in mountainous areas. For each landscape turnover was calculated as the gradient length of a DCCA axis 1 constrained by elevation and expressed per 1000 metres elevation. Turnover of stable landscapes was not significantly different from unstable landscapes. Across New Zealand, richness was significantly higher in stable landscapes than unstable landscapes, with highest mean richness at Coromandel and Waipoua and lowest at Harper-Avoca. However, a separate analysis of South Island landscapes showed no significant difference between stable and unstable landscape richness.

John Parkes[1], Grant Norbury[2] and Richard Heyward[2]. Landcare Research, [1]P.O. Box 69, Lincoln and [2]P.O. Box 282, Alexandra. (Parkesj@landcare.cri.nz).
RABBITS, RHD, AND THE FUTURE

The inability of many landowners to pay for the full costs of rabbit control led to the illegal introduction of Rabbit Haemorrhagic Disease (RHD) as a biological control agent in August 1997. Large reductions in rabbit densities were achieved, independent of the initial rabbit densities, in the initial epidemics where fresh virus was used as a biocide. Large reductions were also achieved where spot baiting and natural epidemics occurred, but these were most reliable where density indices exceeded about 25 rabbits/spotlight km. The disease persisted with new epidemics occurring in 1998. The presence of a partially successful biological control should change the strategy of rabbit control from the proactive approach of reduction and frequent maintenance control to a more reactive approach determined by need. To do this managers will need to be able to predict (or manage) the effect of RHD, measure the impact of rabbits at different densities, and judge how much conventional control it is worth applying.

☺Prebble, M.J.[1]; Carter, J.A.[1]; Schallenberg, M.[2]; Shulmeister, J[1]. [1]School of Earth Sciences, Victoria University, P.O. Box 600, Wellington; [2]Department of Zoology, University of Otago, P.O. Box 56, Dunedin. (matthew.prebble@vuw.ac.nz).

ECOLOGICAL AND CLIMATIC RECONSTRUCTION OF THE LOWER TAIERI BASIN (OTAGO) THROUGH THE QUATERNARY: PHYTOLITH ANALYSIS AS A PALEOECOLOGICAL TOOL.

Paleoecological data was obtained from a 150m long drill core taken from Lake Waipori in February of this year. This core was collected as part of a climate change project (Victoria University), aiming to contribute regional and local paleoecological and climatic data from the last 125,000 years to Global Circulation Models (GCMs are climate change models). A short (1.6m) lake bottom core was also collected from Lake Waihola, as part of a climate change project (Otago University) focusing on the change in wetland plant communities for the last 4,000 years. Phytolith (microscopic siliceous particles found in the stems and leaves of plants) analysis was used in conjunction with more conventional paleoecological analyses in the reconstruction of plant communities throughout the late Quaternary. The key objective of the study was to assess the potential phytoliths to allow detailed reconstruction of grassland and wetland plant communities, by comparing modern phytolith assemblages (found under existing plant communities) with those represented in the core. Reconstruction of the core using phytolith showed a clear correlation of plant community types as shown by diatom and pollen analysis. Where pollen preservation in the core was poor, phytolith analysis enabled a more detailed reconstruction of the vegetation history.

✉Surinder Saggar[1]; G.W. Yeates[1]; P.D. McIntosh[2] [1]Landcare Research, Private Bag 11052, Palmerston North, New Zealand; [2]Landcare Research, Dunedin (Present address: Forest Practices Board, Hobart, Australia).

TUSSOCK-GRASSLAND MANAGEMENT PRACTICES INFLUENCE SOIL BIOLOGICAL PARAMETERS

We evaluated the influence of two tussock-grassland management practices using soil biological parameters that are early and sensitive indicators of soil stress and ecosystem productivity. Four pairs of sites, matched for altitude and aspect, on Longslip and Ben Avon Stations, Omarama, were studied. Soils on Longslip (improved) have been over-sown with clovers, and a total of 1250 kg/ha of sulphur-superphosphate (28% S) has been applied between 1978 and 1994, whereas soils on Ben Avon (unimproved) have not been fertilised or oversown. Soil biological parameters and total soil carbon (C) and nitrogen (N) levels were greatly affected by fertiliser application and over-sowing. Populations of earthworms and cicadia larvae did not differ between sites. However, soils of the unimproved sites had significantly ($P>0.05$) fewer grass grubs, enchytraeids, rotifers and tardigrades, and lower nematode diversity. These soils also had consistently lower microbial biomass C and N contents, wider biomass C : N ratio, and higher metabolic quotient than their counterparts in improved soils. Fertiliser and pasture improvement had no apparent effect on soil pH. The shifts in these biological parameters suggest that populations of smaller organisms that turn over more rapidly are greater in the fertilised area. They also indicate that fertilising and oversowing tussock-grasslands can improve most measures of soil quality.

Mark Sanders and Richard Maloney. Department of Conservation, Private Bag, Twizel
WHODUNNIT? QUANTIFYING CAUSES OF MORTALITY AT NESTS OF BRAIDED RIVER BIRDS USING TIME-LAPSE VIDEOS

Introduced predators have been strongly implicated as the cause of extinctions and continuing declines of New Zealand's avifauna. However, efforts to gain support for predator control, and to target research and management, are hindered by a lack of definitive evidence of the causes of declines, and a lack of understanding of the relative effects of different causes of mortality. We used video cameras to quantify causes of mortality at 138 nests of three species; banded dotterels (95), black-fronted terns (19), and black stilts (24), in braided rivers of the Mackenzie Basin. We recorded 64 lethal events, of which 51 (80%) were caused by cats, ferrets, or hedgehogs. Cats killed or ate adults at 3 nests, chicks at 5 nests, and eggs at 17 nests. Ferrets, hedgehogs, and stoats preyed upon eggs at 14, 12 and 3 nests, respectively. A magpie ate chicks at one nest, and a harrier preyed upon 1 chick and 2 eggs at one nest. Sheep trampled eggs in 2 nests. Incubating parents broke 1 egg at 2 nests. We caused 1 desertion, and filmed 2 desertions that did not have clear causes. Predators did not leave distinctive sign at nests. Implications for monitoring, research, and control are discussed.

Alan Saunders. Department of Conservation, P.O. Box 10-420, Wellington.
TOWARDS AN ECOSYSTEM FOCUS FOR CONSERVATION MANAGEMENT

Further improvements in our capacity to protect biological systems are required if we are to effectively conserve New Zealand's remaining biodiversity. A political intent has been declared to direct management at higher levels of biological organisation, as well as at species and populations. Management programmes directed at communities and ecosystems, and perhaps one day, landscape and even regional scales, can be expected to result in more comprehensive and sustainable conservation outcomes than those aimed at lower levels alone. Any move towards higher level conservation goals will involve challenges associated with increased complexity. A sequential approach to developing the capacity to conserve ecosystems seems most appropriate. An ecosystem focus requires a focus on the interrelationships between species and their environment at a defined site and, as a result, on ecological processes such as soil building and vegetation succession. If we are to achieve more complex higher order conservation goals, a key will be to enhance our understanding of how ecosystems function and respond to management. Important recent progress has been made at ecosystem-focused mainland restoration projects initiated by the Department of Conservation. A feature of these projects is the scope and intensity of ecological monitoring being undertaken. While these projects are in their early stages they constitute an important step towards an ecosystem management approach. Some results from these projects are discussed.

D. Scott. AgResearch, Lincoln.

FERTILISER REJUVENATION OF FESCUE TUSSOCK

Some ascribe the reduction of short tussock to nutrient depletion. Past agricultural experience in oversowing and top dressing is that on some occasions fescue tussock responds to this fertiliser, but on more occasions reduces under the increased grazing pressure associated with the introduced species. An eight year trial of a factorial of 3 rates of superphosphate by 3 rates by 2 types of nitrogen fertiliser treatments on a hieracium-infested fescue tussock stand, without the introduction of seed of pasture species, indicated that the early effect was the response of hieracium to nitrogen. There was little change in the density or vigour of tussocks in the non-grazed treatment. There was a marked fertiliser response in tussocks and the appearance of other species in treatments receiving a single grazing in the 3rd year.

☺Margaret Stanley and Alan Lill. Department of Biological Sciences, Monash University, Clayton, Victoria 3168, Australia

BASIS AND CONSEQUENCES OF AVIAN FRUGIVORY IN AN AUSTRALIAN EUCALYPT WOODLAND

Birds are thought to aid seed dispersal by consuming fleshy-fruits, which are produced by many plants, and dispersing the seeds to potential germination sites. Many features of this fruit-frugivore mutualism are still poorly understood, particularly for temperate areas where fruiting is seasonal. Fruit exploitation patterns and foraging strategies of birds were studied at the community level in an open eucalypt woodland in south-east Australia. The potential for these birds to act as dispersal agents for both native and exotic fruits was examined through faecal analysis and quantitative observations. Silvereyes (*Zosterops lateralis*) were found to be the dominant avian frugivore in this system and were therefore studied in captive birds to determine the relative importance of various fruit traits in the selection of fruit. Experiments to date suggest that aspects of the fruit display, such as fruit size and accessibility, may be a relatively important factor in fruit selection by birds.

Harald Steen[1] and Lyndon Perriman[2]. [1]University of Otago, Department of Zoology, P.O. Box 56, Dunedin; [2]Department of Conservation, P.O. Box 5244, Dunedin.

CLIMATE FLUCTUATION EFFECTS ON HATCHINGS AND BREEDING SUCCESS OF BLUE PENGUINS (EUDYPTULA MINOR)

El Niño and La Niña climate perturbations alter sea currents and food availability for seabirds and thereby may affect their breeding success. Blue penguin (*Eudyptula minor*) breeding success is dependent on whether they lay one or two clutches per season, timing of egg laying and the fledging success of hatched eggs. In Blue penguins there are three pulses in egg-laying: the first clutch of two-clutch-pairs; then clutches from single-clutch-pairs; and finally the second clutch of the two-clutch-pairs. It is obviously beneficial to lay an early clutch, so we expect that only poor condition will prevent the pair from starting early. El Niño and La Niña may influence adult condition and thereby the timing of egg-laying. This study examines whether variation in hatching success and breeding success between 7 years at Taiaroa Head, Otago Peninsula, may be explained by El Niño/La Niña perturbations affecting the proportion of pairs breeding at the three different times. We will also test whether pair fidelity influences hatching success.

☺Wendy Sullivan and Kerry-Jayne Wilson. Ecology and Entomology Group, Lincoln University.

THE USE OF BURROW ENTRANCE FLAPS TO MINIMISE THE EFFECTS OF BURROW COMPETITION BETWEEN BROAD-BILLED PRIONS (*PACHYPTILA VITTATA*) AND CHATHAM ISLAND PETRELS (*PTERODROMA AXILLARIS*).

Chatham Island petrels (*Pterodroma axillaris*) are an endangered marine bird endemic to the Chatham Islands. They are now restricted to a single breeding population on South East Island, Chatham Islands. Broad-billed prions (*Pachyptila vittata*) have a major detrimental impact on Chatham Island petrel breeding success, when prospecting for burrows during the petrel breeding period. In many cases the prions will take over petrel burrows and kill the chick. This research investigated the effectiveness of an artificial burrow entrance flap in decreasing broad-billed prion interference. Chatham Island petrels have a high incentive to push through a flap due to their investment in their chick, and this trial found almost all petrels entered the burrow through the artificial flap. Prospecting prions appear to be influenced by ease of access when searching for potential burrows. Flaps acted as barriers to the prions and decreased the number and frequency at which prions entered burrows. Artificial burrow flaps will provide a low cost, low labour management strategy protecting the known breeding population of Chatham Island petrels immediately while increasing the stability of the population.

✉Mathew Vujcich. Auckland Regional Council, 21 Pitt Street, Auckland.

THE EVOLUTION OF WENDERHOLM REGIONAL PARK

Wenderholm Regional Park, comprises a 50 ha coastal broadleaf headland bounded by the Puhoi and Waiwera Rivers. This small mainland island was developed over a long period of time, and integrates high public use. Protection programmes include small scale annual tree planting and possum control. In 1992 these were supplemented by rat control aimed at enhancing kereru populations. Over the years the area has become a hot spot for ecological research including seedfall, insect recovery, and rat monitoring. In 1999, 21 North Island robins from Tiritiri Island were introduced to the area. The history of Wenderholm's restoration as a mainland island is traced.

Chris Ward. Department of Conservation, Gisborne.

MAINLAND ISLANDS - AN EAST COAST HAWKE'S BAY PERSPECTIVE

Two mainland islands are formally recognised by DOC in East Coast Hawke's Bay Conservancy. Boundary Stream is a "classic" mainland island comprising 800 ha of forest surrounded by pasture. Northern Te Urewera comprises areas of forest within a larger forest tract. Significant progress has been made in each towards "Restoring the dawn chorus" and other goals. I use the contrasting character of the two areas to illustrate some general issues. Mainland islands espouse whole ecosystem "restoration" goals, as distinct from single species/habitat management. Currently we have a multi-species approach to pest control and indigenous species recovery, representing important progress towards such goals. The island analogy or paradigm can easily be overdone. The Northern Te Urewera project does not have fixed boundaries like an island. We are progressing towards a concept of a set of intensively treated 1000-4,000 ha areas, within a less intensively matrix totalling at least 50,000 ha. Current work on mainland islands should be seen as pilot studies for more comprehensive, larger and additional areas, as much as ends in themselves. Mainland islands are resource-expensive, but whether they are sustainable depends not so much on costs but on how much their outcomes, short- and long-term, are valued at the personal, societal and political levels.

✉Rob Wardle[1] and Tony Perrett[2]. Department of Conservation, [1]PO Box 176 Alexandra and [2]PO Box 5244 Dunedin.

THE EMERGENCE OF A CONSERVATION PARK ON THE ROCK AND PILLAR RANGE

Over 2 million hectares of Crown land in the South Island high country are leased to 365 runholders under the Land Act (1948) as pastoral leases. In recent decades there has been increasing opposition to this form of land tenure from many New Zealanders with an interest in the environment, conservation and outdoor recreation on one hand, and from pastoral lessees on the other. Since 1991 the Crown has been divesting ownership of these leases through a process of negotiation referred to as pastoral lease tenure review. Land suitable for farming purposes is freeholded to lessees, whilst areas of high conservation, recreation or other 'public' values are retained in Crown ownership, usually under the stewardship of the Department of Conservation. In 1998 the Crown Pastoral Land Act was passed, in effect making pastoral lease tenure review a statutory process. Tenure review progress on the eastern flanks of the Rock and Pillar Range has been steady. This poster provides a background to the pastoral lease tenure review process, outlines conservation values on the Rock and Pillar Range and documents progress towards protecting them. Central to the Department of Conservation's objectives for the range, is the creation of a "Rock and Pillar Conservation Park".

✉Alexander Wearing. Department of Geography, University of Otago, P.O. Box 56, Dunedin.

SMALL SCALE PATTERNS OF *HALOCARPUS BIFORMIS* (PINK PINE) IN A CONIFER-BROADLEAVED FOREST NEAR DUNEDIN, SOUTH ISLAND

Halocarpus biformis (pink pine) is a small native tree that occurs in low altitude to subalpine forest, scrub and shrubland. There are a few stands containing pink pine on the upper slopes of Pigeon Hill and Mount Cargill, north-east of Dunedin (Dunedin Ecological District, Otago Coast Ecological Region). These stands have been subject to past disturbance. Plant species cover-abundance and density data were collected for sample plots in an area of montane conifer-broadleaved forest characterised by *Libocedrus bidwillii* and known to contain pink pine. Within-landform (topographic position), microtopography and a range of environmental variables were also measured and correlations sought between these attributes and patterns of pink pine. Pink pine presence and cover-abundance varies paralleling spatial variability in stand structure and within-landform units. The spatial distribution of pink pine recruitment is related to differences in microtopography, canopy cover, and the type and extent of ground cover.

Bob Webster[1], Richard Duncan[2], Carol Jensen[1], and Dianne Carter[1]. [1] Knight Frank (NZ) Ltd, Land Resources Division, PO Box 142, Christchurch; [2] Ecology and Entomology Group, P.O. Box 84, Lincoln University, Canterbury.

DECLINING SPECIES RICHNESS IN THE TUSSOCK GRASSLANDS OF CANTERBURY AND OTAGO.

We document a marked decline in species richness over a 7 to 15 year time interval on 119 permanently located transects spread widely across tussock grassland environments in Canterbury and Otago. Environments sampled ranged from higher altitude native snow tussock grasslands to highly modified lower altitude short tussock, sampling both retirement conditions and grazing under extensive pastoralism. On each transect measurements were based on 50 0.5m^2 quadrats, with species richness being calculated at two spatial scales. Mean species quadrat richness was calculated as the average number of species per quadrat, while transect species richness was calculated as the total number of species recorded on the transect. Species with different growth forms behaved differently. The greatest losses in quadrat richness occurred in small herbs <2 cm tall, followed by grasses (excluding *Chionochloa*), and larger herbs. Species of *Hieracium* and *Chionochloa*, and several woody species increased in abundance. Changes in transect species richness were similar but less distinct. Neither increases in the abundance of competitive dominants nor variation in recent grazing history can adequately account for the pattern of decline.

☺Deborah J. Wilson, Charles J. Krebs, & A.R.E. Sinclair. Department of Zoology, University of British Columbia, 6270 University Blvd., Vancouver BC V6T 1Z4, Canada.

HOW MUCH DOES PREDATION AFFECT THE POPULATION DYNAMICS OF LEMMINGS?

Collared lemmings fluctuate periodically in abundance on the Kent Peninsula, Northwest Territories, Canada. We tested whether predation (1) limited the lemming population during a peak and decline summer, and (2) caused the population decline. We reduced predation with a fence and an overhead mesh of monofilament (10 ha). We used mark-recapture and radio-telemetry to investigate demography in this "Exclosure" and three Control areas, and estimated winter predation from droppings and abundance of predators. Density was much higher in the Exclosure than on Controls in both summers. Survival was significantly higher within the Exclosure during the lemming decline only. Neither proportions of reproductive animals nor net movements differed significantly between treatments. We conclude that predation was limiting in the peak and decline, but that limitation was more severe in the decline. Lemmings stopped reproducing early in the peak summer. Density declined over winter on all sites, although estimated winter survival was high. The next summer, survival dropped; the decline accelerated on Controls but was reversed within the Exclosure. We conclude that predation may not have been necessary to cause the decline; instead the decline was initiated by cessation of reproduction. However, predation accelerated and extended the decline into the next summer.

✉G.R.G. Wright[1]; C.T. Eason[1]; E. Murphy[2]. [1]CENTOX (Centre for Environmental Toxicology), Landcare Research, P.O. Box 69, Lincoln; [2]Department of Conservation, Private Bag, Christchurch.

NATIONAL ENVIRONMENTAL AND WILDLIFE VERTEBRATE PESTICIDE RESIDUES DATABASE

A database of 1080 residues in water from nearly 900 samples collected between 1990 and 1998 after 38 aerial 1080-baiting operations has proven extremely useful in assessing human exposure risk mediated via contaminated water. Similar residue data exists for 1080 and other vertebrate pesticides in soil, water, invertebrates, birds, and animals. This data, which has been generated from samples collected throughout New Zealand following pest control operations, is being collated so that researchers and policy makers can be provided with a better understanding of the environmental and wildlife exposure risks following the use of vertebrate pesticides. The weight of evidence generated by the collation of individual datasets provides a robust basis for risk assessment for different poisons for different species. Changing patterns of wildlife contamination reflect increasing and decreasing usage of the mammalian pests. In the last 2 years the range of wildlife species found contaminated with brodifacoum, which includes pigs, deer, ferrets, cats, stoats, weasels, goats, mice, and hedgehogs, as well as a number of introduced and native bird species such as duck, weka, and kiwi. Examination of the database provides a better understanding of food-web pathways for rodenticide and assists with risk assessment for different control tools.

✉E. C. Young. School of Biological Sciences, University of Auckland, Auckland.

A KEY EXPERIMENT - ONLY 38 YEARS LATE

Polymorphism for flight in the families Corixidae (waterboatmen) and Notonectidae (backswimmers) Hemiptera: Heteroptera was described in 1961 (E. C. Young, 1961. Degeneration of flight-musculature in the Corixidae and Notonectidae. Nature, Lond. 189: 328-329.). In this polymorphism, bugs in temporary habitats retain their flight musculature whereas those in permanent habitats did not fully develop theirs, although retaining their wings, and are unable to fly. There is great advantage in not having to maintain the mass of flight musculature under conditions where survival migration is unlikely to be needed, and in not migrating when unnecessary. A trend to flightlessness was hypothesised that began with behavioural changes and ran through loss of musculature to loss of metawings.
The key question not addressed during this research, indeed not even thought of then apparently, is: do flightless individuals attempt dispersal migrations with the others in spring? I now report that flightless individuals do not attempt to migrate under conditions when normal individuals do so. Thus, they benefit both from the loss of the musculature and from higher survival through not attempting migration.

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New Zealand Ecological Society

Student Session

Blenheim
28 June 1999

NZES Student Session
Blenheim, 28 June 1999

First Session starts 10.00 am

Chair: Ben Reddiex

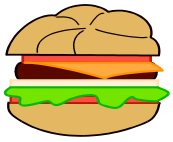
Time	Name	University	Title
10.00 am	Craig Morley	Canterbury	Estimates of ferret abundance, recruitment and survival in North Canterbury, New Zealand
10.20 am	Jonathan Banks	Lincoln	All's Fair in Love: Sex roles in the South Island Pied Oystercatcher, *Haematopus ostralegus finschi*
10.40 am	Max Dewdney	Canterbury	Recovery distance of forest stream ecosystems below pastoral clearings
11.00 am	Nic Irvin	Lincoln	The effects of floral resources on longevity, populations and efficacy of the leafroller parasitoid (*Dolichogenidea tasmanica* (Cameron)) in apples

Tea Break 11.20 am – 11.40 am

Second Session 11.40 am

Chair: Jonathan Banks

Time	Name	University	Title
11.40 am	Nicholette Brown	Auckland	Dusky dolphin (*Lagenorhynchus obscurus)* habitat use, group size and dispersion in Kaikoura, New Zealand
12.00 pm	Amy Trass	Massey	Fruit dispersal and forest regeneration on the central North Island volcanic plateau
12.20 pm	Kelly Drinnan	Canterbury	The effects of native and exotic predatory fish on behavioural drift in stream insects
12.40 pm	Wendy Sullivan	Lincoln	Use of burrow entrance flaps to minimise effects of burrow competition between Chatham Island petrels (*Pterodroma axillaris*) and broad-billed prions (*Pachyptila vittata*)



Lunch Break 1.00 pm – 1.40 pm

Third Session 1.40pm

Chair: Wendy Sullivan

Time	Name	University	Title
1.40 pm	Leigh Marshall	Otago	Spatial ecology of grand and Otago skinks (*Oligosoma grande* and *O. otagense*)
2.00 pm	Grant Harper	Otago	Habitat use and prey selection by feral cats on Stewart Island, and their control by poisoning
2.20 pm	Brent Barrett	Auckland	Near shore habitat use by southern right whale (*Eubalaena australis*) cow/calf pairs in the Auckland Islands
2.40 pm	Craig Bishop	Auckland	Frost flat heathlands: a stable or disappearing feature of the New Zealand landscape?

Tea Break 3.00 pm – 3.20 pm

Fourth Session 3.20 pm

Chair: Nic Irvin

Time	Name	University	Title
3.20 pm	Kim Bestic	Lincoln	*Dracophyllum* scrub invasion in to *Chionochloa* tussock grassland, Campbell Island, New Zealand
3.40 pm	Josh Kemp	Otago	Nest predation and adult female survivorship in kea (*Nestor notabilis*), 1993 –1999
4.00 pm	Eamonn Ganley	Auckland	Coastal Vegetation of the Western Waikato
4.20 pm	Leanne O'Brien	Canterbury	Canterbury Mudfish and Friends
4.40 pm	David Snell	Auckland	Acoustic behaviour of bottlenose dolphins in response to dolphin tourism in the Bay of Islands
5.00 pm	Darryl Jeffries	Auckland	Factors Influencing the Breeding Success of Fairy Tern and White-fronted Tern

Quiz/ Social evening

7.30 pm at the Marlborough Research Centre

Abstract booklet was sponsored by:

Soil, Plant and Ecological Sciences Division
PO Box 84
Lincoln University
CANTERBURY

Session One (10.00am – 11.20am)

Estimates of ferret abundance, recruitment and survival in North Canterbury, New Zealand.

Craig Morley, Department of Zoology, University of Canterbury, Private Bag 4800, Christchurch.
Email: c.morley@zool.canterbury.ac.nz

Ninety-eight ferrets were monitored in a 22 month mark-recapture study on farmland in North Canterbury. Ferret survival, recruitment and abundance were estimated using programmes JOLLY™ and MARK™. Annual ferret survival was 54%, with the longest known ferret living 23 months. Females generally outlived males. Survival may have been higher if farmers on neighbouring farms had not trapped ferrets to control Tb. Site fidelity was strongest in females and this may explain why fewer females were killed on neighbouring farms. Most ferrets were recruited into the population from December to February, although in 1997 a second breeding season was observed. Ferret abundance was highest between February and April and lowest between the September to December breeding season. The number of new ferrets increased in three consecutive years suggesting a growing population. Ferret abundance was closely associated with an increase in rabbit abundance.

All's Fair in Love: Sex roles in the South Island Pied Oystercatcher, *Haematopus ostralegus finschi*

Jonathan Banks and Adrian Paterson, Ecology and Entomology Group, P.O. Box 84, Lincoln University, Canerbury.
Email: banks@lincoln.ac.nz

The role of each sex during parenting is assumed to be a cooperative endeavour to maximise a pair's breeding success. Sex roles have also been viewed as sources of conflict where, within certain limits, individuals in a pair attempt to minimise their investment in raising young and maximise the efforts of their mate. Anisogamy (unequal gamete size) may result in unequal investment by each sex in the production of offspring. Energy costs of behaviours such as territory defence and nest building, are often performed by males, and may balance out the higher energy costs of egg production by females.

The energy expenditure of South Island Pied Oystercatchers nesting on farms in mid Canterbury was estimated for each sex during the breeding season. Males spent more time in territory defence than females while females spent more time sitting. There were no significant differences in other behaviours. Females had a higher, but not significant, rate of energy expenditure (23.3 kJ/hour) than males (23.1 kJ/hour). Males and females used similar amounts of energy over the breeding season but females were unlikely to recoup the cost of egg production. Breeding behaviour therefore appears to be cooperative whereas gamete production appears to be an area of conflict.

Recovery distance of forest stream ecosystems below pastoral clearings

Max Dewdney, Department of Zoology, University of Canterbury, Private Bag 4800, Christchurch.
Email: m.dewdney@zool.canterbury.ac.nz

The central question addressed in this study is how far downstream agricultural impacts can be detected in river systems. This assumes that agricultural impacts are measurable in river systems, and a subsidiary aspect of the work will be to characterise these effects.

Streams that flow out of indigenous forest into pastoral land before re-entering indigenous forest are being considered. The primary question then becomes "how rapidly do stream communities adjust to the return of a forest environment"? This situation is poorly understood, although Storey & Cowley (1997) found that water temperature and dissolved oxygen concentration returned to forest stream levels within 300m, and faunas within 600m of entering fragments of forest in Northland.

The Upper Grey in the Lewis Pass region of the South Island and The Totara, on the West Coast of the South Island arise in indigenous forest, pass through pastoral environments and return to indigenous forest. Thus they are well suited to this studies requirements. Initial research indicates that there are changes in benthic invertebrate community across the three sections surveyed. Stability also varies between the three land uses, pasture being the least stable. An overriding focus of the work is on needs for stream restoration and/or protection from pastoral impacts.

Storey, R.G. & Cowley, D.R. 1997. Recovery of three New Zealand rural streams as they pass through native forest remnants. *Hydrobiologia 353*: 63-76.

The effects of floral resources on longevity, populations and efficacy of the leafroller parasitoid (*Dolichogenidea tasmanica* (Cameron)) in apples

Nic Irvin, Steve Wratten, Bruce Chapman and Chris Frampton, Ecology and Entomology Group, P.O. Box 84, Lincoln University.
Email: irvin@lincoln.ac.nz

Leafrollers (Lepidoptera: Tortricidae) are major pests of pipfruit, largely because of the zero tolerance of their presence in, and damage to export fruit. A field trial was carried out in a Canterbury, New Zealand apple orchard to determine the influence of planting coriander
(*Coriandrum sativum* L.) and buckwheat (*Fagopyrum esculentum* Moench.) on parasitism rates of leafrollers by *Dolichogenidea tasmanica* (Cameron) (Hymenoptera: Braconidae). Coriander significantly enhanced the parasitism rate compared with the control. Buckwheat had a similar but non-significant effect. The influence of floral resources on parasitoid longevity was evaluated in the laboratory. Parasitoids reared on a honey/water solution had the greatest longevity. A combination of buckwheat and coriander resulted in greater parasitoid longevity compared with either plant species alone. The value of this research in the context of biocontrol of leafrollers in integrated fruit production programmes is discussed.

Session Two (11.40am – 1.00pm)

Dusky dolphin (*Lagenorhynchus obscurus)* habitat use, group size and dispersion in Kaikoura, New Zealand

Nicholette Brown, School of Biological Sciences, University of Auckland, Private Bag 92019, Auckland.
Email: n.brown@auckland.ac.nz

The first commercial dolphin watching operation began in Kaikoura in 1989, targeting mainly the dusky dolphin, *Lagenorhynchus obscurus.* Prior to this a major study of dusky dolphin behaviour and activity patterns was carried out from January 1984 to February 1988 by Frank Cipriano (1992). This study represents good baseline data on pre-tourism dusky dolphin behaviour in the Kaikoura region. To assess the effects of long term exposure of boat/tourist interactions on dusky dolphins in Kaikoura, similar data collected in a recent field season will be used to perform a comparison between pre and post tourism periods. Where at all possible Cipriano's methodology was replicated to ensure consistency between the two periods. Dolphin groups were tracked in a research benign technique with the aid of a theodolite from a cliff point vantage point overlooking the study area. This method enables accurate mapping of dolphin group locations and also removes any observer effect. Current day dolphin habitat use (viz. water depth) and information on group dynamics (cohesiveness and location) was also documented.

Fruit dispersal and forest regeneration on the central North Island volcanic plateau

Amy Trass, Department of Ecology, Massey University, Private Bag 11 222, Palmerston North.
Email: a.p.trass@massey.ac.nz

Given that 70% of native woody plants have fruits suited for vertebrate dispersal, forest regeneration and succession are intimately linked with the interaction between frugivorous birds and the fruit which they eat.

This proposal seeks to investigate the interactions between seed dispersal and subsequent forest regeneration. Substantial areas of native forest on the volcanic plateau have been affected by disturbances. Many of these areas are still devoid of forest today and consist of a mosaic of vegetation types including native tussockland species and introduced invasives such as heather, broom and exotic grasses. There are two main factors which may or may not be limiting forest colonisation into these areas (i) lack of seed dispersal and/or germination (ii) inability of forest seedlings to cope with local conditions. Both of these factors will be tested by way of planting experiments both under a canopy of exotic broom and in previously cleared areas. Seed traps will measure the influx of bird-dispersed seed from remnants of native forest into adjacent vegetation. Results on the current regeneration potential of woody species (number and size of seedlings as related to distance from a seed source) will be presented.

The effects of native and exotic predatory fish on behavioural drift in stream insects.

Kelly Drinnan, Department of Zoology, University of Canterbury, Private Bag 4800, Christchurch.
Email: kjd31@student.canterbury.ac.nz

Stream insects normally residing in the benthos may enter the current, ie; drift, for many reasons, eg: moving to a new food patch or accidental dislogdement. These insects may alter their drift behaviour in the presence of predatory fish. The two fish looked at in this study are brown trout (*Salmo trutta*-exotic) and common river galaxiids (*Galaxias vulgarias*-native). Trout feed visually from the drift during the day, while galaxiids are nocturnal, taking insects
from both the benthos and the drift. These two predators may have different effects on drift behaviour.

Last summer, sixteen streams in the upper Waimakariri catchment were surveyed for drift patterns. There were four different fish assemblages in these streams: fishless, trout only, galaxiids only and both trout and galaxiids. Four streams of each fish type were surveyed. Drift was measured during the day and the night and the drift rate calculated for *Deleatidium* sp. (Ephemoptera). The head capsule widths of *Deleatidium* sp. were measured, to see if size of drifting Deleatidium sp. differed during the day and night.

Results showed that for *Deleatidium* drift, trout reduced the drift during the day and night, compared to fishless streams. *Deleatidium* drift in galaxiid streams was significantly higher during the night. The size of *Deleatidium* drifting during the night was significantly higher in streams with trout only.

Use of burrow entrance flaps to minimise effects of burrow competition between Chatham Island petrels (*Pterodroma axillaris*) and broad-billed prions (*Pachyptila vittata*).

Wendy Sullivan, Entomology and Ecology Group, PO Box 84, Lincoln University, Canterbury.
Email: sullivw@lincoln.ac.nz

Chatham Island petrels (*Pterodroma axillaris*) are an endangered marine bird endemic to the Chatham Islands. They are now restricted to a single breeding population on South East Island. Broad-billed prions (*Pachyptila vittata*) have a major detrimental impact on Chatham Island petrel breeding success, when prospecting for burrows from February to May, which coincides with the petrel breeding period. Prions can take over petrel burrows and kill the chick. Current management involves patrols around the petrel colony, culling any prion found within a petrel burrow. This research investigated the effectiveness of an artificial burrow entrance flap in decreasing broad-billed prion interference. Chatham Island petrels have a high incentive to push through a flap due to their investment in their chick, and this trial found almost all petrels entered the burrow through the artificial flap. Prospecting prions appear to be influenced by ease of access when searching for potential burrows. Flaps acted as barriers to prions and significantly decreased the number and frequency at which prions entered burrows. Artificial burrow flaps should provide a low cost, low labour management strategy protecting the known breeding population of Chatham Island petrels, while reducing disturbance by people.

Session Three (1.40pm – 3.00pm)

Spatial ecology of grand and Otago skinks (*Oligosoma grande* and *O. otagense*).

Leigh Marshall, Department of Zoology, University of Otago, P.O. Box 56, Dunedin.
Email: leigh.marshall@stonebow.otago.ac.nz

Grand and Otago skinks (*Oligosoma grande* and *O. otagense*) are two species of threatened lizards found only in Otago. The skinks are found on rocky outcrops amongst tussock grassland. There is considerable overlap between the two species within their distribution. The conservation strategy outlined by the Department of Conservation is to manage the skinks through managing their habitat. Therefore, it is crucial to know the ecology and habitat requirements of both species of skinks. Some preliminary data exist for home range and microhabitat selection in grand skinks. However, there has been no similar study on Otago skinks. This study investigates the spatial ecology of grand and Otago skinks at one site where they are sympatric. Data on home range and microhabitat use has been collected. It is hoped that by investigating the habitat use of grand and Otago skinks our understanding of their habitat requirements will be increased and our ability to successfully manage these species, enhanced.

Habitat use and prey selection by feral cats on Stewart Island, and their control by poisoning

Grant Harper, Department of Zoology, University of Otago, P.O. Box 56, Dunedin.

Feral cats have been implicated in the extinction of many native birds on Stewart Island. A poisoning programme to control cats during the spring and summer breeding of NZ Dotterel has been running for several years. The poisoning has apparently been partially successful as Dotterels numbers are increasing. The aims of the research are to improve the efficacy of the poisoning programme. This to be achieved by investigating prey selection dynamics, habitat preference and home range, and poison take by cats. Prey selection dynamics will involve unravelling the functional responses of cats to seasonal changes in the numbers of their primary prey, which are rats. Habitat preference in cats is probably linked to prey abundance. I am planning to test this by trapping cats and rats in different habitat types (manuka, podocarp/broadleaf, sub-alpine scrub) to test for differences in predator and prey densities. I will also be radio-tracking cats to ascertain their preference for particular vegetation types and tying these results to prey availability. Radio-tracking will also provide information on home range and seasonal changes in home ranges. Poison "take" by cats and other animals (rats/possums) will be investigated, as will the percentage of radio tagged cats killed by poison.

Near shore habitat use by southern right whale (*Eubalaena australis*) cow/calf pairs in the Auckland Islands.

Brent Barrett, School of Biological Sciences, University of Auckland, Private Bag 92019 Auckland.
Email: b.barrett@auckland.ac.nz

The technique of theodolite tracking has been used extensively on a number of cetacean populations around the world. In the winter of 1998 this technique was used to study southern right whales in New Zealand's sub-antarctic islands. This 3-month study was conducted inside the winter breeding ground of the Port Ross harbour, Auckland Islands. Such research has not been previously conducted in this area. Baseline data was collected on the spatial distribution, social interaction and behavioural states of female southern right whales and their young. A theodolite and computer were used to simultaneously record precise information about movements and behaviour states of a number of individuals. Controlled boat approaches were piloted to assess potential risks of vessel disturbance. This data can be compared to the findings of ongoing studies in Peninsula Valdes and other known southern right whale breeding grounds.

Frost flat heathlands: a stable or disappearing feature of the New Zealand landscape?

Craig Bishop, Ecology and Evolution Research Group, School of Biological Sciences,
University of Auckland.
Email: c.bishop@auckland.ac.nz

Ecotones (abrupt boundaries between adjoining vegetation associations) are found in wide range of plant communities throughout the world. Ecotones operate on a wide range of scales, from junctions between biomes to small scale changes in soil moisture which regulate the distribution of individual plant species around the edges of small wetlands. The location and rate of change at the ecotone interface is governed by change in one, or a group of, underlying environmental and/or physical variables. Examples of common environmental variables include minimum ground temperature, rainfall, solar radiation, number of summer frosts and soil moisture content. The rate of change in these environmental variables is often governed by physical features such as changes in altitude, latitude and topography. Ecotone monitoring is an important part of studies which seek to detect and track changes in global climate patterns.

In New Zealand frost flat heathlands and divaricating (or grey) scrub-heathlands are both examples of community types which establish under a specific suite of environmental and topographical situations. This results in the formation of an abrupt ecotone with adjoining (usually forest) vegetation associations. In the current study heathland and scrub-heathland communities have been intensively studied at 13 sites (9 in the Central North Island and 4 in inland north Westland). Ecotones were identified and, through an examination of the population age structure, checked for movement over time. I have also attempted to determine what is the cause of the ecotone location by tracking soil moisture, temperature, soil fertility, slope and soil profile change along transects perpendicular to extant ecotones. Where ecotone movement is occurring this study aimed at finding the cause of the ecotone movement and the speed at which changes are taking place.

Both heath and scrub-heath vegetation types contain a number of rare plants. This study includes a close look at the germination behaviour, growth rates, population structure, phenology and seedling establishment of three rare plant species; *Melicytus flexuosus*, *Coprosma wallii* and *Pittosporum turneri*.

Session Four (3.20pm – 5.00pm)

***Dracophyllum* scrub invasion in to *Chionochloa* tussock grassland, Campbell Island, New Zealand.**

Kim Bestic, Soil, Plant and Ecological Sciences Division, P.O. Box 84, Lincoln University, Canterbury.
Email: bestik@lincoln.ac.nz

Since the 1880s, native *Dracophyllum* scrub has been invading tussock grassland on subantarctic Campbell Island. This process has accelerated since 1950. Two possible explanations for this are; 1), an increase in disturbance on the island as a result of a period of burning and grazing between 1895 and 1931, and feral grazing up to 1987, and 2), 0.5 degrees C regional climate warming since 1950 and 1.0 degrees C since 1870.
This Landcare Research led study will use three methods to assess the nature and cause of the scrub invasion. Pollen samples have been taken to determine the historic distribution of *Dracophyllum*. Discs from *Dracophyllum* stems have been sampled to age plants using dendrochronological methods, and determine the timing and pattern of spread. Photo-records dating back to the 1880s will be analysed for changes in scrub distribution, in conjunction with the other data.

Nest predation and adult female survivorship in kea (*Nestor notabilis*), 1993 -1999

Josh Kemp[1] and Graeme P. Elliott[2]
[1] Department of Zoology, University of Otago, P.O. Box 56, Dunedin.
[2] 549 Rocks Road, Nelson.
Email: joshkemp@ihug.co.nz

To gauge the extent to which predators threaten kea (*Nestor notabilis*) population viability, we studied kea nest survival and adult female survival in southern-beech (*Nothofagus spp.*) forest in Nelson Lakes National Park, from 1993 to 1999. The nest survival rate was high (67%, n=39) compared to 10% for kaka (*Nestor meridionalis*) in similar habitat (Wilson *et al.* 1998, n = 20). We investigate relationships between nest survival, nest site characteristics and landscape processes. We conclude that the low nest predation rate is likely to result from 1) breeding in early spring (before stoat numbers rise in January) and 2) often nesting at high altitude and/or in steep places. We found no evidence of nest predators killing adult females, but the sample size was small. Our results agree with a previous study at Arthur's Pass (Jackson 1963). We believe that these results can be legitimately extrapolated to most kea habitat and conclude that kea are less threatened by introduced predators than New Zealand's other hole-nesters. We recommend that low-key monitoring of adult female survival occurs in the future.

Coastal Vegetation of the Western Waikato

Eamonn Ganley, School of Biological Sciences, University of Auckland, Private Bag 92019 Auckland.
Email: e.ganley@auckland.ac.nz

The coastal environment is an important part of the New Zealand identity. The Waikato coastline extends from Mokau in the south to Port Waikato in the north. This rugged coast is broken by three extensive estuarine harbours and consists of three separate ecological districts; (Waikato, Kawhia, and Herangi). Modification of coastal habitat and the resultant
increasing vulnerability of this ecosystem, is of major concern to Environment Waikato.
The objective of this research is to survey the natural vegetation along the Waikato Coast in early, mid and late successional stages. The method of point center sampling is used to suggest future rehabilitation design, by describing the distribution and abundance of species of importance in these communities. From this the most important species in pre-existing
coastal natural vegetation remnants may be identified and revegetation programmes based on these species developed.

Increasingly intensive use of the coastal environment has created an interest in the sustainable management of these areas. The present study will provide information for Environment Waikato's community-based Beach Care programme, which attempts to address issues associated with coastal ecosystem reconstruction.

Canterbury Mudfish and Friends.

Leanne O'Brien, Department of Zoology, University of Canterbury, Private Bag 4800, Christchurch.
Email: lkb23@student.canterbury.ac.nz

As part of a Masters thesis, aspects of the relationship between Canterbury mudfish (a threatened species), Upland bully (a common species) and Shortfinned eels (a potential predator) were investigated. These species co-exist in highly dynamic and modified freshwater systems running through Canturbury agricultural land. Preliminary results from an on-going field survey suggest a strongly interacting fish community.

It was found that Canterbury mudfish and Upland bully utilize distinct habitat components within waterways. Furthermore, in the presence of Shortfinned eels, Upland bullies appear to be more abundant than Canterbury mudfish. It is suggested that aspects of both real and apparent competition exist and that presently habitat and disturbance mediate the co-existence of these three species. In addition land management practices affect both habitat factors and drought disturbance, for example the macrophyte habitat preferred by Canterbury mudfish is removed regularly. Further survey and experimental work will give a better understanding of how habitat factors mediate interspecific interactions and improve the management of Canterbury mudfish populations.

Acoustic behaviour of bottlenose dolphins in response to dolphin tourism in the Bay of Islands.

David Snell, School of Biological Sciences, University of Auckland, Private Bag 92019, Auckland.
Email: dj.snell@auckland.ac.nz

Dolphin watching and swimming with dolphins is becoming increasingly popular as a tourist activity. Little is known about the acoustic impact of these boats on the dolphins. The major aim of this study is to examine the acoustic behaviour of bottlenose dolphins in response to boats and swimmers. To test this idea I will be gathering data on the differences in acoustic behaviour of bottlenose dolphins in the Bay of Islands in the period before, during and after boat/swimmer encounters with dolphin pods. A hydrophone and digital audio tape (DAT) recorder will be used to obtain the recordings and the acoustical analysis programme Canary™ will be used to analyse the sounds within a frequency of 20-22000 Hz. Comparisons of duration and frequency of dolphin calls as well as the types of calls given will enable an assessment of whether there is a disturbance by boats/swimmers.

Factors Influencing the Breeding Success of Fairy Tern and White-fronted Tern.

Darryl Jeffries, School of Biological Sciences, University of Auckland, Private Bag 92019, Auckland.
Email: d.jeffries@auckland.ac.nz

The fairy tern (*Sterna nereis*) is endangered in New Zealand and rare in Australia. The Department of Conservation in 1997 published a recovery plan for the fairy tern, in which the New Zealand population is estimated to be approximately 30 individuals. The White-fronted tern (*Sterna striata*) has a larger population more widely distributed around the New Zealand coast, with some similar habitat requirements and breeding sites to the fairy tern. The most likely factors influencing breeding success of these species are habitat requirements, predation and human disturbance. The major aim of this study is to assess and compare the importance of these factors for fairy terns and white-fronted terns. Methods used include recording disturbances to breeding birds, and the variation in their responses, by direct observation and video surveillance. The locality used for this study is Papakanui Spit on the Kaipara Harbour, with both white-fronted and fairy terns present during the breeding season. Of the current breeding sites of fairy terns, this site is advantageous in that it has the most potential for population expansion because of its relative isolation and size.