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 poster presentation

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River Hydrology: Quantifying Droughts and Connectivity

Terms such as floods, droughts and hydrological connectivity are used to describe particular aspects of flow regimes for ecological studies but are rarely quantified. The simplest approach to characterising river flow regimes for ecological studies is to use statistics of the streamflow time-series, but this approach overlooks the spatial pattern of hydrological conditions across riverine landscapes. Quantification of flow regimes should include consideration of the ecological process of interest and both the spatial and temporal scale at which this process is important. This paper examines a number of ecological processes affected by flow variations and discusses suitable approaches to evaluating river flow regimes for their investigation. The key hydrological processes regulating spatial hydrological patterns across riverine landscapes are also discussed.

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The capacity of lantana (*Lantana camara* L.) to displace subtropical rainforest along the lantana/rainforest interface

Lantana is a highly aggressive exotic weed well established throughout eastern Australia and is able to displace native vegetation under a range of circumstances. Whether lantana is able to displace native vegetation in the absence of anthropogenic disturbance is subject of some disagreement in the literature. Some authors claim lantana can displace rainforest and resist its reestablishment. Whilst some authors claim that lantana cannot displace rainforest.

In the rainforests of southeast Queensland, lantana is able to maintain large and dense patches apparently for long periods. This leaves open the question whether lantana in these forests is able to displace the forest or whether the rainforest displaces lantana. In this study, lantana has been observed in a number of different locations in the border ranges between New South Wales and Queensland and there is little evidence of its capacity to displace forests in the absence of external disturbances.

The study being pursued here explores the reasons for the apparent inability of lantana to displace forest and focuses particularly on the shading of lantana by the forest and the capacity of forest species to grow through patches of lantana.

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The capacity of lantana (*Lantana camara* L.) to displace native vegetation

There is much conjecture amongst weed researchers as to what influences infestation and success of the environmental weed lantana. Despite extensive qualitative observation on lantana, many aspects of its ecology, biology and, specifically, its invasion ecology as a weed are unclear. There have been incidental reports of some facets of lantana ecology in relation to studies conducted on rainforest regeneration in Queensland and New South Wales.

There is much speculation amongst weed biologists and researchers as to what processes influence lantana infestation and success, especially in subtropical rainforest. The question remains however, as to what is the future for subtropical rainforests in the face of invasion by lantana? Will the lantana displace the rainforest progressively, as natural disturbances create ever more opportunities for the weed? Will the rainforest reclaim space that has been lost to lantana and eventually return to its natural rainforest state? Or is there a permanent stand off between lantana and the rainforest?

This study is mainly directed at looking at the dynamics at the lantana/rainforest interface, especially in the wetter subtropical rainforests of the MacPherson Ranges of southeast Queensland, where the studies will be centered on Springbrook and Lamington National Park.

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Detectability of the Southern Boobook (*Ninox novaeseelandiae*) in relation to season, moon phase and weather conditions

The detectability of the Southern Boobook in relation to season, lunar cycle, and weather conditions was investigated as part of a larger study of the pattern of distribution of the owl and other nocturnal birds. One aim of the larger study is to understand the relative strength or contribution of the significant driving variables at different spatial scales. However, surveys are necessarily carried out at a local scale under varying weather conditions, at different times of lunar and seasonal cycles. The efficacy of the survey depends on the meteorological conditions at the time. For example, moderate to very wet and windy conditions have been found to adversely affect the detectability of the Southern Boobook. This is true not only because of the reduction in activity of the owl, but also because of the diminution in the hearing and sight of the observer in more than moderate wind and rain. Other variables, with possibly less influence on the observer, have also been shown to affect the detectability of the Southern Boobook. These include; weather (temperature, cloud cover), moon phase, moon visibility, season, time of sunset. The findings from this study are discussed and compared with those from other studies.

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The impact of fire on an eastern buttongrass moorland, Central Plateau, Tasmania

This paper presents the first pre and post-burn comparison of vegetation structure and floristics in a Tasmanian sedgeland dominated by buttongrass (*Gymnoschoenus sphaerocephalus*). It examines the results for the first three years of monitoring post-fire responses of plant species at a highland site in central Tasmania. Some significant changes from the pre-burn structure and floristics of the site are evident. Although the height and density of the vegetation are still less three years following fire compared to the original vegetation structure, most species have recovered to their pre-burn covers and the loss of density is primarily due to the loss of accumulated dead plant material in the fire. Several herb and graminoid species including grasses have increased in both frequency and cover post-fire and some herbaceous species absent in pre-burn vegetation were present in the post fire vegetation resulting in an overall increase in species richness. These results have implications for fire management practices in this montane eastern moorland vegetation.

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When too much grazing is clearly enough – floristic thresholds for jarrah and wandoo remnants.

Jarrah dominant and wandoo dominant remnants in south Western Australia were studied to examine their ability to recover their floristic composition after livestock grazing. Wandoo remnants increased both recruitment and cover of native species after ten years of grazing exclusion. In contrast, only cover of native perennial species in Jarrah remnants increased, giving the appearance of recovery from grazing. Numbers of exotic species did not decrease in either community after livestock were excluded. Lack of recruitment of both understorey and overstorey species appeared to be related to depleted soil seed bank, dominance in the jarrah remnants of resprouter species susceptible to sustained grazing pressure and changed soil chemical and physical characteristics. Size of remnant was also important. Grazing exclusion, as a single management practice, will only be useful where remnant vegetation has been infrequently grazed and impacts are low. The concept of crossing thresholds in the degradation of Australian remnant woodlands means that any attempt at restoration of Jarrah and Wandoo dominated remnants in south Western Australia will involve a much greater degree of management than simply removing the disturbance. Additional management is required to increase native species recruitment and decrease the presence of exotic species.

Sullivan, Leigh and Richard Bush



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Geochemical aspects of sulfate salinity in the waterways of the Murray-Darling Basin.

Salinisation of inland waterways is often thought of only in terms of electrolytic conductivity (ie. EC) units, or as sodium chloride (NaCl) with little attention paid to the composition of the ions. Sulfate (SO₄⁻) is often a major anion component of the salinisation of our freshwater bodies, yet its effects in respect to salinisation have received little if any attention in Australia. Sulfate salinisation is known to have the potential to greatly alter the ecology of freshwater ecosystems by shifting the chemistry of bottom sediments towards those of marine environments, causing major biological and chemical changes in the river bed sediments and the overlying water column. Sediments, sediment pore waters, and overlying waters from rivers and other waterways in the Murray-Darling Basin were analysed. The results indicate that sulfate reduction processes sufficient to result in the accumulation of appreciable iron sulfides (monosulfides and pyrite) are occurring widely within freshwater river environments and in waterways within irrigated landscapes in the Murray-Darling basin of Australia as a result of elevated sulfate concentrations consequent of salinisation. Processes that will impact on the ecology of these environments as a result of sulfate salinity include: sulfide toxicity, increased nutrient mineralisation, and deoxygenation of rivers.

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Demographic shifts and changes in spacing behaviour in an outbreak population of mice

In the grain-growing regions of south-eastern Australia, wild house mice (*Mus domesticus*) occasionally irrupt to very high abundances after several years at low numbers. These outbreaks are a classic example of a breakdown in density regulation within a population. The potential exists for a population to be self-regulated by social interactions termed spacing behaviours, specifically: territoriality; dispersal; breeding inhibition and social mortality. The current study investigated the demographic structure of wild mouse populations and the associated changes in spacing behaviours leading into, during and after an outbreak. In particular, the ratio of residents to transients at each site was monitored for each sex and age cohort over the outbreak year. Re-detection of marked mice was enhanced by using a combination of live-trapping and an automated event-recording system designed to identify previously marked mice that may have become trap-shy. Over the study period, a significant shift in spacing behaviour was observed. As the outbreak progressed and abundances increased, the population became less transient, potentially due to a lower proportion of young mice in the population. The implications of this age structure shift and change in spacing behaviour are discussed.

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Biodiversity Loss and Slash-and-burn Agriculture: Underlying Causes and Essential Strategies for Conservation

In the tropical forests of the world where the richest biodiversity resides alongside some of the poorest people, rapid and acute loss of biodiversity occurs from deforestation as a consequence of widespread slash-and-burn agriculture. This paper identifies and evaluates the underlying causes that drive what used to be a traditionally sustainable form of agriculture into an unsustainable cycle that consequently threatens biodiversity. Amongst these causes are population growth and peasant poverty, low levels of agrotechnology (less intensive but highly extensive cultivation methods) and the lack of property rights and tenure regimes. In light of the varied nature of the problem, conservation requires a multidisciplinary approach. Thus any successful conservation plan should address three fronts— socioeconomic, eco-agricultural and institutional. This paper concludes by suggesting a range of strategies that include prioritizing poverty alleviation and providing appropriate economic incentives, enhancing traditional farming practices with agroforestry and eco-agriculture, implementing property right systems and introducing workable protected area policies.

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Chronology and Palaeoecology of an acidic wetland peat northeastern NSW.

This paper provides the results of a palaeoenvironmental study into the chronology and landscape history of two sites located within the wetlands at Byron Bay northeastern NSW. Both sites contain sediments that span from early Holocene (8,710 yrs BP) to the present. The results indicate that although some changes in the location and magnitude of the watercourses may have taken place, throughout this long period the major vegetation types remain very similar. In particular *Melaleuca quinquenervia* open swampy woodlands with herbaceous understories dominate the vegetation sequences. These results have assisted local management authorities plan revegetation strategies

Keywords: peat, pollen, phytoliths, diatoms, wetlands, palaeoenvironments

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Disturbance and the Hastings River Mouse: Landscape-scale processes and management of an endangered species

The endangered Hastings River Mouse, *Pseudomys oralis*, is patchily and sparsely distributed in forests of the temperate eastern Australian escarpment, primarily in higher rainfall areas of the Northern Tablelands. The diet of *P. oralis* is similar throughout its range, indicating quite specific dietary requirements, however the mix of plant species required only occurs in some areas of these forests. The key ecological processes that affect this floristic composition are examined in this paper. There is considerable disagreement about the habitat requirements and appropriate management of the Hastings River Mouse, in particular the impacts of cattle grazing and fire. Both are complex processes, and their effects depend on the nature of the regime of disturbance and the environment and context in which it occurs. The notion that some species, especially endangered ones, may benefit from anthropogenic disturbances such as grazing and fire is unpalatable to many people. However, ecological theory clearly indicates that intermediate disturbance can promote diversity and benefit many species. In this paper the ecological processes that affect habitat quality for *P. oralis* are discussed, results from a recent study of disturbance in the wet sclerophyll forests of the Northern Tablelands are presented, and new management options suggested.

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Mechanisms of coexistence in the sympatric lizards, *Ctenotus robustus* and *Ctenotus taeniolatus* (Scincidae).

I examined the role of microhabitat use, thermal requirements and competition in coexistence of *Ctenotus robustus* and *C. taeniolatus* on sand-mined dunes in the Port Stephens-Myall Lakes region, south-eastern Australia. *Ctenotus robustus* and *C. taeniolatus* coexisted at medium vegetation densities, but *C. taeniolatus* were rare in or absent from open vegetation and *C. robustus* rare in or absent from dense vegetation.

Ctenotus taeniolatus selected lower laboratory temperatures than *C. robustus*. In medium vegetation *C. taeniolatus* selected cooler and *C. robustus* hotter microhabitats. In open vegetation where *C. robustus* used cooler microhabitats, *C. taeniolatus* survived when competition from *C. robustus* was reduced. However, reduced residency times and lack of breeding indicated open vegetation was less suitable for *C. taeniolatus* than medium or dense vegetation. Removal of *C. robustus* from medium vegetation resulted in an influx of and improved body condition of *C. taeniolatus*. Removal of *C. taeniolatus* from medium vegetation increased residency times of *C. robustus*, but slower growth suggested that medium was less suitable than open vegetation for *C. robustus*. In dense vegetation hotter microhabitats were uncommon. Competition from *C. taeniolatus* prevented juvenile *C. robustus* using dense vegetation but dense vegetation was not suitable for adult *C. robustus*.

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Effects of tourism on Australian sea lions (*Neophoca cinerea*) at Seal Bay Conservation Park, South Australia

Seal Bay Conservation Park is one of the largest breeding colonies of the Australian sea lion (*Neophoca cinerea*), a species listed as “rare” by the South Australian government. It is imperative that the impact of human disturbance on *N. cinerea* at Seal Bay is examined, since previous studies have found adverse behavioural responses to such impact in other pinniped species. The objective of this project is therefore to determine if tourism at Seal Bay is affecting sea lion behaviour to the extent that population growth is suppressed via altered social interactions and/or breeding habits. This aim will be achieved through the use of behavioural observations, controlled approaches, tourist group manipulations, and comparison of sea lion activity budgets on beaches with and without human disturbance. These results will assist in creating a management strategy to sustain biodiversity and ecotourism at Seal Bay.

Thomas, Paul¹, E Charles Morris¹ and Tony Auld²



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Before and after the fire: how seasonal conditions influence the germination response to fire

The post-fire germination response of seeds is well known. Whether other factors, such as temperature or water potential, that vary seasonally influence the post-fire germination response is less well known. This question was investigated for a number of species that form soil seedbanks in SE Australia. Fire related germination cues (combinations of heat shock and smoke) were combined with a range of ‘post-fire’ temperatures and PEG controlled water potentials. Interactions between heat shock levels, and ‘post-fire’ temperatures and water potentials occurred, hence differences in germination responses across fire intensities may depend on the season in which fire occurs. Heat shock and smoke increased the rate of germination, but did not reduce the water potential at which germination can occur. Germination responses were related to the habitat of these species.

Thompson, Scott and Thompson, Graham



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Rehabilitation index and monitoring protocol for evaluating the success of rehabilitated disturbed areas

I will describe a rehabilitation index for measuring the degree to which a disturbed area has developed a near natural, self-sustaining, functional ecosystem similar to that in the adjacent undisturbed areas by using reptile assemblages as the bio-indicator. I will present data from two years field sampling and demonstrate the usefulness of a rehabilitation index that I have developed. This rehabilitation index provides mining companies with an objective measure of rehabilitation progress in developing sustainable and functional ecosystems. The rehabilitation index uses a series of quantifiable parameters (diversity, taxonomic and ecological groups) for comparing reptile assemblages in rehabilitated sites and the adjacent undisturbed areas. This is a new and innovative technique not previously reported. Weighted scores for each parameter and a final score are calculated for each disturbed area based on the reptile assemblage for the nominated analogue site. A target rehabilitation score is defined. This target score represents the level at which rehabilitation interventions are no longer required and given time the disturbed area will eventually develop into a self-sustaining, functional ecosystem that resembles the adjacent undisturbed areas. Results from this study will form an important component to aid mine site environmental officers in planning their disturbed site rehabilitation programs. This will lead to a reduction in the cost of rehabilitation and a more environmentally sustainable end landscape..

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Understanding the success of invasive plants: a leaf carbon strategy approach

The invasion of natural communities by introduced plants is recognised as a significant threat to global biodiversity and as a major component of global change. Much of the success of invasive plant species is thought to be associated with their superior ability to capture and maintain space, with potential for rapid growth (particularly where resources are not limiting) being a key component of this ability.

The potential for rapid growth is a fundamental component of plant ecological strategies. We examined trade-offs among leaf traits and assessed whether there are consistent differences in leaf trait relationships between invasive and native plant species. We measured the specific leaf area (leaf area/leaf mass), photosynthetic capacity, dark respiration rate, and leaf nitrogen and phosphorus concentration for invasive and native species co-occurring in a range of Australian habitats including woodland on sandstone-derived soil, woodland on shale-derived soil, riparian vegetation, sub-tropical rainforest, and alpine vegetation.

Tierney, David and Glenda Wardle



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Indehiscence in the Myrtaceae shrubs *Kunzea rupestris*, *Kunzea capitata* and associated putative hybrids: a new understanding of dormancy, germination and dispersal capabilities for the Myrtaceae.

Increased levels of disturbance and fragmentation imply alteration to fundamental landscape processes such as fire regimes, dispersal or colonization. For many Australian plants their ability to persist, reproduce and recruit in these altered landscapes are unknown. General traits or models help in guiding our understanding of these changes, and for some species there is comparatively good data. The Myrtaceae, for example, is an important widespread family within Australia and we have an understanding of the reproductive traits of a number of well studied genera and species in the family. However, even in this family, there are a range of widespread genera and reproductive traits that remain poorly understood. A number of species in the Myrtaceae have thin walled indehiscent capsules. Previous studies have failed to demonstrate the functionality of these capsules. We compare dispersal, dormancy and germination patterns in two *Kunzea* species and associated putative hybrids from disturbed sites. We investigate these in relation to indehiscence and provide data that indicates distinct dispersal, dormancy and germination patterns.

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Regional Scale Vegetation Sampling of the Greater Illawarra and Southern Highlands Region

Regional native vegetation conservation and management relies on accurate and reliable information about the extent, distribution and floristic composition of vegetation across the landscape. Traditionally, regional scale vegetation maps have been favoured as a method for representing such information. Vegetation maps are often created, distributed and utilised as accurate representations of native vegetation across a landscape. However, due to political priorities, resource, time and access constraints, the majority of existing vegetation maps in eastern New South Wales have been based on data primarily collected on public lands. With over 80% of the Eastern Division of NSW being privately owned, it is questionable if such maps are providing accurate and reliable information for regional vegetation management and conservation. In a recent vegetation survey of the Greater Illawarra and Southern Highlands native vegetation region, we aimed to achieve a balanced sampling across all land tenures for the purpose of mapping native vegetation at a regional scale (1:100 000). By sampling both public and private lands we were able to investigate if sampling of private lands reveals further insights into floristic diversity, composition and distribution across the landscape and therefore highlight the adequacy and/or inadequacy of information collected on public lands in providing an accurate and reliable source of information for regional vegetation planning and management.

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Implenting Wild Country in Northern Australia

Northern Australia retains exceptional natural values both on land and sea. The lands are of international conservation significance as one of the few large and intact Wet/Dry tropical ecosystems remaining on Earth. The seas of the northern coastline remain relatively unpolluted and free of exotic invasive organisms. To date planning for developments in Northern Australia has relied largely on conservation models developed in fragmented landscapes in southern Australia. Such models, which use targets for reservation and retention of natural ecosystems, are inappropriate for the effective protection and sustainable use of intact landscapes. Needed for the northern savannahs and seas is an approach that explicitly seeks to retain natural processes such as water flows both above and below ground. The Northern Australia Wild Country project seeks to establish the regional and continental scale processes in Northern Australia that are needed for biodiversity conservation and planning in the long term. Industries compatible with retaining these processes can then be developed to provide the economic and social development needed for Northern Australia. This approach can avoid the trade-offs which have dogged conservation work in the fragmented landscapes of southern Australia.

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Seed dispersal of invasive cadaghi (*Corymbia torelliana*) by stingless bees

Cadaghi is a north Queensland eucalypt, widely planted as an ornamental and amenity species, which is invasive in southern Queensland and northern New South Wales because of its unique seed dispersal mechanism. Native stingless bees forage for resin in cadaghi fruits, and seeds attached to the resin droplets are transported to the nest or hive. Seeds are discarded by bees outside the nest, where they germinate and establish in abundance. Our early estimates of dispersal distance in southern Queensland (>30 m to >300 m) were based simply on distance from the nest to the nearest fruiting tree. More recently, we have confirmed seed dispersal by bees at a natural stand of cadaghi in north Queensland. We used microsatellite markers to assess seedling identity, and determined that the average distance of seed dispersal by bees was 135 m (range 96-229 m). Additional sampling of cadaghi trees up to 1 km from nests will be used to estimate limits of seed dispersal. Cadaghi x spotted gum hybrids have great potential for plantation forestry in northern Australia but, because of the invasiveness of the cadaghi parent, our selection of suitable hybrids requires us to first assess their capacity for dispersal by stingless bees.

Kobavashi, Tsuyoshi and Anthony Church



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Role of nutrients and zooplankton grazing on phytoplankton growth in a temperate reservoir in New South Wales, Australia

The role of nitrogen (N) and phosphorus (P) and zooplankton grazing on the growth of phytoplankton was investigated at different times in Ben Chifley reservoir. Growth rates of phytoplankton without nutrient enrichment and without zooplankton grazing ranged from 0.009-0.423 per day (mean 0.224 per day, n=10), while the nutrient-stimulated growth of phytoplankton ranged from 0.085-1.031 per day (mean 0.461 per day). In situ nutrient enrichment bioassays (n=12) indicated that phytoplankton growth was limited by P in 33% of experiments, by both N and P in 25% of experiments and no limitation was found in 42%. Grazing rates of the reservoir zooplankton ranged from 0.023-0.199 per day (mean 0.078 per day, n=8). The effect of nutrient enrichment exceeded that of zooplankton grazing in 62% of experiments. Results suggest that the outcome of trophic interactions between phytoplankton and zooplankton can be influenced by supply rates of limiting nutrients in the reservoir.

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Thermoregulation during day-roosting by Australian long-eared bats, *Nyctophilus geoffroyi* and *N. gouldi*: advantages of thermally unstable roosts to energy expenditure.

Tree roost structures used by bats differ in thermal buffering qualities, which affect roost temperatures and therefore energetic costs of thermoregulation during day-roosting. To understand the interrelation between roost quality, thermal biology and energetics, we used temperature-telemetry to locate roosts and record skin temperatures (T_{skin}) of non-reproductive bats in open forest on the Northern Tablelands, NSW. In summer, bats mostly roosted under bark of ribbon gums and dead acacias and entered torpor every day. Torpor patterns mirrored the daily temperature cycle: bats were torpid early morning, aroused after partially passive re-warming to normothermy whilst diurnal temperatures were highest, but often re-entered torpor late afternoon. In winter, bats also roosted under bark, preferring a northern aspect, or in sun-exposed, dead trees. Torpor bouts lasted up to 13 days with T_{skin} as low as 3 °C, although T_{skin} fluctuated passively up to 15 °C/day. Arousals occurred at dusk, and during occasional warmer nights activity lasted several hours suggesting some winter foraging. Long-eared bats use torpor extensively whilst day-roosting throughout the year. However, unlike thermally stable roosts, energy expenditure was minimised by selection of tree-roosts providing low temperatures during torpor but also heat for passive re-warming and low-cost periods of normothermy.

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Interactions between two biocontrol agents, a leafhopper and a rust fungus, attacking the environmental weed bridal creeper

Bridal creeper, *Asparagus asparagoides*, is recognised as a weed of national significance. A biological control program for this weed was initiated in the early 1990's, leading to the release in Australia of a leafhopper, *Zygina* sp. in 1999 and a rust fungus, *Puccinia myrsiphylli* in 2000. Interactions between these two agents are likely since they occupy the same broad feeding niche and rely on bridal creeper foliage for reproduction. Although there are numerous studies on plant-herbivore and plant-pathogen interactions, few have focused on indirect herbivore-pathogen interactions. Using controlled field and glasshouse experiments, this project is investigating the indirect interaction between these agents and their effects on growth parameters of bridal creeper. The response of the weed to a single versus multiple agents will be explored in order to determine whether alterations of the plant caused by one agent affect the performance of the other agent. Preliminary results show the combined effects of these agents as additive. Relative growth rates of bridal creeper are discussed in terms of how these two agents interact in suppressing this weed, and how the results advance our understanding of plant responses to multiple enemies.

Turton, Steve, Miram Goosem, Craig Harriss and Guy Chester



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Application of no net adverse ecological impact concept to the Kuranda Range Road Upgrade

The requirement to consider no adverse impact (no net loss) is based on the assessment criteria set out in the Wet Tropics Management Plan 1998. The Plan includes a number of statutory policy statements and assessment criteria that set out the basis for issuing a permit for construction of roads through the World Heritage Area. A major principle is that of no net adverse impact on the integrity of the area. Integrity means the extent to which the world heritage values of the area or land (a) are in their natural ecological, physical and aesthetic condition; and (b) are capable of sustaining themselves in the long term. In this paper we develop and apply ecological indicators of no net loss to the Kuranda Range highway upgrade, west of Cairns. Potential indicators include: footprint of habitat disturbance, canopy connectivity, surface connectivity, riparian and aquatic connectivity, catchment integrity, linear edge effects, edge effects and visual dominance and scenic alteration. This study is underpinned by some 10 years of research on ecological impacts of linear infrastructure (roads and powerline corridors) in the rainforests of the Wet Tropics WHA.

Valentine, Leonie



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Impacts of repetitive burning in riparian habitats on bird assemblages in grazed open woodlands of north Queensland

Fire has the potential for widespread use in Queensland as a land management tool used to control the introduced weed rubber vine (*Cryptostegia grandiflora*). One possible fire management technique includes repeatedly burning areas within short time frames, including potentially sensitive riparian habitats where rubber vine is prevalent. However, the impacts of controlled burning on faunal assemblages in Queensland savannas are unknown. This project examined the impact of repeatedly burning riparian habitats to remove rubber vine on bird assemblages in Queensland open woodlands. Replicate experimental study sites were established on three ephemeral tributaries of the Burdekin River, north Queensland. Bird species number, abundance and assemblage structure were surveyed early 2003 and compared among three experimental treatments, including: unburnt controls, singularly burnt plots (burnt December 1999), and repeatedly burnt plots (burnt December 1999 and December 2001). Both species richness and overall bird abundance were significantly lower in the repeatedly burnt treatments compared to the unburnt controls. These results suggest that repeatedly burning riparian habitats in tropical savannas, within short time frames, will have substantial impacts on the avifauna.

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Linking decision making scales for improved natural resource management

Generally within Australia, the achievement of healthy landscape outcomes is dependant upon the decisions of multiple land managers who have a diverse range of goals and objectives for the use and management of natural resources. The coordination of these diverse goals and objectives in both space and time is crucial to working toward healthier landscapes. Currently, significant emphasis is being placed on the use of regionally based approaches as a means to improve implementation of actions that contribute to healthy landscapes. Consequently, one approach to examining how coordination of goals may be improved is by linking property resource management planning to current regional and local planning efforts for sustainable natural resource management. This presentation will outline an approach to a study conducted with regional organisations and beef cattle producers within the Northern Gulf region of Queensland. The study focuses on understanding the influencing factors within the decision making environments of both the property and regional scales and examines the common links as well as differences between these environments. In particular, the study uses these understandings to develop potential options to improve capacity of individuals to contribute to achievement of regionally desired outcomes related to healthy landscapes.

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Inter-annual Rainfall Variability of Arid Australia – Greater than Elsewhere?

Climatic variability is a feature of most arid and semi-arid regions, but some such regions are more variable than others. Temporal rainfall variability has an important influence on many of the physical and biotic elements of arid and semi-arid environments. For instance, it influences: the rate and degree of run-off and depositional processes; plant and animal survival, growth and reproductive strategies; and, the degree of spatial patterning in such environments. There is also a conceptual link between rainfall variability and its prediction.. It has been claimed by several authors that the Australia's arid climate is more variable than arid regions elsewhere. In this study, inter-annual rainfall variability of Australian localities in the 100-400 mm average annual rainfall range were compared that of localities in other drylands across the globe. Rainfall data from almost 500 localities were used. Regression analyses of the data show that northern Australia drylands indeed has comparatively high rainfall variability for given rainfall averages, but is no higher than other arid regions located in the tropics such as the Thar, Kalahari/Namib and Somali deserts. Reasons for these arid areas having high variability are discussed, but seems chiefly related to the unreliability of cyclones, thunderstorms and monsoons in summer. Regions with lower than average variability relative to their rainfall average, which include southern Australian deserts, are also identified – these generally are those located at higher latitudes. Potential uses and implications of the data and analyses are discussed.

Vaughton, Glenda and Mike Ramsey



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Harsh environments favour gender dimorphism in *Wurmbea biglandulosa* (Colchicaceae)

In flowering plants, the evolution of dimorphic sexual systems (e.g., gynodioecy and dioecy) from monomorphic ancestors is often associated with aridity, or otherwise harsh environmental conditions. One hypothesis to explain this pattern is that harsh conditions adversely affect seed fertility of hermaphrodites more than females, resulting in greater relative female fitness in such environments. *Wurmbea biglandulosa* exhibits interpopulation variation in sexual system and in female frequency in dimorphic populations. We investigate how environmental quality and hermaphrodite seed fertility differ between monomorphic (hermaphrodites only) and dimorphic (females and hermaphrodites) populations and whether relative female fitness and female frequency are higher in harsher sites. Dimorphic populations were characterised by hotter and drier conditions with lower soil moisture and less vegetation cover than monomorphic populations. Consistent with these environmental differences, hermaphrodites had lower seed fertility in dimorphic than monomorphic populations. In dimorphic populations, relative hermaphrodite fitness was correlated with site quality and the frequency of females. By contrast, female frequency was not correlated with site quality. These results confirm that harsh environmental conditions play a role in the evolution of gender dimorphism in *W. biglandulosa* by differentially affecting the seed fertility of the sexual morphs.

Venn, Susanna



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Alpine plant ecology in Australia: the importance of snowmelt on plant function

Alpine plant communities are under threat from climatic changes, with the impacts likely to become apparent within coming decades. Recent trends and future predictions all point towards increasing temperatures and a loss of snow cover in alpine areas. Snow cover and timing of snowmelt is particularly important for alpine plant growth and development. Alpine plants are most vulnerable to a lack of snow in spring when the insulating properties of snow cover are reduced and plants become susceptible to frosts.

Part of my PhD study aims to simulate the effect of climate change in alpine regions by reducing snow cover over small areas, in different plant community types. Reducing snow cover (by use of wind-fences and shoveling) will lead to changes in environmental factors such as soil moisture, pH, decomposition rates, light availability and above- and below-ground temperatures. Changes in soil and environmental attributes can lead to changes in recruitment success, timing and abundance of flowering, growth and re-generation after fire. Significant correlations have also been found between timing of snowmelt and snow depth with flowering, biomass accumulation and standing crop, seeding and seedling-establishment. By quantifying these changes and responses, predictions can be made about the potential impact of climatic change and reduced snow regimes in these communities.

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Ecological thresholds in southern Queensland: lessons from the lizards

Remnant native vegetation in southern Queensland has been extensively cleared for agricultural development in the past 100 years. Resultant habitat loss and fragmentation remains the biggest threat to wildlife in the region. As a part of a broader project on ecological thresholds of habitat retention and management, this study seeks to establish relationships between degree and patterns of fragmentation in poplar box ecosystems (*Eucalyptus populnea*), and the responses of reptiles. Preliminary analyses are presented of reptile diversity and species composition in relation to the level of vegetation retention at three management scales: paddock (500 ha); property (8000 ha) and sub-catchment (275,000 ha). This information will guide future analyses and interpretation of thresholds. The study will provide information on long-term impacts of vegetation clearing on biodiversity. This will be used to revise the principles behind current assessments of land clearing, thereby leading to improved prescriptions for native vegetation management.

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Seasonality, dung specificity and competition in dung beetle assemblages in the Australian Wet Tropics, northeastern Australia.

We examined seasonal diversity, abundance and dung-specificity of dung beetles associated with their dung of native mammals in wet sclerophyll forest adjacent to rainforest in the Australian Wet Tropics. 542 dung beetles from 11 species were recovered from beneath the traps of 1104 mammal captures. Diversity of beetles associated with the dung of the northern bettong, a mycophagous marsupial, differed significantly from diversity predicted by a null model. Beetle numbers varied significantly with type of dung, indicating preference by beetles, and were positively correlated with a one-month lag in monthly mean minimum temperature and less strongly with maximum temperature and rainfall. Significantly more beetles per mammal capture were detected in the wet season than the dry season. The majority of beetle species showed a strong preference for either the *Eucalyptus* woodland or the adjacent *Allocasuarina* forest. Beetles occurring in the *Eucalyptus* woodland were typically only detected in the late wet and early dry seasons, while species from the wetter *Allocasuarina* forest were generally collected during the late dry/early wet seasons. A significant checkerboard species effect was detected in both time and space in both habitat types, suggesting competition for dung.

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Habitat as resource: modelling dynamics under revegetation

Extensive areas in the southern Australian sheep-wheat belts are the focus of current and future revegetation effort. Revegetation efforts vary in aim, scope and intensity and are widely expected to benefit biodiversity. However, little information is available on the time-course of revegetation and, importantly, its provision of habitat resources for fauna. This research aims to improve our knowledge of the time-course of habitat suitability for a comprehensive set of macrofauna likely to respond to landscape change (birds and mammals). Habitat is defined as a collection of resources (foraging substrate, nest sites) provided by three vegetation layers: ground-storey, shrubs and trees. Habitat requirements of fauna are coded according to use of a resource, such as hollows or ground-storey seeds. Growth-rate estimates of vegetation lead to habitat-resource trajectories over time. At any time, the abundance of a particular habitat resource is used to predict suitability for use by each animal species. The model can be used to compare revegetation scenarios including a baseline "business-as-usual" scenario. I describe results of analyses showing how land-use history and site productivity might affect provision of useful habitat for the macrofauna. This model suggests that biodiversity benefits of revegetation may be long delayed.

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Habitat segregation of *Banksia marginata* and *B. spinulosa* at Gibraltar Range, NSW.

Post-fire regeneration studies have shown that plant species may segregate into different habitats early in the lifecycle. At Gibraltar Range in northern NSW, *B. marginata* is largely confined to swamp margins, whereas *B. spinulosa* occurs in surrounding woodland. Both species are highly serotinous, although *B. marginata* is an obligate seeder and *B. spinulosa* is a resprouter. This project takes advantage of recent fires in 2002 to examine factors operating during juvenile lifecycle stages to explain the observed habitat segregation. In the glasshouse under optimal moisture conditions, a reciprocal germination and seedling establishment experiment demonstrated that soil type was not a key factor contributing to habitat segregation. However, in the field both species had similar germination in the swamp, but *B. marginata* had reduced germination in the drier woodland. The reduced *B. marginata* germination may be caused by low soil moisture, and may determine habitat segregation. Additional glasshouse experiments will examine the effects of different soil moisture conditions on seedling growth and survival. Also, a reciprocal seedling transplant experiment will be conducted in the field to examine habitat effects on growth and survival. These results will be used to examine further the pronounced habitat segregation of these *Banksia* species.

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Dispersal and seed bank ecology of a riparian invader, balloon vine (*Cardiospermum grandiflorum*).

Balloon vine (*Cardiospermum grandiflorum*) is a high impact invasive species of riparian habitats. Little is known about the reproductive ecology and dispersal of the species. This study aims to determine the importance of riparian corridors for dispersal of balloon vine and to understand seed bank recruitment dynamics of the species. Dispersal studies focus on the in situ seed bank and seed deposition patterns along stream corridors. Seed bank dynamics studies focus on seed germination requirements, seed longevity and patterns of seedling emergence from artificially constructed seed banks. Our initial results indicate that balloon vine produces large quantities of seed throughout the year and that many seeds are transported along stream corridors, particularly after flooding/rainfall events. Balloon vine seeds germinate in both light and dark, but in field conditions emergence is greatest for buried seeds. Seed bank sampling indicates a large in situ seed bank concentrated under and around existing infestations. A large proportion of the seed is dormant, suggesting a persistent seed bank. Ultimately this information will provide input to catchment-wide weed management strategies and riparian weed management programs via a greater understanding of reinfestation potential and more strategic removal programs.

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Aspects of the reproductive ecology and seedling establishment of *Banksia aemula*

In the family Proteaceae, selection for the ability to establish in nutrient poor environments is thought to be an important factor in determining the seed size-seed number trade-offs (Vaughton and Ramsey, 1998). As species from this family grow in fire-prone, nutrient poor environments, large seeds with high concentrations of nutrients are produced to supplement the limited supply in the surrounding soil environment (Vaughton and Ramsey, 1998). However, despite the apparent importance of seed mass in this family, little is known on the extent and sources of seed mass variation within species and how this relates to seed nutrient reserves and effects on seedling growth (Vaughton and Ramsey, 1998).

The study is examining:

1. Seed mass and seed nutrient content variation between four populations and its relationship to plant morphology and soil fertility.
2. Variation in timing and rate of germination between populations.
3. Seedling establishment of two populations of *B. aemula* through a reciprocal transplant experiment between high and low fertility sites.

The results and interpretations of these field and greenhouse experiments will be presented at the conference.

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Bottlenecks and booms: management in response to environmental variability

Environmental variability caused by disturbance is important for the maintenance of diversity within natural ecosystems. In recognising ecosystem dynamism, the key for planners and managers is to identify thresholds of change where action is required, rather than responding to any observed change. This paper examines common themes in the description of return times of disturbance for forested and riverine ecosystems associated with fire and flooding, respectively.

The capacity of the biota to withstand extreme disturbance events is compromised by human use. Examples where the intensity and duration of disturbance-dependent bottlenecks are exacerbated include the abstraction of water from rivers and the harvesting of timber from forests. A management system is proposed that encourages resolution of conservation and industry values through consideration of the risk-weighted consequences of ecosystem dynamism. Actions advocated by the system involve reallocation of management units associated with particular resources and values as environmental events play themselves out. Where the number of flood events within a specified time horizon is less than the mean expectation, water abstraction from a river system may be relatively restricted. If the area of forest burned within a specified time horizon is less than the mean expectation, then more area might be made available for timber production. It is argued that adoption of 'bottlenecks and booms' management represents an efficient approach to the explicit accommodation of variability.

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Effects of colony size on the invasion of the Argentine ant (Hymenoptera: Formicidae): implications for biotic resistance by native ants

The Argentine ant, *Linepithema humile* (Mayr), is a widespread invasive ant that has been associated with declines in native invertebrate fauna in its introduced range. In Australia, the presence of aggressive native ant species may impede the spread of Argentine ants. We experimentally manipulated colony sizes of Argentine ants to assess whether Argentine ants were able to survive and compete for resources with a dominant native ant, *Iridomyrmex rufoniger*. Over 24h, the proportions of Argentine ants that were alive, at baits, and at sugar water decreased significantly in the presence of *Iridomyrmex*, while their mortality significantly increased. Argentine ants were only able to overcome *Iridomyrmex* when their colony sizes were 5-10 times greater than those of *Iridomyrmex*. We also conducted field trials in which colonies of Argentine ants of varying sizes were introduced to baits occupied by *Iridomyrmex*. The results showed that larger Argentine ant colonies significantly affected the initial foraging success of *Iridomyrmex*, however, over the experimental period the numbers of *Iridomyrmex* at baits did not differ with the size of the Argentine ant colony. These results suggest that Argentine ants may need to attain large colony sizes to survive and compete with *Iridomyrmex*.

Wardell-Johnson, Angela



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People and their frameworks of environmental practice: a case study of two contrasting landscapes

Environmental problems are found at the complex interface of ecosystems and human social systems. Almost all environmental problems result from particular social patterns. Social bonds and norms in a range of institutions and structures are shaped and maintained by paradigmatic practice that is identified in the domain of language unified by common, underpinning assumptions. These frameworks of practice form the discourses of the environment that this research explores and identifies in two contrasting landscapes. Both landscapes comprise similar rural social communities but the state of their landscapes are in sharp contrast. Enquiry into environmental discourses exposes definitions, interpretations and negotiations that exemplify relationships with nature and the environment. These discourses provide an insight into how people living in each of these sub-catchments define and solve environmental problems within a landscape scale. Implementing environmental solutions is, in essence, as activity that must engage people and operate within the frame of their relationships with the landscapes in question. This research identifies these framing discourses and provides an insight into the possibilities each discourse is framed by.

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A botanical perspective on landscape as heritage: a case study in the Mangkuma Land Trust, Cape York

There is a long and continuing history of complex interactions between Aboriginal people and plant communities, which has fashioned the Australian landscape. We integrate floristic assemblage data with data on human ecological, economic and cultural uses, to assess landscapes for management planning in the Mangkuma Land Trust, Cape York. Floristic data from 99 quadrats in the immediate environs of five outstations were combined with recorded local Aboriginal people's uses of the plant species. Integrating the analysis of floristic pattern with plant uses reveals congruency between vegetation types, and economic and cultural landscapes. All plant communities defined include species valued for various economic and cultural purposes (ceremony, food, shelter, medicine and tools) by local people. However, some communities, such as coastal vineforest, include proportionately more categorised useful species, receive greater use, and are accorded different levels of importance for particular cultural and economic practises than others. These are also the environments most readily manipulated using fire to achieve different economic and cultural outcomes. This work has application in the identification, mapping and prioritisation of cultural landscapes for management actions, but does not imply that particular cultural landscapes are any more constant than the plant communities with which they are associated.

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The invasive potential of *Pinus radiata*: seed production, dispersal and the role of fire.

The extensive plantations of *Pinus radiata* in Australia provide a substantial source of seeds that disperse into native vegetation. Here we investigate the reproductive output of these self-sown pines to determine whether they are contributing to a second wave of invasion which may become self-sustaining after the plantation is harvested. Cone production, seed number and proportion of viable seeds per cone were quantified for two sites in the Blue Mountains west of Sydney. Reproductive trees varied considerably in cone production (1-400 cones), and cone number did not simply relate to tree size. Tree ages were estimated using ring counts from increment cores and were only related to tree size for smaller diameter trees. A survey of pine abundance in native eucalypt vegetation surrounding an experimental plantation revealed that the direction of spread was related to the prevailing wind. A recent fire killed smaller pine trees but led to the release of seeds from cones on larger trees that survived. The subsequent opening of remaining cones by black cockatoos, and favourable conditions for germination, led to a substantial pulse of seedling recruitment. Clearly managing fire has important implications for control of pine invasions.

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Nutritional quality affects choice by predators in feeding preference experiments

The interaction between chemical defenses and the nutritional quality of the prey is generally poorly understood. In particular, it is not known how chemical and nutritional factors interact to affect food choice. To examine the role of nutritional quality in the susceptibility of aquatic invertebrates to predation, an array of predators in the field were offered a choice of four artificial foods varying in protein and energy, within the natural range found among many intertidal organisms. High quality food (high protein/high energy) was strongly preferred over low quality food (low protein/low energy) in both estuarine and marine environments ($Q = 2.72$, $P = <0.05$; $Q = 2.72$, $P = <0.05$). Feeding preference experiments were then undertaken using the egg masses of *Conuber cf. sordidus*, which have relatively low nutritional quality in order to examine the effectiveness of their chemical defense in realistic versus high nutritional quality. Control and treatment strips containing the same levels of protein and energy as egg masses, were consumed at a greater level than strips containing egg masses, indicating that *Conuber cf. sordidus* egg masses may be chemically defended. However, when the nutritional quality of the artificial feeding strips was much greater than the egg masses no deterrent effect was detected. This experiment highlights the important role that nutritional quality plays in predator feeding behaviour and its significant role in the design and execution of feeding preference experiments.

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Determining appropriate fire frequencies for Cumberland Plain Woodland, an endangered grassy woodland ecosystem in Western Sydney

Cumberland Plain Woodland (CPW), once the dominant vegetation type in the low-lying shale basin between Parramatta, Liverpool and the Blue Mountains, is now found only as remnant patches. This vegetation type differs considerably from the more frequently-studied shrubby woodlands on the surrounding sandstone slopes and plateaus. Appropriate fire regimes for biodiversity conservation may also differ. CPW supports a limited number of tree and shrub species, and a species-rich ground layer of grasses interspersed with forbs. Fire regimes that encourage a balance between trees and shrubs on one hand, and forbs and grasses on the other, may hold the key to maintaining species diversity. Two studies in remnants which differ in their past fire history are currently underway. Trends in the data suggest that density of *Bursaria spinosa* increases markedly as fire frequency decreases. Other native shrubs, particularly obligate seeders, may be more abundant in areas where fire is moderately frequent than in areas burnt often, or rarely. Species richness in the ground layer is not affected by fire frequency, nor by microhabitat type: areas around trees, beneath *Bursaria* thickets, and open patches have been surveyed. Individual forb and grass species, however, may vary in abundance between the microhabitat types.

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Plant species' attributes and spatial patterns of regeneration in secondary rainforests

In many areas of the Wet Tropics, conservation of rainforest species and ecosystems depends on protection of intact or remnant rainforests, but also on understanding the ecology of 'secondary' rainforest regeneration, on formerly cleared lands.

This project combines perspectives from spatial ecology and plant functional ecology, relating spatial patterns of regeneration to i) spatial distributions of rainforest cover and source plants, and ii) ecological traits of plant species, including dispersal mechanisms, age of reproduction, life-span, and attributes of seeds, stems, and leaves.

This research is based on studies of plant regeneration in secondary rainforests on abandoned pastures, and adjacent, intact rainforests on the Atherton Tablelands, Queensland, and at La Selva Biological Station, Costa Rica.

'Comprehensive' studies quantify changes in representation of plant species and functional traits with distance from intact rainforest, and through strata from understorey to canopy. Analyses consider six attributes of each species present along 180m transects from primary into secondary rainforest.

Focal Species studies at 13 sites involve analysis of a more-extensive set of functional traits and their inter-relations, and spatial modelling of 'regeneration shadows' for individual species, based on source distributions and the estimation of source strengths and probability density functions for dispersal distances, via Likelihood methods.

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The leaf economics spectrum worldwide

Bringing together leaf trait data spanning 2550 species and 175 sites we describe, for the first time at global scale, a universal spectrum of leaf economics consisting of key chemical, structural and physiological properties. The spectrum runs from quick to slow return on investments of nutrients and dry mass in leaves, and operates largely independently of growth form, plant functional type or biome.

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Systematics of introduced blackberries in Australia

Blackberries, introduced to Australia from Europe, America and Asia, are important weeds of agriculture, forestry and natural ecosystems. A taxonomic revision of the exotic *Rubus* species present in Australia recognised 23 introduced species. The most commonly encountered group is the *Rubus fruticosus* aggregate, originating from Europe. It is taxonomically complex, including many polyploid, facultatively apomictic taxa. Many taxa are difficult to distinguish, and there is variation between states in the application of names to some taxa. A study of morphological and genetic variation within the *Rubus fruticosus* aggregate revealed at least 15 taxa. DNA phenotyping was used to confirm identification in doubtful cases and to support the taxonomic determination based on morphology. A summary of the taxa found in Australia, their distribution and DNA phenotypes, and any names used previously for these taxa in Australia, is presented. The adoption of best-practice management of blackberry is dependent on correct species identification for determining biological and chemical control methods optimal for each species and location. Exotic species must also be distinguished from native *Rubus* species, to prevent unnecessary removal of the latter. The first draft of a Lucid tool for distinguishing the various blackberry species is now available on the web.

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Does post-fire herbivory decline with distance from an unburned edge?

Several studies worldwide show a reduction in post-fire herbivory with distance from an unburned edge. This has been inferred as one possible explanation for lower herbivore effects after large-area fires than small, patchy fires. We tested the hypothesis of declining herbivory with distance from unburned edges by measuring (i) herbivory on planted and natural seedlings and (ii) seed removal from seed caches at various distances from the unburned edges. We used replicate sites within a number of fires between Sydney to Jervis Bay. There was no consistent decline in herbivory or seed predation with distance from the edge of any of the fires, although there was variability between both fires and sites. In fact, there were only a very few instances in which seed removal or herbivory was lower at the most distant locations. We suggest two possible explanations: (i) the furthest distances we sampled (200m) were still not far enough from the unburned edge to detect an effect, and (ii) the characteristics of herbivores and seed removers allow them to survive in many burned locations within the dissected, sandstone-based landscapes we studied, thus maintaining equally high levels of activity in all parts of a burned area.

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The spatial distribution of invasive *Pinus radiata* wildlings in native Eucalypt vegetation

Spread of pine seedlings from plantations into native vegetation has been reported for Australia, South Africa, Chile and New Zealand. Unlike other invasion processes where the original source is often unknown, the nature of plantations allows us to temporally and spatially track the invading population. In order to determine if *Pinus radiata* equally invades different dry Eucalypt woodland vegetation types, two areas in the upper Blue Mountains were surveyed. Average pine abundance recorded for 20m x 20m plots located 50m from the plantation boundary was 54.9 individuals for the *Eucalyptus oreades* and *E. sieberi* vegetation type and 49 individuals for the *E. mannifera* and *E. dives* vegetation type. To identify the spatial distribution of the pines, transects were placed perpendicular to the plantation edge. While pine numbers diminished with distance from the plantation, mature adults were found up to four kilometres away from the seed source signifying the occurrence of long distance dispersal. At a smaller scale, spatial analysis of plots found positive associations between pine seedlings and reproductive adults suggesting the presence of a second cohort of wildlings. The results of this study demonstrate the ability of *Pinus radiata* to invade and establish in areas of intact native vegetation.

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Regenerating landscapes: energy, earth, air and water.

Australian landscapes have been modified to varying degrees by human activities. In southern and eastern Australia, broad-scale conversion of native systems to those dominated by exotic species has occurred largely through the clearance of native vegetation. In central and northern Australia, more subtle changes such as altered fire regimes and weed invasion have had considerable impacts on landscape patterns and dynamics. The regeneration of landscapes that are more closely attuned to the Australian environment, and that can maintain biodiversity in the long-term, is a key issue for research, policy and management in the coming decades. Understanding the importance of, and interactions between, four fundamental elements at a range of scales will help meet the major targets and thresholds that are being set. These are energy (fire regimes and sunlight), earth (soil formation, diversity and health), air (wind, circulation patterns, carbon dioxide) and water (rainfall, soil moisture, environmental flows). Examples will be provided that illustrate the relevance of these elements to reconnecting and regenerating Australia's landscapes.

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Rainfall Dynamics and the Response of Native Grasses

Rainfall in Australia is highly variable across the landscape, with gradients existing not only in total annual precipitation, but also in seasonality and event size. A continuous index of seasonality, and the slope of the rainfall event size power law, have been calculated for a large number of sites across Australia. The resulting contour maps reveal gradients in rainfall regime that will impact on soil water availability, due to seasonal interaction with evaporation and the infiltration depth of different sizes of rainfall event. An experiment to determine the effect of rainfall regime on the productivity and root distribution of two native perennial grasses, *Austrodanthonia caespitosa* and *Microlaena stipoides*, is discussed. These species may show a plastic response in root growth to soil water availability, or may display population differentiation in root distribution, correlated with the rainfall regime. Native grasses may be useful in salinity mitigation, and understanding the response of the grasses to rainfall variability will aid in the selection of plants of non-local provenance suitable for this purpose.

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Roost switching, roost sharing and social cohesion: Forest-dwelling big brown bats (*Eptesicus fuscus*) conform to the fission-fusion model

For bats, the benefits of group living combined with longevity and low reproductive output, might favour large, temporally stable social groups. In spacious roosts (e.g. buildings) colonies can be large, but in forests, aggregations may be constrained by cavity size. Roost switching may maintain long-term social relationships between individuals spread among different roosts. In this fission-fusion scenario, switching trees would increase the numbers of bats an individual associates with. We used telemetry to quantify roost switching by individual forest-dwelling big brown bats (*Eptesicus fuscus*). Bats remained loyal to small areas of forest within and between years but switched roosts (every 1.7 ± 0.7 days) within years. Tagged bats that switched more often were found with a significantly greater number of different individuals. We quantified associations between pairs of individuals, finding that most pairs associated more often than expected randomly but that all tagged bats spent at least some days roosting in different trees than preferred roost-mates. Our results suggest that roosting by big brown bats conforms to a fission-fusion pattern, in that bats tend to roost with certain individuals but occasionally away from them. We contend that roosting areas in forests are analogous to large roosts in caves or buildings.

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Habitat differentiation in open forest understoreys: Investigating the scarcity of shrubs in grassy open forests

In eastern Australia, open forests and woodlands with an herbaceous understorey occur predominantly on finer textured, more fertile basic substrates such as basalt. In contrast, open forests and woodlands with a shrubby understorey are found on the coarser textured, less fertile, acid granites, such as leucoadamellite. Field and glasshouse experiments show that several processes, acting in the early stages of the life cycle, are influential in the establishment and maintenance of these patterns of habitat differentiation. Emergence and survival for herbs and shrubs are strongly influenced by their physiological tolerance or intolerance of habitat conditions (e.g. water and nutrient availability). In the grassy habitats, survival and growth of shrub seedlings are strongly influenced by exposure to grazing and competition from existing herbaceous vegetation.

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Effect of spatial scale in post-fire heathland succession

Ecological patterns and processes are often spatially and/or temporally scale-dependent. Despite the growing literature, we still have much to learn regarding the scale(s) at which different biological processes operate, the scale(s) at which different organisms live and interact, and the scaling of ecological communities. This study examines the effect of spatial scale (sampling grain) on post-fire vegetation succession in sand heathland in the Gippsland Lakes Coastal Park, Victoria. Results indicate that species composition differed significantly between young (0-6 years since fire) and old (23-27 years since fire) sites, and young and intermediate (9-19 years since fire) sites with increasing time since fire; however, the relationship was scale-dependent. Species richness and evenness (J) both decreased significantly with time since fire using linear regression; a finding commonly reported in Australian heaths; however, these relationships were also scale-dependent. In addition, the decline in species diversity (H) was independent of sampling grain, while the relationship between community heterogeneity and time since fire was unclear. These findings suggest that studies reporting changes in heathland vegetation parameters over time should only be interpreted at the grain sampled, and any extrapolation to larger spatial scales should be undertaken with extreme caution. The study also gives further weight to the view that multiple sampling grains are essential to comprehensively understand pattern and process in communities.

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Scattered paddock trees, soil chemistry and landscape management

The effects of scattered paddock trees on soils in agricultural landscapes has received only limited attention in Australia, although reduced soil acidity and enrichment of soil nutrients and organic matter have been reported around trees in similar environments elsewhere. This study investigated the influence of scattered Blakely's Red Gum (*E. blakelyi*) trees on both near-surface and deeper soil layers in temperate grazed pastures on the northern Tablelands of NSW. Trends of increased nutrient and organic matter concentrations were found in surface soils around individual trees confirming previously observed patterns. These soil changes were linked with litter quantity and quality and indicate possible soil "improvement" around trees in these near-surface layers. However, changes in soil chemistry at depth in the soils provide a new insight into the processes of plant-induced soil change in these environments. These findings have significant implications with regard to the functions of scattered trees in the landscape and their importance to the management of soil acidification, salinity and nutrient retention in these environments.

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Remnant vegetation – how to define it and what does it mean ecologically?

In the context of native vegetation management, there is a need to categorise vegetation into different condition classes in terms of biodiversity values. Vegetation condition can range between the extremes of biodiverse undisturbed vegetation to cropped or totally non-native vegetation with relatively low conservation value. Classification systems used in Australia include using thresholds to differentiate native vegetation from non-native vegetation, age since last cleared, an ecological assessment of the condition of the vegetation compared to reference sites and the structural and floristic characteristics of the dominant layer.

With any system where artificial thresholds are applied to continua like vegetation communities, there will be "grey areas" where there is doubt over which side of the threshold the vegetation occurs. In this paper some Queensland case studies of "grey areas" of vegetation are discussed in regard to the remnant vegetation definition of the Vegetation Management Act 1999. An ecological definition to remnant vegetation is applied to provide a consistency in interpretation in relation to issues such as practicality, disturbance, and limits of acceptable change.

While classifying vegetation into remnant and non-remnant vegetation is a means of prioritising areas, it also has a major impact on whether vegetation is assessable under the VMA. Much non-remnant vegetation also retains high ecological and biodiversity value. Regional based assessments provide one way for landscape context and biodiversity value of remnant and non-remnant vegetation to be integrated into vegetation assessments.

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Bird species richness and community composition in woodland remnants in Cowra Shire, NSW

This study examined the responses of bird species richness and community composition to the type, size and condition of 69 woodland remnants, ranging in size from 1ha to 250ha, within the Cowra Shire in the central NSW wheat-sheep belt. Bird data were gathered using 20-minute 2-ha censuses across four seasons in 2002 and were analysed using generalised linear modelling and analysis of similarity. Remnant size had no effect on bird species richness, but was strongly correlated with community composition. Some small woodland species preferred sites >100ha, while open country species preferred smaller remnants (<50ha). Identity of the dominant tree in the vegetation association was highly significant for both species richness and community composition. Mid-storey vegetation, logs and rockiness also had strong associations with several groups of birds and woodland bird species richness. In general, open country species preferred structurally simple habitats and small woodland birds more complex remnants. The study indicates that to conserve woodland birds in the Cowra region it is important to consider habitat heterogeneity along with remnant size. Information gathered in this study can be used to develop a benchmarking system to advance conservation and habitat restoration in the region.

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Willows and Blackfish: a Weed of National Significance (WON) hosts a threatened species.

Willow invasion of riparian zones has rarely been linked to fish habitat, despite speculation of widespread impacts on aquatic ecosystems. In Birch Creek over 80% of River Blackfish (*Gadopsis marmoratus*) sampled occupied undercut banks as daytime refuges. In catchments with native riparian vegetation and low levels of post-settlement disturbance blackfish are associated with large woody debris and debris dams. Birch Creek had a highly modified catchment and willow-dominated riparian zones yet blackfish were abundant. The banks occupied by blackfish were associated with riparian willows. The willow-lined banks contained complex structures, labelled 'overhangs' to distinguish them from 'undercut' banks observed in native vegetation lined channels. Below willow overhangs, channels up to 180 cm long with entrances up to 20 cm diameter penetrated into the bank. We introduced alternative habitats to pools, including hollow logs, in a multiple BACI design to test blackfish loyalty to willow overhangs as daytime refuges. Willow overhangs remained the preferred daytime refuge. This case study exemplifies the dilemmas that arise when an exotic species, in this case a WON, appears to be 'beneficial' rather than 'harmful' in terms of a target organism. Current willow management and research does not effectively deal with such an interaction.

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Biodiversity conservation in northern Australia - the need for extensive linkages between reserves

Northern Australian environments offer great potential, and need, for coordinating biodiversity conservation across vast areas because (i) human population density is very low; (ii) environments are typically extensive and relatively intact; (iii) most threatening processes operate across extensive areas and are relatively tenure-blind, and hence require integrated whole-of-landscape management; (iv) the current formal conservation reserve system is limited, and likely to remain inadequate, and (v) many species disperse broadly in response to seasonal cycles, so require protection across environmental mosaics and large geographic areas. Further environmental management offers one of the few employment opportunities in many impoverished communities. The need for integrated and improved management of the landscape to protect biodiversity is heightened by recent evidence demonstrating broad-scale decay of biodiversity, occurring across all tenure types. WildCountry offers an approach for delivering such broad landscape conservation.

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Holistic decision making and grazing management: looking after biodiversity and profits at 'Lana', Uralla, NSW

'Lana' is a 3350-ha property on the Northern Tablelands with infertile granite soils and 750 mm rainfall. Pasture improvement began in the 1960s but few of the introduced grass species survived. In 1993, we changed our farm business decision making to simultaneously enhance our lifestyle, profits and the environment. We studied Holistic Management, subdivided paddocks and implemented short duration-high intensity 'planned grazing' with a long pasture recovery. Sheep and cattle have been amalgamated into six farmlets and are rotated through small (~ 15 ha) paddocks for 2-3 days per season. We now carry 4000 DSE more livestock with fewer inputs and grow better wool. The benefits are most apparent in dry seasons because stock are no longer supplemented with hay or grain. The abundance and diversity of fungi, animals and plants have increased. The grass now grows to the water's edge along creeks, wetland vegetation has increased, and water quality has improved. The changes are attributable to pasture recovery, an increase in desirable plants, improved soil infiltration, greater biological production, and improved nutrient availability. Various management approaches that aim to look after biodiversity and profits are being examined in the New England region through the Land, Water & Wool Program.

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Temporal comparison of bird assemblages in forest fragments in Gippsland

Habitat fragmentation has been identified as a major contributing factor in the decline of woodland bird species. The value of remnants for the long term conservation of bird species is widely recognized. Less is known about long term changes in bird assemblages within fragments. The majority of studies are conducted over a 1 - 3 year period and it is only recently that older data sets have become available to provide benchmark data for comparison. Avian biodiversity in fragments of varying size classes was measured in Lowland Forest in Gippsland, Vic. 22 years ago. A subset of these fragments is currently being revisited, and changes in bird assemblages are being documented. Loyn's (1985) model predicts that 9 species would be lost from patches of constant size over a 100year period. This would translate to an estimated loss of almost 2 species over a twenty year period. Differences in bird assemblages over 20 yrs are related to changes in fragment size, habitat quality and surrounding land use. Comparison of sites which have undergone little change to those which have undergone more extensive changes may allow better understanding of the effects of long term fragmentation.

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Social and economic dimensions to WildCountry

Achieving WildCountry in practice will require not only the appropriate conservation science, but also social and economic structures which are consistent with and can support the desired outcomes. Unless we can develop better community understandings of conservation needs, and ways by which people can make a living in a WildCountry landscape, WildCountry will end up being just another nice set of principles or a passing fad long before its conservation timelines even become relevant.

Given WildCountry's focus on protecting core areas and the 'best of what is left', traditional expansion of core protected areas will remain appropriate. But WildCountry aims to be more than this. A conservation system with incorporates large scale connectivity and restoration principles across all land tenures must ultimately address a number of social and economic questions. For instance: what kinds of economic activities will complement WildCountry objectives in different landscapes; how can legal and economic rights sit with the imperative to include economically active private land in a conservation system; how is our federal system to address connectivities which cross borders; what social and economic scale best fits with the conservation scale of WildCountry, and how is indigenous ownership and knowledge incorporated into the WildCountry vision?

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Assessing Landscape Change in the eastern Darling Downs, Queensland, 1975-2001

The Darling Downs region of southern Queensland, like many agricultural areas, has in recent years been subject to considerable change in land use activities. However, little information exists on the nature of these changes, their causes and consequences, particularly for remnant vegetation and overall biodiversity. Here we describe an interdisciplinary project spanning 1,500 km² of agricultural landscapes centred around the town of Pittsworth that uses a spatial data base of land uses (digital classification of Landsat MSS, TM and ETM+ imagery) from 1975 to 2001, socio-economic and agricultural commodity statistics, an inventory of potential policy and technological drivers for change, and an ecological assessment of remnant vegetation. Preliminary results indicate the extent of native vegetation has been reduced by 60% over the past 25 years, from 37,745ha to 15,679ha. The most significant period of change for native vegetation was between 1985–1991, when almost 40% of the vegetation at the start of that period was lost to other land uses. However, pasture land has increased by over 50%, from 24,583ha (1975) to 38,8002ha (2001). The predominant land use in the study area continues to be cropping, with a rise from 86,566ha (1975) to 94,487ha (2001).