



KEY:  talk

 poster presentation

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Native pollinators of native parsnips - insect visitation to *Trachymene incisa* in the absence of introduced honeybees

Several studies have shown that not all pollinators are equally effective at depositing pollen. Variability in insect foraging behaviour is also likely to affect gene flow in insect-pollinated plants. In widespread plant species, the taxonomic composition of the pollinator assemblage may vary among populations across the geographic range. However, few studies have addressed how geographical variation in pollinators may affect mating in plants, particularly generalist pollination systems. We assessed the diurnal insects visiting native parsnip, *Trachymene incisa*, in order to determine the effective pollinators of populations located in similar habitats but different regions of NSW. Visitation rates varied among the three populations and five time periods surveyed, with most visits recorded during the 10-11am and 1-2pm time periods. At Myall Lakes and the Tomago Sandbeds, flies and native bees were common visitors to male and female umbels, whereas ants made over 96% of the visits at the Agnes Banks Woodland. A notable absence was the introduced honeybee, *Apis mellifera*, which was observed visiting umbels only twice during the survey period. We will continue to investigate the effects of the absence of honeybees this season, through seed production and fitness, in these populations with a recent history of extensive honeybee foraging.

Davis, Jenny, Karin Strehlow, Lien Sim and Jane Chambers



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Ecological function the key to decision-making. Ecological function: the key for managing salinised aquatic systems?

Many rivers and wetlands in southwestern Australia are threatened by salinisation due to rising saline watertables as a result of land clearing and the replacement of deep-rooted perennial species with shallow-rooted annual species. Previously we suggested that alternative states theory commonly applied to shallow European lakes that may be dominated alternately by macrophytes and phytoplankton, may be extended to describe states occurring with changes in wetland salinity. A program of monthly measurements at seven seasonal wetlands, started in September 2002, has confirmed the occurrence of two main types of saline wetlands: those dominated by submerged aquatics (*Ruppia* and *Lepilaena*) and those dominated by benthic microbial mats. Much interest currently exists in Western Australia with regard to developing drainage networks to remove salty water from agricultural land. We recognise that species composition has already changed in many systems as a result of increasing salinisation. For these systems we suggest that the potential impacts of drainage be assessed not with respect to biodiversity alone, but rather the potential to alter ecological function. Specifically, we need to consider whether drainage waters may result in a switch from submerged macrophytes to benthic microbial mats within the receiving waters.

Debuse, Valerie¹, David Taylor¹, Scott Swift¹, Alison Lawrence², Ross Wylie¹ and Chris Chilcott³



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Broken sticks, bent cables and ecological thresholds.

Ecosystem dynamics can be strongly influenced by the degree of habitat fragmentation. The response of ecological variables to fragmentation will depend on factors such as life history and dispersal ability of the study species and type, abundance and spatial arrangement of the habitat. Where there is evidence of a threshold, the onset of change is commonly estimated using "broken-stick" models, where the a priori assumption is that there is an abrupt break point. While these models are structurally simple, there is often little theoretical evidence that the onset of change is abrupt. Alternative approaches such as the "bent-cable" and hyperbolic tangent models allow for a more gradual transition and relax the prior assumptions of abruptness. We discuss these methods and demonstrate the estimation of thresholds for forest structure data collected from *Eucalyptus populnea* remnants in southern Queensland.

de Barse, Monique



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Restoration of Temperate Eucalypt Woodlands – Getting it Right

This project will look at current methods used to regenerate eucalypt woodland on abandoned agricultural land. The National Parks and Wildlife Service and Greening Australia, who are the Industry Partners for this project, are faced with the problem of restoration of eucalypt woodland on abandoned agricultural and disturbed land in a cost-effective manner. There is very little information currently available on how to achieve this in a landscape subject to long-term disturbance as has occurred in eucalypt woodlands, and efforts to date have primarily used empirical methods. My project will investigate the ecological processes underpinning revegetation methodology

This project will be building on an existing experiment on the use of fire as a tool to regenerate abandoned agricultural land in Scheyville National Park. The experimental design included fire as a factor (burnt vs. unburnt) together with previous land use (3 categories of abandoned land and established woodland/forest). No significant difference in floristic composition was found between 'burnt' and 'unburnt' plots across the four land-use types in the pre-burn survey. The preliminary results of the post-fire survey have found a difference between the 'burnt' and 'unburnt' plots for the abandoned land sites. Further surveys of the sites will be useful in determining the dominant species response to fire over a longer time frame and whether the difference observed continues or diminishes.

Delfs, Leah and Marcello Pennachio



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Distribution and relative abundance of *Tiliqua* species in southern Western Australia

Many Australian species have become extirpated or declined in abundance due to natural and anthropogenic impacts. However, not all animals are affected by these forces. Lizards of the genus *Tiliqua*, for example, seem to be able to persist in urbanised and agricultural environments. This is perhaps due their life history strategies and social characteristics. This is not clear, since few data are available on the abundances and success of either *Tiliqua* species, especially in differing environments in Western Australia.

Preliminary studies are currently underway to determine relative or approximate abundances and success of populations of both lizard species in Western Australia. *T. occipitalis* is rarely encountered in moderately to highly urbanised environments, whereas *T. rugosa* is more common. In agricultural areas, *T. occipitalis* occurs in low to moderate abundances, but is still considerably less common than *T. rugosa* in those same areas.

This finding has prompted research into the biology and ecology of both species, with a focus on their life history strategies. This may help to determine the reasons for this occurrence. In addition, many *T. rugosa* individuals have become ill due to a yet to be described pathogen that has the potential to cause reductions in their abundances. It is not known if *T. occipitalis* is susceptible to the pathogen.

Del Socorro, Alice and Peter Gregg



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Development of commercial attract-and-kill systems using plant volatiles, for management of *Helicoverpa* spp. in cotton

We have developed attract-and-kill systems for the control of noctuid moths, especially *Helicoverpa armigera* and *H. punctigera*, the key pests of Australian cotton. Behavioural responses of female moths in an olfactometer were combined with GC-MS profiling of the plant volatiles released by the most attractive plants to identify volatile blends which are combined with small quantities of insecticide. Commercial scale field trials in which about 1.5% of the rows within 40 ha fields were treated with these formulations resulted in large numbers of moths being killed. Substantial reductions in oviposition and the use of conventional insecticides were obtained, with minimal effects on non-target insects, especially beneficials. The technology has been licensed to an Australian company and will be trialled extensively during the coming cotton season.

Denham, Andrew



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Kangaroo grazing and rangeland condition in arid NSW

In drought conditions, managers of reserves in rangelands are under pressure to actively manage populations of native herbivores (kangaroos). However, the impact of kangaroo grazing can be difficult to determine, especially in areas with unreliable rainfall. Here I report on a study at Mungo National Park in far western NSW that aims to assess range condition under differing grazing regimes by examining changes in ephemeral vegetation and soil cover over time. In poor seasons, total exclosures had higher biomass than open exclosures, while in good seasons, all treatments had similar levels of biomass. Assemblages of species were initially clustered within community and location. This influence persisted over the time of the study, although in poor seasons there was reduced differentiation. Clustering was poorer for soil surface composition, with some consistent outliers. Treatment had no marked influence on species composition or soil surface composition. The study failed to detect consistent change among treatments over time, although a trend is apparent in biomass. The influence of seasonal (rainfall events) and spatial factors are likely to mask treatment differences. Demographic studies of a small number of species, or on the upper strata of the vegetation may provide more meaningful insights into grazing impacts.

di Folco, Maj-Britt



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The impact of fire on organic soils in West and South West Tasmania

The impact of fire on organic soils has been in question in Tasmania as a focus for management, especially on the highly pyrogenic buttongrass moorland plains. What role fire has had to play in the development or destruction of peat remains, as yet, a bone of contention. As part of a doctorate degree, soils have been collected from comparable sites throughout the West and South West of Tasmania, representing a range of fire frequencies. Some of the initial data will be discussed in light of possible effects of burning regimes on the removal or development of peatlands in Tasmania.

Divljan, Anja, Kerry Perry-Jones and Glenda M. Wardle



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Age Determination of Wild Grey-headed Flying-foxes (*Pteropus poliocephalus*): A Study of Cementum and Morphometric Parameters

Lack of suitable techniques for quantitative age determination has hindered population studies of the Grey-headed Flying-fox (*Pteropus poliocephalus*), a species listed as vulnerable. In an attempt to find a reliable method for aging these animals, morphometric relationships and counts of cementum growth layers in tooth roots of 16 known-age and 54 unknown-age bats were investigated. While morphometric parameters are limited in their ability to predict the absolute age, a strong linear relationship ($r^2=0.936$) between the number of cementum layers and the known age was found, proving that layers can be used to accurately predict the age. On this basis, a regression equation was generated from the known-age animals. Subsequently, wild bats, most of which died from electrocution and barbed wire, were aged and no significant difference in age classes between the two causes of mortality was found. The results suggest that the majority of animals dying from electrocution and barbed wire (80% and 91% respectively) are younger than six. In contrast, the oldest age calculated for a wild flying-fox that was not caught on barbed wire or power lines, was in excess of 20 years. Age-based mortality estimates will be valuable in future population studies needed for conservation of *P. poliocephalus*.

Dorrough, Josh¹, Jim Moll² and Jim Crosthwaite³



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Meeting biodiversity and financial goals on wool properties in Victoria

Working with farmers on ways to meet income and other family goals into the future may help meet biodiversity targets for native vegetation. In Victoria regional targets are largely based on levels of depletion, with an emphasis on threatened and endangered vegetation classes. As many of these occur on private land, success will

depend on adoption at the farm scale. To help address these issues, a project funded by the Land, Water & Wool Program is developing future management options with woolgrowers that aim to enhance native biodiversity and maintain farm profitability. Management options are ranked using regional biodiversity targets, site-specific biodiversity requirements and an assessment of agricultural impacts. A subsequent filter includes levels of foregone income, capital expenditure and labour inputs. Preliminary results indicate that negotiated management options show considerable promise for biodiversity conservation on the hillier parts of farms. On the more productive areas, where the most depleted ecological communities are often found, incentives to undertake conservation measures appear less attractive if they are not accompanied by productivity gains. These results suggest that financial, biodiversity and agronomic assessments are needed as the basis for examining investment options that may help reconcile private business and public conservation goals.

Drake, Paul and Ray Froend



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An association between water source, leaf gas exchange and xylem hydraulic properties in three co-occurring *Banksia* species growing on a coastal sand plain.

To date few studies have explored the linkage between xylem hydraulic efficiency and water source partitioning, particularly in xeric habitats. In more mesic environments, xylem hydraulic properties have been shown to be more dependent on the ability of a species to regulate transpiration rate (E) than access to a particular water source. We characterised the water relations and xylem hydraulic properties of three co-occurring *Banksia* species in association with their water source in a semi arid dune system. Specifically, natural variations in stable isotopes of hydrogen in water obtained from both biotic and abiotic elements were exploited to determine the water source of a species during the transition from wet to dry season. Differential access to seasonally permanent water was related to plant physiological properties such as vulnerability to water stress-induced xylem cavitation and whole plant hydraulic conductance (Gt).

Drielsma, Michael and Ferrier, Simon



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'Connectivity' shouldn't be isolated! Defragging the analysis of habitat functionality.

It is widely assumed that with all other things being equal, functionally connected systems will support higher populations and are more likely to result in species persistence than fragmented systems. In practice however the ecological consequences of fragmentation, habitat alteration and habitat loss are confounded, making conservation planning for ecological connectivity in isolation nonsensical.

Yet many ecological studies and planning processes treat habitat connectivity as one among a set of separate considerations along with such things as habitat composition and habitat condition, leaving the awkward task of synthesising results into a useful form.

We argue that what is needed are approaches that address ecological processes directly: where habitat amount, the spatial arrangement of habitat and the dynamics of habitat are combined into a single analysis.

We have integrated landscape ecology's concern with fine-scale pattern, connectivity measures from metapopulation ecology and the least cost path algorithm from graph theory to produce a new approach to measuring ecological connectivity which we term the Cost-Benefit Approach (CBA). The approach evaluates the capacity of sites or systems, viewed at the relevant scale, to support processes that rely on an interaction between habitat structure and the movement behaviour of organisms. We illustrate the approach, with examples from regional conservation planning in NSW where CBA has been successfully incorporated into scenario testing, conservation prioritisation and monitoring of the effects of habitat loss.

Driessen, Michael



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Terrestrial Invertebrate Fauna of Buttongrass Moorlands and the Effects of Fire

Buttongrass moorland is a significant component of the landscape of western Tasmania. It is a unique ecosystem of world heritage value, poorly represented on mainland Australia and absent elsewhere. The invertebrate fauna of buttongrass moorlands has not been well studied and is often over-looked for arguably more glamorous communities such as rainforest. Pitfall trapping and sweep sampling revealed an invertebrate community numerically dominated by Collembola, Diptera, Araneae, Acarina, Formicidae and Orthoptera. The most bio-

diverse groups were Diptera (36 families, 290 species/morphospecies), Araneae (29, 214), Coeloptera (25, 98), Acarina (35, 68), Lepidoptera (17, 62) and Collembola (12/51). Buttongrass moorland is a pyrogenic community and the use of fire as a management tool in this community has been hotly debated in recent decades. Initial results, based on before-after-control-impact studies that have been conducted over the past 5 years, indicate that there are a variety of responses by invertebrates to fire. Taxa that showed a negative response are those that inhabit the sparse emergent overstorey (eg Araneae:Thomisidae) and litter (eg Amphipoda:Talitridae); these habitats recovered slowly following fire. Taxa benefiting from the fire include Orthoptera: Gryllidae, Coleoptera:Alticinae; probably responding to herbs and grasses that increased after fire.

Drinnan, Ian



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Thresholds for remnant size and isolation in relation to species diversity in a Southern Sydney Suburb.

Fragmentation of habitat is recognised as the number one threat to biodiversity and as such has attracted considerable research. However, much of this research has been conducted in forestry and agricultural environments, with little research in urban areas. In this study, field surveys were conducted measuring the impact of fragmentation on bird, frog, plant and fungi species richness, within the fragmented urban landscape of southern Sydney. Of all fragmentation parameters examined, reserve area was the best and most significant predictor of species diversity for all taxa studied. Reserve size thresholds, below which biodiversity declined rapidly, were observed at approximately 4ha for bird and frog diversity and approximately 2ha for plant and fungal diversity. Significant relationships were also observed for P:A Ratio, indicating the influence of various edge effects on all taxa. Isolation effects were observed in the form of an inverse linear relationship between distance to other large reserves and species richness for fungi, birds and frogs. Connectivity also produced a positive linear relationship for birds and frogs. It is concluded that the identification of fragmentation thresholds and relationships provides an important management tool for the design of networks aimed at conserving biodiversity in fragmented urban environments.

Driscoll, Don



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Beetles over the threshold. How many survive 90% habitat loss?

How much biodiversity can we expect to lose when “threshold” levels of habitat loss are exceeded? Whether or not a species declines from extensively cleared landscapes can be influenced by patch characteristics such as shape and condition, and species’ ecological traits such as dispersal ability. In central New South Wales, Australia, 90% of the mallee woodland has been cleared for agriculture. Using pit-fall traps to sample beetles at 10 sites in each of three 100 km² locations, I asked (1) What proportion of the beetle fauna is declining? (2) How is the impact of fragmentation mediated by remnant condition and shape? (3) Are ecological traits of beetle species correlated with responses to fragmentation? I will contrast this study with research in a naturally fragmented landscape in south-west Tasmania. The Tasmanian landscape consists of eucalypt patches 15-50m wide that are embedded in a sedgeland matrix. The patches occur in a range of contexts, from abutting very large rainforest patches to isolated by hundreds of meters. I will examine the landscape contexts in which beetle species disappear from the system, and this may demonstrate how generally important threshold effects are for the beetle fauna.

Drolz, Louise



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Carbon trading in an uncertain policy environment

The additional potential revenue derived from trading the rights to carbon sequestered in revegetation schemes underpins the financial viability of many current and proposed schemes. Australia's reluctance to either ratify the Kyoto Protocol or implement a domestic carbon trading scheme on a national level has added to the financial uncertainty and risks of carbon sequestration projects. This presentation will discuss some common risk management techniques and financial derivative instruments that can be applied to tradeable carbon rights to

decrease uncertainty and allow transactions based on carbon sequestration in vegetation to proceed in an environment of extreme policy volatility.

Dunlop, Michael



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Decision Points for Land and Water Futures

One hundred years ago Australian landscapes were very different from how they are today. Over the coming century there will almost certainly be equally as dramatic changes. Past developments of land and water resources brought profit to many, sustained vibrant rural communities and contributed significantly to national economic growth, but they also resulted in negative impacts, for example, on land resources, biodiversity and river health. No-one can predict exactly what changes there will be in the future, and what their positive and negative impacts will be. But it is possible to explore what the future might be like, and ask how we might do better. We have used a combination of traditional scenario planning methods and analytical simulation modelling to explore some of these issues from a national and multi-generational perspective. We developed and explored three scenarios for the use of land and water in Australia, over the coming 50-100 years, driven by global developments, society's aspirations for Australia's landscapes and technological developments. The scenarios represent a (not quite random) sample of feasible futures. The presentation will describe the rationale for developing the scenarios, the scenarios themselves and some lessons from the future (and the past).

Easton, Lyndlee C., Molly A. Whalen and Duncan A. Mackay



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Seed size, germination and seedling growth of Australian species of the desert and halophytic plant genus *Frankenia*.

This study focuses on seed germination and seedling ecology in the genus *Frankenia* (Frankeniaceae). *Frankenia* occurs in Mediterranean, arid and semiarid areas and shows considerable variation in seed size and in seed number per fruit. We tested the hypothesis that large and small seeded species differ in their germination behaviour. We compared germination rates of species of varying seed sizes at 16°C, 24°C and 30°C. Results indicated that larger seeds tended to germinate more rapidly. Both large and small-seeded species exhibited higher germination levels at cooler temperatures, but the decline in germination percentage at higher temperatures was more pronounced for smaller-seeded species. At the warmest temperature, the variability in final germination percentages was also greater among small-seeded species than among large-seeded species.

Plant responses to edaphic stresses such as salinity may be influenced by seed size. Seed size often has a strong influence on seedling success, with larger-seeded species showing a general tendency to survive better under 'difficult' conditions. *Frankenia* species often occur on specialised soil types, commonly on saline or gypseous soils. Results of experiments examining growth and survival of seedlings of several *Frankenia* species under varying salinity conditions will also be presented.

Ede, Fiona and Nigel Ainsworth



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Tree Recruitment in Riparian Zones - What Impact Weeds?

The long-term survival of riparian vegetation communities is dependent on the success of natural recruitment processes for key native species. It is often asserted in weed publications that many weed species prevent or limit the recruitment of native trees and shrubs, but there are limited data to back up these assertions, or to place weed impacts into the context of other processes impacting on recruitment. It is not known which weed species have most effect; which native riparian species are most susceptible to weed competition; which riparian systems are more at risk; the temporal components of the competitive relationship; or the shape of the recruitment response to weed density. A three year project, funded by the CRC for Australian Weed Management, is attempting to answer some of these questions. Assessment of weed cover and tree recruitment in a large number of riparian sites across Victoria will be undertaken in spring 2003. This dataset will allow the first extensive assessment of the relationship between weed cover and recruitment of native tree species in Australian riparian zones. Further experimental work will follow up key questions identified in the initial survey phase.

Edwards, Todd Andrew, Eddie van Etten and Ray Froend



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Environmental Correlates and Associations of Tuart (*Eucalyptus gomphocephala*) Decline

The declining health of Tuart (*Eucalyptus gomphocephala* D.C.) has been noted in literature since the beginning of last century, but only recently has the predicament caused media and public concern. This two phased study, firstly involved an assessment of Tuart crown condition at 46 sites across the Tuart distribution. At each site measures of crown condition were taken to indicate Tuart decline status, including: crown completeness, tree size reduction and crown condition indices. The second phase of the study involved collecting data on a wide selection of environmental factors considered to be important to crown condition. Including soil condition, fragmentation, hydrology, fire regime, anthropogenic activities, understorey and stand structure. All sites showed some crown decline, with most sites having average crown completeness (cc) of 65 and 85%, with considerable tree to tree variation. Six sites did have severe crown decline (cc <30%), predominantly sites from the Yalgourup region of the distribution. Classification by non-metric multidimensional scaling identified two crown condition classes. No strong correlations were found between crown condition and environmental variables measured (150 approx.). Only a number of mild significant correlations were found. Stepwise multiple regressions and general linear models did also help explain crown condition of Tuart.

Eldridge, David¹ and David Freudenberger²



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Ecosystem wicks: woodland trees enhance water flow in fragmented agricultural landscapes

Woodland trees provide a range of ecosystem goods and services, among them the enhancing water flow into soils. We report on a study to examine the impact of trees on water flow in an agricultural landscape with substantial areas of extant native vegetation. Water flow was examined within three landscape strata (below *Eucalyptus melliodora* and *Callitris glaucophylla* canopies, and within the inter-tree zone dominated by perennial grasses and cryptogams), and compared these with sites homogenised by cultivation.

On fine-textured soils, both sorptivity (the early phase of infiltration) and steady – state infiltration were significantly greater (approximately five-times) under the timbered strata compared with the grassy slopes or cultivation. We attribute differences to the greater proportion of macropores (large pores created by soil animals and plant roots) below the tree canopies compared with the non-timbered strata. We attribute the lack of a significant difference on the coarse-textured soils to differences in surface litter and plant cover which would expect to maintain continuous macropores at the surface and thus conduct large amounts of water. The tendency of grassy, cryptogam-dominant slopes to shed runoff and for the trees to absorb substantial quantities of water reinforces the important ecological service provided by trees which moderate large runoff events, and capture small amounts of water leaking from the grassy patches. In the absence of these ‘ecosystem wicks’, runoff would find its way into regional groundwater and contribute to rising salinity.

Elith, Jane



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Collecting data for modelling and evaluation

Ecologists collecting data on the spatial or environmental distribution of a species will piece together a set of data from previous surveys and / or do new surveys. The latter are often based on some sort of sampling scheme (e.g., stratified on environmental gradients). These data may be used to model the distribution of the species, and perhaps to evaluate how well these predictions fit the observations. This talk will present results of a simulation study that has shown some interesting (and sometimes disturbing) features of model building and evaluation. The results suggest that certain sampling strategies will produce data sets that commonly produce biased evaluations. In these cases the only way to reach less biased estimates of predictive accuracy is to collect independent data – but how much and with what sampling scheme? Some of the important issues in data collection, modelling and evaluation will be explored and some practical suggestions given. The results have implications for people intending to model species distributions or to use those predictions in conservation planning, population modelling or survey planning.

Ellis, Murray and Michael Bedward



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Modelling the impacts of habitat loss on vertebrate populations in the sheep-wheat belt of New South Wales

CafeAnimal is a spatially explicit, rule-based simulation program for modelling the population dynamics of territorial vertebrates. Model features include territories with floating boundaries; the use of map sequences to consider temporal and spatial changes in habitat resources; animal movement modelled in continuous space; the ability to depict various forms of social organisation; and tracking of individuals, groups and territories over time. We have developed CafeAnimal as part of research into predicting biodiversity outcomes for alternative policy and management options in an agricultural landscape: the sheep-wheat belt of New South Wales. Clearing of native woodlands in this region commenced over 150 years ago but has increased markedly since the 1950s, with a corresponding decline in native flora and fauna. In such fragmented landscapes, fauna species may take years to reach new population equilibrium levels even after clearing has ceased. We are using CafeAnimal to model the responses of selected species to past sequences of clearing and possible future landscape scenarios; to identify species at risk of continued negative responses to past clearing; and to explore landscape design questions.

Ens, Emilie



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Evidence suggesting that Chilean Needle Grass threatens the sustainability of the endangered Cumberland Plain Woodland

The Cumberland Plain Woodland community of greater Sydney has a history of intensive post-European anthropogenic disturbance. The few remnants of this woodland type are listed as endangered ecological communities under the Environment Protection and Biodiversity Conservation Act 1999 (Cth) and the Threatened Species Conservation Act (1995) (NSW). However the integrity of these relics is still thought to be jeopardised by exotic plant and animal species that see no legal boundaries. It was the aim of this study to determine whether a Weed of National Significance, Chilean Needle Grass (*Nassella neesiana*), imposed a real threat to the sustainability of the Cumberland Plain Woodland. Invertebrates are known as essential components of ecosystem functioning, and were hence employed as indicators of threat.

Infestations of Chilean Needle Grass at two locations were found through multiple regression and ANOVA techniques to exert a negative impact on the ant (Formicidae) fauna by altering the ground cover composition. Interestingly, a beneficial effect on cockroaches (Blattodea) and some beetle (Coleoptera) species was found to result from the change in plant architecture. At the site where a more extensive invasion was present, a significant negative impact was found on most invertebrate groups studied. The abundance of many invertebrates was not only affected by a direct change in habitat structure but also by indirect effects to the trophic hierarchy.

Etter, Andres¹, Hugh Possingham², Clive McAlpine¹, David Pullar³, Stuart Phinn³ and Martin Bell³



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Patterns and rates of Land Cover change in Colombian Ecosystems (1940-2000)

Colombia is one of the biologically mega-diverse regions in the world, but is heavily impacted by human activities, with over 40% of the land currently cleared of the natural vegetation. This presentation addresses the spatial and temporal patterns of change for different Colombian ecosystems, using multi-temporal data sets at 1:50 000 scale, and applying statistical and stochastic models to analyse the probabilities and identify the significant factors of change. A consistent sigmoid pattern of land clearing including four phases is established, but regional differences in the colonisation waves are evident. The results show that the order of importance and significance of factors such as soil fertility, distance to roads, and amount of neighbouring forest and secondary vegetation, change during the clearing process. Cattle grazing is the most extensive and impacting land use in recent Colombian history, with introduced pastures the major land cover type, having also the lowest transition probability to other covers. For the different ecosystem types, distinct rates of loss and fragmentation of their original cover are established. While savannas tend to be completely replaced in the landscape, forested

ecosystems tend to stabilize between 5 and 20% of the original cover. The proportion of remnant natural vegetation and patch size in forested ecosystems is correlated with topographic constraints, soil fertility and distance to roads. Conservation implications of patterns and rates of change of the major ecosystem types are discussed.

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When does nutrient accumulation under trees increase productivity?

Accumulation of nutrients under the crowns of trees and shrubs is a preeminent source of soil heterogeneity in open landscapes. This patchiness has been linked to increased productivity in systems with low resource availability: at same resource levels a system with patchy distribution should have higher productivity than a system with resources homogeneously distributed. This generalization is based on assumptions that have seldom been explored, let alone experimentally tested. The simple model assumes a checkerboard patch distribution, with the same proportion of patches of low and high resource availability, and random species distribution. In this paper I explore the consequences of relaxing these unrealistic assumptions, using simple models of productivity as a function of resource availability. The results indicate that the variance, as well as the average of resource distribution are key determinants of the outcome. A further simulation relaxes the assumptions of symmetric distribution of frequencies and random distribution of species. I use Poisson distributions of patches, and explore the response of a system with species with different resource/growth curves, sorting themselves in the landscape according to their performance. The results cast doubt on the generality of the connection between soil heterogeneity and increased productivity, and provide detailed, testable hypotheses.

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Can conservation learn from medicine about bridging the gap between scientists and practitioners?

Effective communication between researchers and practitioners is necessary so that practitioners understand and can apply research results to their management practices. In medicine, an evidence-based approach assists doctors to apply scientific evidence when treating patients. The approach has required the development of new methods for systematically reviewing research, and has led to the establishment of independent organisations to disseminate the conclusions of reviews. We ask whether systematic reviews can be applied to conservation. We find 1) that methods already applied in medicine for the review of non-experimental studies will be required for syntheses of conservation management; 2) that an independent organisation to guide the production and dissemination of systematic reviews is necessary for effective implementation of these reviews. By investigating the mechanisms employed in medicine for bridging the communication gap between researchers and practitioners, this paper highlights how far conservation needs to go to achieve effective implementation of science. There is also an urgent need for more research on the accessibility, communication and implementation of conservation science.

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Relative horn and body growth in bighorn rams vary with resource availability

In polygynous and iteroparous mammals, males may vary their allocation of resources to maintenance and to the development of secondary sexual characters according to food availability. We assessed the effects of resource availability on body mass and horn growth of bighorn rams (*Ovis canadensis*) at Ram Mountain, Alberta, Canada, over 30 years. Resource availability, measured by the average mass of yearling females, was negatively correlated with the body mass of rams of all ages, but it affected horn growth only during the first three years of life. Among rams aged 2-4 years, the heaviest individuals had similar horn growth at high and at low resource availability, but as ram mass decreased, horn growth for a given body mass became progressively smaller with decreasing resource availability. When food is limited, all but the largest young rams appear to direct more

resources to body growth than to horn growth, possibly trading long-term reproductive success for short-term survival. We found no evidence of compensatory horn growth: small-horned young rams became small-horned mature rams. Because young rams with long horns were likely to be shot by sport hunters, trophy hunting may select against rams with fast-growing horns.

Finegan, Anne



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The utility of ten road structures along the F3 Freeway as fauna underpasses.

Roads impact upon native fauna in many ways, including wildlife injury and mortality through collision with vehicles, removal and fragmentation of habitat, creation of barriers to movement and gene flow, isolation of populations, alteration of hydrological regimes, siltation of waterways and edge effects such as noise disturbance. Various measures, including fauna underpasses, have been proposed and implemented to mitigate the impacts of roads on fauna. A number of studies conducted overseas have specifically focused on the use of underpasses by wildlife. Comparatively few studies document the use of underpasses by Australian fauna. In this study, ten structures – comprising bridges, pipes, culverts and a purpose-built fauna underpass – along the F3 Freeway between Sydney and Newcastle were monitored over a six week period using sand traps. One of the aims of this study was to investigate whether there was a relationship between size and underpass use. Results of this study suggest that size alone does not determine the effectiveness of an underpass. Several factors, including quality of habitat within surrounding bushland, vegetation within an underpass approach, presence of directional fencing, topographical location, and length of time underpass has been available for use, are likely to interact with size to influence the effectiveness of an underpass.

Fisher, Nigel, Yvonne Nussbaumer and Michael Cole



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Sustainable Nutrient Acquisition after Coal Mining using the Legume-Rhizobia Symbiosis

Mining operations will pass through Ravensworth State Forest. Past land use in the upper Hunter Valley has greatly reduced plant root-microbe associations. Mine rehabilitation will require the use of alien substrates such as spoil. These materials are mostly deficient of biological activity and, therefore, of nitrogen, and provide a poor substrate for the reconstruction of forest. The focus of this study is to create an inoculum of rhizobia that will effectively nodulate a number of provenance species and to trial this inoculum on a number of soil substitutes. A library of >80 nodulating bacteria isolates has been isolated, and their host specificity for nine local species is being determined in a series of trials. Preliminary results show that *Hardenbergia violacea* is a generalist, able to form effective nodules with several of the isolates tested, *Indigofera australis* and *Acacia parvipinnula* are more specific in their ability to nodulate, while *Pultanea retusa* nodulates with all isolates tested to date, but only forms effective nodules with a minority of isolates. Further trials with other nodulating taxa are underway. Field trials involving *H. violacea* and a generalist isolate have commenced to determine rates of spread and nodulation ability in a number of substrates.

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Arid land vegetation dynamics after a rare flooding event: influence of fire and grazing

Arid vegetation is subjected to more or less frequent fire, drought, sporadic flooding events and grazing. Whilst fire, drought and grazing have been the subject of considerable research, little is known of the impact of flooding in arid environments. In this study we examined opportunistically the effects of an episodic flooding event, and its interaction with fire and grazing on molding the arid vegetation. We assessed vegetation in fenced and unfenced plots subjected to different combinations of flooding and fire. We used pRDA:s to decompose the explainable variation in the data. The results showed that average number of species per 25m² dropped from 12.3 in year 2000 to 6.0 in 2002, while cover increased from 27 to 83%. This increase in cover was greater when plots had been burnt than when not burnt. Flooded plots differed in species composition from non-flooded plots. Plots left open to grazing by vertebrates differed significantly from fenced plots, but the amount of variation explained was small compared with flooding and the change over time. Species that seemed to benefit most from flooding were the exotic *Nicotiana glauca* and the native *Pseudognaphalium luteoalbum*. Species

associated with non-flooded plots were most notably *Triodia scariosa* and *Ptilotus exaltatus*. Increase over time was exhibited by eucalypts (resprouts) and the grasses *Triodia scariosa* and *Stipa* sp. Short-lived perennial herbs decreased. The exotic *Nicotiana glauca*, was found associated with unfenced plots. The results indicate that relative interaction between episodic flooding, fire and grazing had major impacts on the native vegetation composition. Major flooding events not only trigger native species germination and recruitment but also create an avenue for exotic species to invade.

Ford, Fred



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Rock on! Ecological consequences of pebble-mounds

Pebble-mound mice are a group of Australian tropical rodents. Pebble mounds are rock structures built above and within nesting burrows. They are a unique behavioural determinant of aspects of these species ecology. Mounds are a critical limiting resource, and perform an important role in nest defence. The need for mounds manifests itself as a need for pebbly substrate at local and landscape scales. Compared to other small conilurine rodents the population dynamics of pebble-mound mice are stable, and populations are immobile. Fire does not have a marked effect on the habitation of an area, or on the size of a population in the short or medium term. Sympatry of pebble-mound mice and morphologically similar *Pseudomys* species may be facilitated by the very different ecological attributes of population and landscape ecology that result from pebble mound building.

Ford, Hugh, Stephen Debus and Annette Harrison



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Ecological processes causing the decline of woodland birds across southern Australia.

The second Bird Atlas confirmed substantial declines in many woodland birds across southern Australia, over the last 20 years. Small, ground-feeding and aerial insectivores, such as robins, flycatchers and woodswallows, are most affected. These declines are primarily due to the widespread clearance, fragmentation and degradation of woodland. However, ecological processes that cause populations to decline, and sometimes go extinct, are unclear. We explore three hypotheses: inadequate dispersal, high nest predation and poor habitat structure. Patchy distribution and local extinction of robins near Armidale suggest that they rarely colonise remnants or rescue sub-populations. Translocated Yellow Robins re-established in a nature reserve from which they went extinct. However, two Robins also dispersed naturally to this reserve. Open-nesting birds suffer high levels of nest predation. Culling of Pied Currawongs, a major nest predator, increased the survival of artificial nests and led to more robins fledging. Caging of nests also increased the productivity of robins. Yellow Robins occupied sites with high shrub or sapling densities. If different bird species prefer habitats of different structure, this could account for the lack of relationship in their patterns of decline across NSW.

In conclusion, probably poor dispersal, low nest success and recruitment and inadequate habitat all contribute to the decline of woodland birds. Resources are being committed to connecting remnants to increase dispersal. Control of native nest predators may be beneficial, though is controversial. Furthermore, fire and grazing could produce appropriate habitat structure for the most needy species.

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Experimental manipulation of habitat structure: a retrogression of the small mammal succession

During post-fire succession in wet heath, *Rattus lutreolus* follows *Pseudomys gracilicaudatus* and becomes dominant with time. Abundance of each species correlates with vegetation density in markedly different ways. Asymmetric interspecific competition has been demonstrated using controlled, replicated removal experiments. We examined if vegetation density was causal, manipulating habitat by clipping 60-70% of the vegetative cover from 100 m² area surrounding each of six trapping stations on four experimental plots, with four controls undisturbed. We monitored effects with three censuses in January 1993 before clipping in early February, then three censuses to assess immediate, short-term effects, and others in August and December. The abundance of *R. lutreolus* was significantly reduced, abundance of *P. gracilicaudatus* remained relatively unchanged. An abundance index (standardized difference between clipped and control plots) assessed responses to habitat manipulation. *Rattus lutreolus* had significant negative values, *P. gracilicaudatus* had values close to zero,

while two species normally at very low abundance on wet heath, *P. novaehollandiae* and *Mus domesticus*, had strong positive indices soon after clipping. Habitat manipulation produced a retrogression of the post-fire small-mammal succession, demonstrating a causal role for vegetation density as the mechanism operating, and supporting the habitat accommodation model for animal succession.

Frazier, Paul¹, Ken Page², John Louis² and Sue Briggs³



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Effects of regulation on the wetland inundation regime of the Murrumbidgee River, NSW.

This paper describes the effect of river regulation on the floodplain wetland inundation regime of the mid-Murrumbidgee River. Techniques were developed to: describe the relationship between wetland inundation and river flow; quantify effects of regulation on the river flow regime; and quantify effects of regulation on the floodplain wetland inundation regime. Flow regime descriptors were combined with the wetland inundation – river flow models to describe the effects of regulation on wetland inundation regime. Regulation has reduced wetland inundation by approximately 40%. For the majority of wetlands the capture of small and medium floods by dams reduced wetland inundation substantially. However, for low connecting wetlands in reaches upstream of the main irrigation off-takes, summer irrigation flows have increased inundation.

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The resource value of native and exotic garden plants and their relative contribution to the diets of suburban nectarivores

A lack of food resources is often used as a reason for the decline in native birds in cities. This study investigated the value of exotic and native food resources to the nectarivores of suburban areas. We investigated nectar volume, concentration and sugar reward of two common native and two exotic garden plant species, and determined the relative preference of the nectarivorous bird community for native and exotic plants. Banksias and grevilleas produced significantly higher volumes of nectar than camellias and hibiscus per floral unit, per plant and per cubic metre of foliage. Banksias also produced significantly more concentrated nectar and consequently a higher sugar reward per floral unit than the other three genera. *Banksia* and *Grevillea* were preferred by all bird species, which spent significantly more time in *Banksia* than in any other genus. The number of floral units per plant and the number of *Banksia* and *Callistemon* plants in the garden influenced the time birds spent in a plant. Overall, the native genera were not only a more valuable source of food than the exotic genera, but they were also the preferred foraging sites for suburban nectarivorous birds.

Freudenberger, David and Nick Nicholls



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Thresholds: arbitrary or statistically valid?

Thresholds or discontinuities clearly exist in physical and chemical systems. A marble rolls along a table at a fairly constant rate until it reaches a threshold at the edge of a table, after which its rate of movement rises rapidly as it falls to the floor. A match doesn't burn until the heat delivered by striking the match is sufficient for ignition. Do thresholds or discontinuities exist in far more complex biological systems like landscapes? Perhaps. Simple grid-cell modeling suggests that connectivity thresholds might exist – connectivity decreases markedly for modeled sedentary species when habitat retention declines below 60% (e.g. Pearson et al. 1996). Are there any field data to rigorously support simple landscape models? Not that we've seen. Published data are usually analysed by simple graphical approaches or generalised linear models which are not amenable to identifying discontinuities or thresholds. We suggest that response variates should also be modeled as factors (classes) to try and identify a statistically significant break in data that otherwise appear to be continuous. We will briefly describe other statistical methods that can be used to identify thresholds. Until greater statistical rigour is applied, thresholds will remain a sometimes useful but essentially arbitrary concept.

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Crop killers? The Possible Impact of Paddock Trees on Wheat Production

There are trade-offs involved in keeping scattered trees in cropping paddocks. These trees provide a wide variety of wildlife habitat, but also get in the way of establishing, growing and harvesting grain crops. Some farmers claim that a tree costs \$50 a year in lost production and added costs. Possible? That depends on many variables including the density of trees, the size of the tree, its surface rooting zone, soil type and climate. If we assume a density of 0.3 trees/ha based on measurements from central NSW (Ozolins *et al.* 2001), preliminary modeling suggests that during a severe drought this density of trees could depress crop yields by about 8% based on a zero yield zone of 30 m radius around a tree 15 m in height. Yields could be depressed by less than 3%/ha if there is only a 30% loss in crop yield in a 30 m radius out from a 15 m tall tree. We will provide field data on yields around paddock trees from crops sampled this November. The estimates of long-term agronomic costs of paddock trees is relevant to analysing the public and private benefits and costs of maintaining trees in cropped paddocks, or replacing them in strips and blocks.

Garland, Paul. R., Stuart Mutzig and Evan. J. Harris



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Assessing the effect of insect growth regulators (IGR) on Red Imported Fire Ants (*Solenopsis invicta* Buren) using viability assessment techniques.

The Red Imported Fire Ant was discovered in Brisbane, Australia in February 2001. The Queensland Department of Primary Industries began an eradication program in September 2001 using baits including those containing insect growth regulators (methoprene and pyriproxyfen).

Insect growth regulators disrupt a fire ant queens' capacity to produce offspring, but do not cause immediate colony death. This delay complicates assessments of the effectiveness of treatment. To determine whether remaining active colonies have been affected by the baits two key assessments methods were used: (1) presence or absence of worker pupae in nests; and (2) insemination and ovary status of queens. Non-viable colonies were indicated by the absence of worker pupae and presence of queens with non-functional ovarioles. These viability assessments were also supported by: the presences or absence of other invertebrates in the nests; wingless alates in the nest; and a change in production from worker to reproductive brood type.

Gibbons, Phil and Sue Briggs



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Where are the jewels in the crown? Vegetation condition benchmarks for widespread woodland types in Central West New South Wales.

Premises for using reference conditions as benchmarks to inform ecosystem management include the following: (1) contemporary anthropogenic change may diminish the viability of many species adapted to past conditions and processes; (2) approximating past conditions is a suitable strategy for ecosystem management when our understanding of natural ecosystems is limited; (3) managing within the constraints of site variability can be more cost-effective than managing outside these constraints; and (4) natural variability is a useful benchmark for evaluating the extent of anthropogenic change within ecosystems. We quantified benchmark values for several surrogates of vegetation condition across seven broad vegetation types on sites identified by a range of experts to exhibit least evidence of modification since European settlement. Of 441 plots that were measured, 70% had at least one cut stump, 42% had evidence of recent grazing by stock, 39% had perennial exotic plants and 35% had evidence of rabbits. Thus, our benchmarks represent a substantial degree of modification since European settlement. We summarise values for several proven surrogates of vegetation condition measured on these plots: tree diameter distribution; tree regeneration; tree hollows; dead trees, coarse woody debris, bare ground cover, cryptogam cover, litter cover and cover and species richness of native plant lifeforms. We discuss how these data can be used, and abused, in ecosystem management.

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Management of Wildlife using Repellents: Movement of Red-necked Wallabies (*Macropus rufogriseus banksianus*) through a Scent Barrier.

Captive two-choice feeding trials highlighted the potential of both Plant Plus (Roe Koh and Associates) and an egg formulation for use as repellents with red-necked wallabies (*Macropus rufogriseus banksianus*). Further trials to assess if scent barriers (constructed from egg or Plant Plus) could influence the movement of red-necked wallabies were conducted in Autumn 2003. Ten red-necked wallabies were housed in a large semi-natural enclosure. Each of the barrier treatments (Plant Plus, egg) and control barriers (water, dry), were trialled four times in a random sequence. Scent barriers were trialled over 24 hour periods, with recovery periods following each trial. Scent barriers were placed at the interface between the main enclosed area and the feeding area. Movements of wallabies between the two areas were monitored by video surveillance. The numbers of wallaby movements through the Plant Plus barrier were significantly fewer than the number of movements through the control barriers. The numbers of wallaby movements through the egg barrier were not significantly different to the number of movements through either the control barriers or the Plant Plus barrier. The implications of these results for wildlife management (eg. roadkill abatement) will be discussed.

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One size fits all? Fauna use of road underpasses in northern NSW

In the last few years there has been widespread recognition by Australian government authorities of the potential benefit to fauna of underpasses beneath roads. These structures, if coupled with directional fencing installed parallel to the road, not only prevent road deaths but can enable fauna to continue their normal movements across the landscape. In Australia, the NSW Roads and Traffic Authority has been at the forefront of trialling this amelioration measures and has included underpasses in sections of the Pacific Highway upgrade. This study examines the results of the monitoring of 23 fauna underpasses located along an 18 km section of the Pacific Highway between Bulahdelah and Coolongolook. A total of 12 native and six introduced vertebrate species were recorded using the underpasses. Some of the underpasses record as many as 23 passages per day while others recorded as few as four. We also compared the efficacy of the purpose-built 3m X 3m box culverts with larger 'default' underpasses such as bridge and road underpasses. The potential influences on fauna use of other variables, such as presence of vegetation near the entrances and quality of adjoining habitat, was also examined.

Gillieson, David and Les Searle



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Estimating rainforest canopy connectivity across highways in the Wet Tropics World Heritage Area

The availability of high resolution (sub-metre) digital imagery presents opportunities for the estimation of landscape ecology metrics at the individual tree canopy scale. In the Wet Tropics of Queensland, linear barriers such as roads and powerlines fragment rainforests, and limit connectivity for a variety of species. In this study we estimate the canopy connectivity across a major road that bisects rainforest communities on the coastal escarpment near Cairns. Road details are gained from AutoCAD files from the Main Roads Department, while canopy details are gained from orthorectified digital aerial photography with a ground resolution of 0.30m. Their intersection enables estimation of canopy connectivity and road verge cover along a seven kilometre stretch of highway. The implications of this analysis for "No Net Loss" in World Heritage values during road upgrade are discussed.

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Evidence for the Balance of Nature: From a Guild of Forest Inhabiting Ground Feeding Birds

Density estimates of up to eight co-existing species, were made at 94 sites stratified within the Macleay-McPherson overlap zone. Energy expenditure, total density and richness of size classes and species in each assemblage, was found to be proportional to energy and nutrient turnover in forest detritus. Compensation for different body weights by population density, lead to the remarkable constancy of energy expended by the average ground feeding bird at any site (62±2 MJ / 10ha / year). Smaller species exhibit density compensation, where large species are precluded from occurring, apparently due to habitat edge effects on economic foraging by larger birds. Assemblage power expended per unit biomass supported, was a near constant minimum at 10.41±0.22 watts/kg, irrespective of species composition and assemblage energy expenditure, with a corollary of maximising inter-specific relative to intra-specific competition. This result is plausibly interpreted as a co-evolved assembly rule, based on efficient food allocation that economically optimizes fitness across all species. These results support a highly co-ordinated super-organismic organization for various aggregates of this guild, (congeneric pairs, co-existing species, biogeographic division associates), apparently through the co-evolution of mutualistic niches. This leads to a "centrifugally structured" guild, consistent with a shared preference niche model.

Gosper, Carl



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Invasive Bitou Bush alters the bird community of coastal vegetation

Invasive plants can alter the abundance and composition of fauna communities. These changes are not consistent and are likely to vary with plant, site and ecosystem characteristics. Bitou Bush (*Chrysanthemoides monilifera* spp. *rotundata*), a vertebrate-dispersed invasive plant, has become established along 80% of the NSW coastline. I investigated whether dominance of the vegetation by Bitou Bush affects the abundance of birds or composition of the bird community, which species of birds are affected, and over what periods of the year the impacts are greatest. From bird surveys in invaded and natural vegetation, I found the abundance of birds to be significantly lower in invaded vegetation over the period of the year when flower resources provided by native plant species were greatest. This was most pronounced for insectivorous and nectarivorous species. However, canopy cover of a key native plant species, *Banksia integrifolia*, showed as strong a relationship with bird community composition as did cover of Bitou Bush. For bird conservation in coastal NSW, I argue that management of key native plant species is more important than management of Bitou Bush per se.

Gove, Aaron



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Isolated trees: their role in improving conservation value of matrix habitats. A perspective based on the study of Mexican ant communities.

In many countries, current reserve systems are inadequate for the long term persistence of many species. Greater emphasis needs to be placed on managing matrix habitats for conservation, and integrating land use with habitat conservation. This is vital in the Gulf Coast of Mexico, in which only 2.3% of land is placed within a formal reserve system. In this study, I examine the extent to which the ant community is conserved by isolated trees and, precisely, which subset of the community is conserved in these trees. In comparison to trees occurring in scrubland patches, isolated trees experience a significant depletion of arboreal ant species, and an invasion of ground-dwelling (matrix) species. This leads to significant contrasts in the scrubland and isolated trees, which at the same time support similar species richness. Despite significant contrasts in microclimate, size of species remains constant, while shape of ants differs, with ant species in isolated trees being more gracile. A second set of sites demonstrates that both retention of larger trees and promotion of secondary regrowth reduce loss of arboreal species. While isolated trees do increase habitat value of matrix habitat, it appears that regrowth and larger trees can provide valuable habitat.

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Host Specificity in Sarcanthinae Orchids

Orchid establishment in the wild is dependent upon a highly specialised fungal association, the benefit of which does not appear to be mutual. Thus, the spatial arrangement of orchids is likely to be a product of fungal distribution and, in turn, depending on the spatial arrangement of suitable fungal substrates. As part of a multi-disciplinary investigation into orchid-fungal associations I conducted an habitat analysis to determine whether the abundance and distribution of epiphytic orchids is indeed affected by the spatial arrangement of suitable substrates (host trees). My research suggests that for members of the Sarcanthinae sub-tribe (= Aeriidae) there is indeed a substrate specificity and that this relationship continues across the geographic distribution of the orchids. In each site surveyed, *Backhousia myrtifolia*, (Myrtaceae) is the preferred host for the three Sarcanthinae orchids, despite being a relatively small component of the overall tree flora. Further, we suspect that each orchid is dependent upon different fungal symbionts. Future research will determine the degree to which these orchids and their hosts are dependant on particular fungi and whether or not the interactions change across the distribution of the orchids.

Graftdyk, Jon, David Goldney and Johannes Bauer



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Optimising restoration of *Casuarina cunninghamiana* woodlands in river floodplains in the Central Tablelands of New South Wales

Many pre-European riparian upland rivers and creeks appear to have been characterised by a narrow fringing forest of River She-oak. Extending further into the floodplain, an irregular band of River She-oak woodland with a predominantly grassy understorey, was often present. While both woodland and fringing forest were cleared by Europeans, the fringing forests have been able to regenerate naturally under a wide range of conditions. In contrast, the *Casuarina* floodplain woodlands were and continue to be subject to a range of management regimes that mostly repress regeneration. Hence, attempts to recreate these woodlands now require restorative intervention, generally in circumstances where native understorey plants has been completely replaced by exotic weeds or pasture plants. A landscape restoration experiment was set up in two tableland upland catchments one on the Macquarie River near Bathurst and the other on the Cadiangullong Creek near Orange in the Lachlan River Catchment. The project was undertaken to determine the optimal site preparation conditions needed for restoration outcomes based on the use of tube-stock, and the factors that limit establishment and growth of *C. cunninghamiana*. The spit-split plot experimental design enabled a range of intervention measures to be assessed. Treatments included: scalped, scarified, scalped and scarified, burnt, irrigated, grazed (unguarded), mulched, deep drilled, longstem tubestock, transplanted and a control plots. The results of the experiments to date are illustrated and discussed together with the implications for floodplain restoration.

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Tidal wetland restoration: Spatial analysis of vegetation responses

Many floodplain and estuarine wetlands of the north coast of NSW have been drained and fitted with floodgates. This process resulted in significant environmental degradation including: loss of fish breeding grounds and nurseries; changes in vegetation communities; development of acid sulphate soils and reduced water quality. Restoration is based on returning aspects of the tidal regimes. However, little is understood of the effects of reintroducing tidal water on ecosystems that have developed behind the floodgates. This project analysed the changes to vegetation communities following the reintroduction of tidal water into the Yarrahapinni wetland (mid-north coast NSW).

Seasonal vegetation data were collected for vegetation community composition and health across seven communities over three years. Significant changes in species composition were recorded in three of the seven communities, while the health of all communities declined significantly. Multi-temporal satellite imagery will be linked to the ground-based analysis to investigate the spatial-temporal changes in vegetation communities to extrapolate data to regional scales.

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Methods for testing biodiversity surrogates for regional conservation planning

Biodiversity surrogates are essential for regional conservation planning. Surrogates can be broadly categorized as environmental (e.g. vegetation types for species) or taxonomic (one species group for another). All surrogates are imperfect representations of biodiversity, but some are better than others. Surrogates therefore need to be evaluated and their limitations recognised. Various methods have been suggested for testing surrogates with each having its particular advantages, assumptions and limitations. Each method also has its specific set of hypotheses, providing a different picture of the performance of the surrogate being tested. Here I examine two land types (environmental surrogates), one based on biotic data (forest ecosystems) and one based on abiotic data (environmental units). The test data sets consist of species of conservation concern, and indicate the likelihood of species falling through a conservation net based on land types. I apply several methods for testing the surrogates and outline their respective limitations and assumptions. The effectiveness of the surrogates varies, depending on the method for testing and I discuss the implications of these differences for further work.

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Stress indicators, due to salinity, in *Phragmites australis*: a long-term study

Within Australia the historically freshwater macrophyte *Phragmites australis* has begun invading coastal marsh areas. *P. australis* control is mainly based upon the reintroduction of saltwater tidal regimes, through removal of previously installed flood mitigation structures. This method of saltmarsh reclamation assumes that, as soil salinity values increase, floral composition will return to approximately those of pre-flood mitigation conditions. This project attempts to predict the mortality of *P. australis* to salinity over time, through the identification of specific stress indicators. We conducted a glasshouse trial over four months to evaluate if particular morphological, physiological and biochemical indicators may predict subsequent stress and mortality over time. The trial consisted of seven (0,5,10,15,20,30,40ppt.) salinity treatments (N=5) and eight (24,48,96 hrs, 1,2 week, 1,2 and 4 month) time periods. Before the end of the trial 100% mortality was observed in 40ppt NaCl and 25% at 30ppt. Plants were not affected at 15ppt. Results indicate that photosynthesis and respiration are affected at all treatment levels. However, photosynthetic and respiratory activity is able to recover at treatments below 20ppt NaCl within 48 hours. Although Chlorophyll a, b and carotenoids were consistently lower in the higher salinity treatments, long-term trends were altered by the onset of senescence. Over time, shoot count and height are negatively correlated to salinity, as is above-and below-ground biomass.

Gregg, Peter



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New developments in chemical ecology and insect pest management

Recent advances in insect chemical ecology have opened new frontiers for insect pest management using semiochemicals (behaviour modifying chemicals). The use of pheromones (especially sex attractants) is becoming widespread but is limited because these chemicals usually affect only males. Recent behavioural and electrophysiological research indicates great promise for the use of plant volatiles in attract-and-kill systems for female insects, as well as manipulation of trap and suicide crops, and the behaviour of natural enemies. In this talk I will explore these prospects, particularly in relation to the development of integrated pest management systems intended to reduce the dependence on conventional pesticides in the Australia cotton industry.

Griffith, Stephen J.^{1,3}, C. Bale¹ and P. Adam²



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The influence of fire and rainfall upon seedling recruitment in sand mass (wallum) heathland of north-eastern New South Wales

Wallum heathland is extensive on coastal sand masses in north-eastern NSW and south-eastern Queensland. Here the climate is subtropical, although monthly rainfall is highly variable and unreliable. We examined the influence of fire and rainfall upon seedling recruitment in bradysporous dry heathland (*Banksia aemula* R. Br., *Melaleuca nodosa* (Sol. ex Gaertn.) Sm.) and wet heathland (*Banksia oblongifolia* Cav., *B. ericifolia* L. f. subsp. *macrantha* (A. S. George) A. S. George, *Leptospermum liversidgei* R. T. Baker and H. G. Sm.) species. Two specific questions were addressed. Do elevated levels of soil moisture facilitate seedling recruitment? Is the post-fire environment superior for seedling recruitment? Field experiments demonstrated that heathland species studied here are capable of successful recruitment in atypical habitat, and this proceeds irrespective of fire and unreliable rainfall. Conditions for growth and reproduction were found to be adequate if not more favourable in dry heathland, and this outcome included species usually associated with wet heathland. Spatial and temporal trends in seedling emergence and survival were examined in relation to post-fire predation and plant resource availability. Existing ideas about wallum management and conservation are evaluated, in particular the role of fire.

Grimbacher, Peter, Carla Catterall and Roger Kitching



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Habitat fragmentation effects on beetle species in upland Australian Wet Tropics rainforest.

The fragmentation of rainforest and conversion to pasture is considered to be a major threat to biodiversity with predicted reductions in species richness and changes to species composition due to both area and edge effects. The high species and trophic diversity of beetles make them excellent study organisms to test habitat fragmentation theories. The Atherton Tablelands landscape in North Queensland contains rainforest remnants of varying sizes surrounded by a matrix of pasture. Beetles were sampled from six well-separated replicate sites within each of: pasture, small (4.8-0.75 ha) rainforest remnants, and both interiors and edges of large (>40ha) rainforest remnants. Four flight interception traps were operated for two weeks at each site. The 5935 beetles captured were placed into 325 species within ten family/ sub-family groups. Pasture sites were characterised by significantly lower species richness (ANOVA, $P < 0.001$), and a species composition that differed significantly from that of intact rainforest sites (ANOSIM, $P < 0.001$). Species richness did not differ significantly among intact rainforest sites although the species composition of small remnants was most dissimilar to that from the interiors of large remnants (ANOSIM, $P = 0.01$), with edges from large remnants showing more similarities to interior sites than small remnants. Fifty years after forest fragmentation, beetle communities in small remnants are changing, although remnants are still maintaining relatively high levels of species richness.

Groom, Philip¹ and Byron Lamont²



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Leaf and environmental attributes influence heat damage in sclerophylls

Mediterranean southwestern Australian experienced two successive days of extreme ($> 45^{\circ}\text{C}$) maximum temperatures and hot winds during the summer of 1991, resulting in adult mortality and extensive crown damage in a sclerophyllous mallee-heathland. To investigate the relationship between leaf attributes, plant environment and heat tolerance in sclerophylls, measurements of plant height, leaf clustering, leaf morphology (thickness, dry density, area, perimeter/area ratio), percentage crown damage and percentage mortality, and categories of exposure to wind, shade and bare soils, were recorded for 40 heat-damaged and 14 undamaged co-occurring species. Analysing the dataset by principal component analysis showed that undamaged species had thicker leaves (on average 61% thicker) than species with damaged leaves, and were more exposed to wind, sun and bare soil. Differences between undamaged and damaged species may be a result of preconditioning, whereby species growing in more exposed habitats were pre-adapted to tolerate periods of heat stress. It is unlikely that the study species were able to reduce leaf temperatures via transpirational cooling during the hottest part of the 2 day heatwave. The ability of a species to tolerate extreme temperature events will be determined by the interaction between leaf heat loads, leaf heat-storing capacity and the degree of exposure to environmental elements.

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Using Life History Characters from the Australian Angiosperms to Examine Patterns in Recently Extinct and Endangered Australian Plants.

Life history characters are increasingly being used to evaluate extinction risks and to determine whether there are patterns that present useful conservation directions. The utility of this approach will depend upon the completeness of the data set used to generate the expected values. Australia has at least 18 500 flowering plant species and c. 3% of these is considered recently extinct or critically endangered. A continental wide exploration of four life history patterns in the Australian flora (c. 18 500) was undertaken to determine whether patterns can be extracted from our recently extinct and endangered species. The important life history characteristics for this evaluation can be separated into those that affect population persistence (e.g. habit and duration) and those that influence reproductive success (sexual system and fruit type). Within the extinct data set of 32 species we detected a significant departure from the expected values for habit but not for duration, sexual system or fruit-type. In the habit character there are significantly less trees on the extinct list than expected. This may reflect the greater resilience of trees than other growth habits to extinction processes. Within the endangered data set of 500 species we found significant differences in the observed from the expected counts within all life history characters. We explore the significance and utility of combining life history characters as a tool for risk management. Finally we compare our findings with work outside of Australia.

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Effect of experimental trampling on alpine and subalpine vegetation in Kosciuszko National Park

Ecological impacts of recreation activities in protected areas are widespread and increasing. Activities such as off-track bushwalking can be particularly problematic in mountain environments, as vegetation can be susceptible to damage and slow to recover.

This study considered the impacts of increasing intensities of trampling (from bushwalking) to vegetation in tall alpine herbfields and subalpine grasslands in Kosciuszko National Park. Vegetation cover, species diversity and vegetation height were assessed to identify threshold levels of use. Treatments consisting of a control, 30, 100, 200, 500 and 700 passes were applied by walkers to each of five sites in the alpine and subalpine vegetation communities. Vegetation was assessed prior to treatment, at 2 weeks, 6 weeks and 12 months later.

Six weeks after trampling there was a significant decrease in grass cover, herb cover and vegetation height at 200+ passes as well as a reduction in species diversity at both alpine and subalpine sites. For 200+ passes there was also significant increases in dead material. At 12 months, limited recovery of grass and herb cover was evident. Species diversity however, had returned to pre-treatment levels. Vegetation height also showed signs of recovery for all treatment levels. The threshold level for trampling impacts for these two vegetation types appears to be around 200 passes.