

Pacific Conservation Biology

Order Form and Subscription information appears at the end of this document —
please complete and return it to Surrey Beatty & Sons

Volume 1 Number 1

News and Views

The South Pacific biodiversity conservation programme

G. ROBIN SOUTH

Research challenges and opportunities in the Wet Tropics of Queensland World Heritage Area

WILLIAM F. LAURANCE

Forum Essays

Ecocolonialism and indigenous knowledge systems: village controlled rainforest preserves in Samoa

PAUL ALAN COX and THOMAS ELMQVIST

Ecocolonialism, the imposition of European conservation paradigms and power structures on indigenous villagers, is incompatible with the principles of indigenous control of village rainforest preserves. Since 1988, four rainforest reserves in Western Samoa and one US National Park in American Samoa have been created on communal lands using the principles of indigenous control, preserving a total of 30 000 hectares of lowland rainforest and associated coral reef. The reserves in Western Samoa are owned, controlled, administered and managed by the villagers. While these reserves appear to be robust approaches to preserve establishment within the communal land tenure system of Samoa, the concept of indigenous control appears to conflict with ecocolonialist attitudes that disparage the traditional knowledge, culture, political systems, and integrity of indigenous peoples. We discuss problems that have occurred in the Samoan village preserves and offer suggestions for the establishment of future village-controlled preserves in other areas of the South Pacific.

Ua le mafai ona fa'afetaui ai Ecocolonialism, o le fa'aeeaga atu ai lea o manatu ma pulega fa'asaoina fa'apalagi, ma le fa'amoemoe e pulea fa'asaoina e ali'i ma faipule o nu'u lava ia. E amata i le 1988, ua faatulagaina faasaoga 'ese'ese e fa i Samoa i Sisifo ma le tasi i Amerika Samoa i fanua o aiga ma nu'u e lalo ifo ai le pulega o tamalii ma faipule, o le aofa'i o ia faasaoga o le 65 000 eka. Ua pulea, faatulagaina, ma faatonuina ai ia faasaoga i Samoa i Sisifo e faipule ma tamalii o nuu ia. E ui lava ina ua foliga lelei ai ia tulaga, ua tau fete'ena'i ai pulega o matai ma isi manatu faapalagi ae maise manatu faailoga aganuu e fia ta'u vale ai le popoto, aganuu, ma fa'amaoni o ali'i ma faipule atoa ma tagata nu'u o ia fa'asaoina. Ma te fa'amatala atu nisi fa'afitauuli ua o'o mai i fa'asaoina i Samoa ma si'i a'e isi manatu o ma'ua e tusa ai ma le fa'atulagaina o fa'asaoina fa'alenu'u i isi motu o le Pasifika.

The conservation of Leadbeater's Possum in southeastern Australia and the Northern Spotted Owl in the Pacific north-west of the USA; management issues, strategies and lessons

DAVID B. LINDENMAYER and TONY W. NORTON

Aspects of the conservation and management of the endangered species Leadbeater's Possum *Gymnobelideus leadbeateri* in southeastern Australia and the Northern Spotted Owl *Strix occidentalis caurina* in the Pacific north-west of the USA are similar in their nature and the intensity of public debate. Both species occur in temperate forests that are also used for intensive wood production. Due to historical factors and present forestry management regimes, a major conflict in land-use exists between the conservation of these animals and intensive timber harvesting in both geographic regions. The long-term persistence of Leadbeater's Possum and the Northern Spotted Owl will depend primarily on the protection and appropriate management of mature and old growth stands or attributes of such types of forest. The Interagency Spotted Owl Scientific Committee developed a set of guiding biological principles and used knowledge of

the autecology and natural history of the species to formulate a management plan to help ensure the viability of populations of the Northern Spotted Owl beyond the next century. Unfortunately, the strategies currently proposed for the conservation of Leadbeater's Possum are unlikely to ensure its long-term persistence, and, therefore, the Victorian Government's position on this matter is inconsistent with its undertakings in the new National Forest Policy. We discuss the application of the approach and strategies proposed by the Interagency Committee to the conservation of Leadbeater's Possum. Attempts to manage the Northern Spotted Owl and Leadbeater's Possum will reflect the ability of governments to pursue truly ecologically sustainable development and resource use.

Research Papers

Biological diversity of micro-organisms: an Australian perspective

MARGARET M. ROPER

Micro-organisms (bacteria, archaeas, fungi, protozoa, algae and viruses) occur in all environments and are interrelated with all other life forms. Micro-organisms are largely responsible for maintaining ecosystem function. They are extremely important in biological control mechanisms and in the transformations of food, energy and chemicals, including the mineralization of nutrients.

Despite their importance, our understanding of the role and diversity of micro-organisms is very limited largely because of our inability to culture more than a few per cent of them. Molecular techniques being developed should result in the identification of many new micro-organisms. Notwithstanding our limited knowledge it is essential to evaluate the threats to microbial diversity and to attempt to minimize losses.

Micro-organisms and microbial diversity risk being lost due to environmental causes such as pollution (by sewage, oil, organic compounds, pesticides and heavy metals), habitat loss (e.g., pH and salinity changes, and flooding), over-exploitation (e.g., in agriculture, forestry and fisheries), species introductions and global changes. Micro-organisms that are particularly vulnerable to extinction, be it on a local or global scale, are those with a limited distribution, in specific habitats or those in habitats subject to widespread stress. Accompanying the loss of microbial diversity is the potential for losses of ecosystem function.

A number of measures are needed to conserve microbial diversity. It is necessary to improve identification and measurement in terms of taxonomy, genetics and function. *Ex situ* collections are a means of securing micro-organisms for use and study by man. Where populations are poorly understood *in situ* conservation in protected habitats is the only option. Systems of indices and bioindicators need to be developed to monitor changes in microbial communities in such habitats.

In order to co-ordinate conservation efforts it is essential to develop a global network of information. This can best be done through national and international policies being developed to conserve biological diversity.

Can revegetation assist in the conservation of biodiversity in agricultural areas?

RICHARD J. HOBBS

It has been suggested that revegetation in agricultural areas to tackle land degradation problems can also aid in the conservation of biodiversity in these regions. Native biota is restricted to remnant areas, which are mostly small, often unconnected, and subject to a variety of impacts from the surrounding altered landscape. The current remnant network is not sufficient to ensure the long-term persistence of the biota, and requires enhancement. Revegetation provides an opportunity to protect and add to the existing remnant network. However, there are few data available with which to assess the likely impact of revegetation on conservation values, and few guidelines as to how revegetation should be designed for conservation purposes.

This paper presents an initial framework for developing revegetation strategies which tie into the existing conservation network. Revegetation can either provide buffer strips around existing remnants to protect them from external impacts, corridors between them to increase connectivity, or additional habitat to increase the area of vegetation available, or can enhance degraded remnant areas. Precise design principles and specifications for these types of revegetation are lacking, and may not be appropriate since they will depend on vegetation types and the requirements of target species. In addition, revegetation will help retain biodiversity indirectly if it helps stabilize an otherwise degrading agricultural landscape.

Revegetation in agricultural areas is compared with minesite rehabilitation, where the redevelopment of functioning ecosystems and faunal habitat appears to be possible. The task is harder in the agricultural situation because the scale of modification is greater, soil changes are more difficult to redress, and recolonization by native species is less likely.

Increased research effort is needed on the implementation and effects of differing types of revegetation, strategies for increasing rates of adoption of revegetation and methods of integrating conservation considerations into revegetation programmes.

A framework for the improved management of threatened species based on Population Viability Analysis (PVA)

H. P. POSSINGHAM, D. B. LINDENMAYER and T. W. NORTON

Considerable funding and effort is dedicated to the conservation and recovery of threatened species in Australia. We describe a series of five iterative steps that will improve the effectiveness of programmes for threatened species management. These steps are best integrated using Population Viability Analysis (PVA) in an approach to management where the key stages are completed concurrently. In this way management actions for the conservation of threatened species can be regularly assessed and upgraded as more information and improved computer simulation models become available.

Genetic variation in the greater bilby (*Macrotis lagotis*)

RICHARD SOUTHGATE and MARK ADAMS

The taxonomic status of and genetic diversity amongst extant populations of the greater bilby, *Macrotis lagotis*, were assessed using allozyme electrophoresis. A total of 47 bilbies sampled from three geographic areas and two captive colonies were screened for 42 loci, six of which were polymorphic. The results are consistent with the view that all extant populations represent a single biological species. All populations were genetically very similar (Nei D^2 's 0.000 to 0.004) and overall levels of within-population genetic variability were low (H_o 0.004 \pm 0.004 to 0.0026 \pm 0.017). The allozyme data support the hypothesis that there has been no significant loss of variability in the captive colonies when compared to the species as a whole.

Biodiversity and systematics: the use and misuse of divergence information in assessing taxonomic diversity

DANIEL P. FAITH

Limited resources for conservation highlight the need for placing priorities on species or other taxa. While priorities or "weightings" based on taxonomic information are now well-established in principle, there is no agreement on a preferred approach. One set of methods attempts to use phylogenetic branch length or divergence information, when available. The "Phylogenetic diversity" measure of Faith (1992) uses sums of branch lengths from phylogenetic estimates in order to predict underlying patterns of feature diversity among taxa. An alternative approach suggested by Altschul and Lipman also uses divergence information and would appear to yield results similar to phylogenetic diversity. However, it is demonstrated here that their method in fact can give results opposite to those required if feature diversity is to be maximized. A simple conservation management example, based on mtDNA variation at the population level, illustrates the relative advantage of using phylogenetic diversity to set conservation priorities.

Genetic variation in fragmented populations of an Australian rainforest rodent, *Melomys cervinipes*

LUKE K.-P. LEUNG, CHRIS R. DICKMAN and LESLIE A. MOORE

Small, isolated populations of an Australian rodent, *Melomys cervinipes*, occur in rainforest fragments on the Atherton Tableland in northeastern Queensland. We studied the genetic structure of four of these populations: one island (4.3 ha; isolated in 1960), three fragments (2.5, 7.5, 97.5 ha; isolated between 1920 and 1930) and a control population in continuous rainforest. The relative density of *M. cervinipes* did not differ among the populations, hence population size was approximately proportional to the forest area.

Electrophoresis was performed on blood samples taken from the populations. Average heterozygosity (H) was estimated from the allelic distribution of 24 loci for each population and varied from 0.01 to 0.05. The island population had reduced heterozygosity compared to the control population, but the fragment populations were not significantly less heterozygous than the control. Although the fragment populations were markedly different in size, they did not differ in heterozygosity among themselves.

The ability of fragment populations to maintain genetic viability is probably due to migration. The rainforest fragments exist in an extensive grassland containing a variety of habitat corridors which could facilitate movement and gene flow. Following the electrophoretic work, spool-and-line and radio tracking and live-trapping were carried out in the corridors; the presence of *M. cervinipes* in the corridors and its use of the corridors for movement was confirmed. The island population appears to be substantially more isolated than the fragment populations as water is likely to be a much more effective barrier to movement in *M. cervinipes* than is heterogeneous grassland. The genetic viability of the island

population has probably been reduced through drift, leading to fixation of alleles: six of eight polymorphic loci being fixed in the island population. We therefore suggest that retention or establishment of habitat corridors is an important means of sustaining the genetic variability of populations in fragmented systems.

Declines in populations of Australia's endemic tropical rainforest frogs

STEPHEN J. RICHARDS, KEITH R. McDONALD and ROSS A. ALFORD

Comparisons of present and past occurrences suggest that populations of six frog species endemic to the tropical rainforests of northern Queensland have declined during the past ten years. Most declines have occurred at high altitudes in the southern portions of the tropical rainforest. An extensive survey conducted during the summer of 1991–1992 did not locate any individuals of two upland species, *Litoria nyakalensis* and *Taudactylus rheophilus*. Another upland species *T. acutirostris*, which formerly was widely distributed, appears to have declined in rainforests south of the Daintree River. Three species (*Litoria nannotis*, *L. rheocola* and *Nyctimystes dayi*) were absent from most upland sites south of the Daintree River, but were common at lowland sites and at all sites north of the Daintree River.

Aspects of water chemistry, including inorganic ions, heavy metals, and pesticide residues, were analysed for many sites. These analyses failed to identify any abnormalities that might have contributed to frog declines. Declines appear to be unrelated to the history of forestry or mining at sites, or to low rainfall in wet seasons. Levels of habitat disturbance by feral pigs appear to have increased at some sites in recent years and, either by this disturbance or through direct predation, feral pigs may have contributed to declines in some populations. However, pigs are unlikely to be the sole cause of frog population declines. Once declines have occurred, fragmentation of rainforest habitats may prevent recolonization from adjacent sites. Until causal agents associated with declines can be identified, management strategies to ensure the long-term survival of these species must involve protection of the riparian habitats in which they occur.

Research Note

Predictable effects of agricultural development on the long-term availability of hollows for animals: observations from the Western Australian wheatbelt

MAX ABENSPERG-TRAUN and GRAEME T. SMITH

Volume 1 Number 2

News and Views

A vertebrate person in an invertebrate court

GLEN INGRAM

Coastal marine resource management in the Pacific region

TIM ADAMS

Correspondence

Management for the conservation of Leadbeater's Possum (*Gymnobelideus leadbeateri*) — a reply

M. A. MACFARLANE and R. H. LOYN

Rebuttal

DAVID B. LINDENMAYER

Correspondence

Ecocolonialism and indigenous knowledge systems — *comment*

G. B. K. BAINES

Rebuttal

P. A. COX and T. ELMQVIST

Forum Essay

Modern conservation and indigenous peoples: in search of wisdom

PETER D. DWYER

The resource management systems of indigenous people often have outcomes that are analogous to those desired by Western conservationists. They differ, however, in context, motive and conceptual underpinnings. To represent indigenous management systems as being well suited to the needs of modern conservation, or as founded in the same ethic, is both facile and wrong; it will not serve the interests of either modern conservation or disadvantaged indigenous peoples. It is argued that encounters between the interests of modern conservation and indigenous peoples must be resolved in favour of the latter.

Research Papers

Biogeography of Australian monsoon rainforest mammals: implications for the conservation of rainforest mammals

D. M. J. S. BOWMAN and J. C. Z. WOINARSKI

Monsoon rainforests form an archipelago of small habitat fragments throughout the wet-dry tropics of northern Australia. According to the definition of Winter (1988) the current monsoon rainforest mammal assemblage contains only one rainforest specialist mammal species (restricted to Cape York Peninsula), and is dominated by eutherian habitat generalists (murids and bats) that mostly occur in surrounding savannah habitats. The mammal assemblages in monsoon rainforests across northern Australia (Cape York Peninsula, Northern Territory and the Kimberley) are essentially regional subsets of the local savannah and mangrove mammal assemblages and consequently share only a limited number of species in common (most of which are bats).

The lack of rainforest specialists in northwestern Australia is thought to be due to: (i) the lack of large tracts (>1 000 ha) of monsoon rainforest habitat; (ii) the possible substantial contraction of these habitats in the past; and (iii) the limited extent of gallery rainforests, such rainforests being important habitats for rainforest mammals in South American savannahs. Unfortunately it is not possible to identify the threshold of habitat area required to maintain populations of monsoon rainforest specialist mammal species because of an impoverished fossil record pertaining to the past spatial distribution of monsoon rainforests.

The implications of the lack of a specialist mammal fauna in Australian monsoon rainforests for the future of heavily fragmented tropical rainforests elsewhere in the world is briefly discussed. It is concluded that the analogy of habitat fragments to true islands is weak, that rainforest plant species are less vulnerable to local extinction than mammals, that the loss of mammal rainforest specialists may not result in a dramatic loss of plant species, and that corridors of rainforest may be critical for maintenance of rainforest mammal assemblages in areas currently subject to forest clearance.

Quantifying the impact of disease on threatened species

HAMISH McCALLUM

Determining whether a disease or parasite is having a substantial impact on a population of a threatened species is not straightforward. Highly pathogenic parasites are not those which have the greatest influence on hosts, and diseases present at high prevalence are not likely to have a major effect on the host population. I develop simple mathematical models which show that a microparasitic disease such as a viral or bacterial disease will have the greatest impact on its host if it prevents host reproduction, but does not affect host mortality. If infected hosts can still reproduce, intermediate levels of pathogenicity have the greatest impact on hosts. Macroparasites such as helminths likewise have maximum impact on hosts at intermediate pathogenicity. The impact of a helminth on its host population is, however, determined by a complex interplay between pathogenicity per parasite and the nature of the host response to infection. For example, in the absence of density-dependent constraints on parasites within individual hosts, the smaller the impact per parasite on the host, the greater the impact of the parasitic infection on the overall population.

Several recommendations can be made to wildlife managers who detect a disease or parasite and wish to determine its impact on a population of a threatened species. There is no entirely satisfactory alternative to experimental manipulation. Treating part of a population and comparing survivorship or fecundity with controls is the only way to confirm the impact of a disease on a free-ranging population. Such an approach is impractical with every potential pathogen in a population. Some idea as to which pathogens may be of significance to the population can be gained from comparison of disease prevalence or parasite burden between dead and dying hosts and the overall population. Overall high prevalence or high pathogenicity are not good indicators on their own.

The application of fluctuating asymmetry in the monitoring of animal populations

STEPHEN SARRE, JOHN M. DEARN and ARTHUR GEORGES

The maintenance of fitness levels is an important part of the management of animal populations. Unfortunately measuring fitness and determining the relative contribution of genetic and environmental components to that fitness represent considerable problems for management. The simple and inexpensive method of measuring non directional asymmetry (fluctuating asymmetry) in bilateral morphological characters may provide a useful contribution to this problem. The relationship of levels of fluctuating asymmetry to fitness has been explored at considerable length in the scientific literature but this knowledge has yet to be used effectively by wildlife managers. We examine the potential of fluctuating asymmetry as a management tool and show by use of a case study of island and mainland populations of lizards, how it may be used as a comparative tool in which to determine populations that require management priority.

Genetic studies of the Hawksbill turtle *Eretmochelys imbricata*: evidence for multiple stocks in Australian waters

D. BRODERICK, C. MORITZ, J. D. MILLER, M. GUINEA, R. I. T. PRINCE and C. J. LIMPUS

The Hawksbill turtle, *Eretmochelys imbricata*, is endangered and currently declining in many parts of its global distribution. Efforts to manage the species are hampered by the lack of knowledge of the appropriate geographic units of management and the relationship among breeding populations and feeding assemblages. The Australian populations are among the few remaining large assemblages in the world, but may be under threat from harvesting in neighbouring countries. We use patterns of mitochondrial DNA variation to determine the geographic scale of breeding populations and to compare the genetic composition of turtles in feeding populations to those nesting at nearby major rookeries. Four of the major Australian rookeries were sampled, two on the western coast and two in northeastern Australia, as were turtles at two foraging sites. Significant differences in the frequency of two divergent mitochondrial DNA types separated the turtles nesting at major rookeries sampled on the northeastern versus western coasts of Australia, demonstrating that these populations are not connected by significant amounts of gene flow and should be considered as separate entities for management. There was no significant difference between the turtles nesting at two western rookeries 100 km apart, nor between those using the two northeastern rookeries separated by 750 km. This indicates that the size of the interbreeding unit for the Hawksbill turtle is likely to be a region consisting of a group of islands rather than an individual island. Feeding populations were screened with gene amplification test that discriminates between the two major DNA types. In each case, there was a significant difference in allele frequency between feeding populations and the nearest major rookery. This, together with previous reports of long distance migrations from tag returns, suggests that individual foraging areas support Hawksbill turtles from distant breeding populations.

The zoogeographic significance of urban bushland remnants to reptiles in the Perth region, Western Australia

R. A. HOW and J. DELL

The 71 reptile species occurring in the Perth region make this area as diverse as any similar sized coastal region in Australia. Cluster analysis of the lizard assemblages of 17 bushland remnants in the region indicate that three main sub-regions can be identified; Darling Plateau and Scarp, Offshore Islands and Swan Coastal Plain. Within the Swan Coastal Plain the lizard and skink faunas of remnant bushlands on the same landform are more similar to one another than they are to those of adjacent landforms. The Swan River appears to be a distributional boundary for some species. Species-area relationships indicate a variety of responses amongst the different taxonomic groups of reptiles, with snakes being the most sensitive to loss of habitat. The isolated remnant bushlands of inner urban areas retain a variety of reptile species, but there is no significant relationship with remnant size. The implications of zoogeographic and area relationships to conservation are discussed.

**Trends in the population of the Northern Hairy-nosed Wombat
Lasiorhinus krefftii in Epping Forest National Park, Central Queensland**

DOUG G. CROSSMAN, CHRISTOPHER N. JOHNSON and ALAN B. HORSUP

The Northern Hairy-nosed Wombat *Lasiorhinus krefftii* now survives only in Epping Forest National Park, central Queensland. The species was formerly more widespread in the Epping Forest region than at present. Its decline appears to have occurred in three distinct episodes of contraction, two of which were associated with prolonged drought. Indirect monitoring of abundance suggests that the population was stable from 1974 to 1981, when cattle were excluded from the Park, but has increased since 1983. A trapping programme between 1985 and 1989 suggests that the absolute size of the population may be about 70. The population contains approximately equal numbers of males and females; almost all females breed; and a large and apparently increasing proportion of the population consists of young animals. Further increases in density and range within Epping Forest National Park appear possible. Removal of some animals for translocation should be attempted when it is clear that such removals will not jeopardize the stability and vigour of the Epping Forest population.

Research Note

**Further evidence for the precipitous decline of endemic rainforest frogs
in tropical Australia**

M. P. TRENERRY, W. F. LAURANCE and K. R. McDONALD

Volume 1 Number 3

News and Views

“Conservation through sustainable use of wildlife” Conference Report

PETER HALE

**The CRC for Biological Control of Vertebrate Pest Populations: fertility
control of wildlife for conservation**

H. TYNDALE-BISCOE

Forum Essay

Conservation: a starfish without a central disk?

JOHN L. CRAIG and ANNE M. STEWART

Conservation is for people and depends on public support for its success yet public perceptions of the value of conservation are highly variable. A lack of a strong commitment from the majority of the public may relate to problems determining priorities for research and management. There is ample evidence in the literature and in public opinion that there is a need to address these issues. An image of a starfish lacking co-ordination among its arms is offered as a metaphor of the problems in worldwide conservation today. There appears to be miscommunication between scientists and managers, lack of balance among research activities, a misunderstanding of how to manage the views of all stakeholders and an overall lack of agreement on direction and priorities in a normal situation of limited resources. We offer suggestions on how to increase effectiveness by negotiating a strategic direction that accommodates the views of all stakeholders and that links research to management.

Review Paper

**Landscape ecology and conservation: moving from description to
application**

RICHARD J. HOBBS

The focus of conservation biology has been predominantly the study of single species, and conservation management and legislation has been directed mostly at the species level. Increasingly, however, there has been a recognition that ecosystems and landscapes need to be considered, since they form the physical and biotic context within which species exist. Increased emphasis on the landscape scale suggests that the emerging discipline of landscape ecology might have much to offer conservation biology. Landscape ecology is still a young science with no well-defined theoretical framework and little rigorous quantitative methodology. It aims to study patterns, processes and changes at the scale of hectares to square kilometers. Its focus on the pattern and dynamics of ecosystems or patches within a landscape offers much which is of relevance to conservation biology. Topics such as disturbance, patch dynamics, metapopulation dynamics, landscape flows, connectivity and fragmentation all have relevance to the conservation of biodiversity in natural, altered and rapidly changing systems. The papers in this issue provide a cross section of Australian research into landscape ecology which is of relevance to conservation biology. Methodological, theoretical and practical aspects are covered. I suggest that effective conservation of biodiversity will be achieved only if the landscape context is taken into account.

Research Papers

Variation in mosaic diversity in the forests of coastal northern New South Wales

O. NICHOLLS

The measurement of diversity at the landscape scale is likely to suffer from many of the limitations that plague other measures of species diversity; there is little agreement as to how to calculate or interpret the measure or index. A recent addition to the suite of diversity measures is that of Scheiner's "mosaic diversity". In an attempt to accept Scheiner's challenge that "explorations of mosaic diversity among diverse landscapes . . . will lead to new insights into the processes responsible for assembling species into communities" mosaic diversity has been calculated for 119 transects that sample the forests of the mid-north coast of New South Wales. Each transect is composed of five quadrats placed to encompass the variation in canopy floristic composition from xeric exposed slopes to mesic gullies. This paper looks at the environmental and spatial pattern of mosaic diversity. In addition I explore the relationship between mosaic diversity and other more readily grasped measures of diversity. Although very variable, Scheiner's mosaic diversity measure is shown to be weakly correlated with mean annual rainfall and mean annual temperature. In addition there is a weak trend in increasing mosaic diversity from the tablelands to the coast together with a trend of increase from south to north. Mosaic diversity did show a significant correlation with average species richness per quadrat within a transect but not with total species richness recorded on the transect nor with the number of alliances sampled by the five quadrats. The utility of this diversity measure to ecology remains unanswered by this study but the demonstration of weak relationships with both environmental and spatial variables given the small (5) sample size compared to that recommended (30+) suggests that further work is warranted.

Landscape heterogeneity indices: problems of scale and applicability, with particular reference to animal habitat description

P. G. CALE and R. J. HOBBS

Efforts to quantify landscape heterogeneity have resulted in the production of a large number of indices based on the number and proportions of different types of landscape (usually vegetation) patches. In this paper we question whether these indices provide useful tools with which to examine functional aspects of landscape heterogeneity. In particular, we consider faunal use of the landscape, focussing on the case of birds in vegetation remnants in the Western Australian wheatbelt. We argue that attempting to describe landscape heterogeneity by a single heterogeneity index is inappropriate, because the qualitative differences between patch types and their spatial relationships frequently cannot both be described by a single value. Also, scales of study have to match the scale of the processes in which we are interested, or the scale at which particular organisms perceive their environment. Generalized indices of landscape heterogeneity may therefore have little predictive capacity for detailed process or habitat studies.

Connectivity and complexity in landscapes and ecosystems

DAVID G. GREEN

The connectivity of sites in a landscape affects both species distribution patterns and the dynamics of whole ecosystems. Dispersal tends to produce clumped distributions, which promote species persistence and provide a possible mechanism for maintaining high species richness in tropical rainforest and other ecosystems. Simulations of multi-species systems show that, below a critical rate, disturbance regimes have little impact on species richness. With super-critical rates of disturbance the rate of decrease in species richness depends on the balance between the rate of

disturbance and dispersal range. Theoretical and simulation studies discussed here reveal that landscape connectivity falls into three distinct classes: connected, disconnected, and critical. Landscape processes are inherently unpredictable when connectivity lies within the critical range. Critical levels of connectivity lead to phase changes in the behaviour of many ecosystem processes. For instance epidemics, fire spread and invasions by exotic plants or animals are all suppressed if inter-site connectivity is too low. Conversely, genetic drift within individual populations is an order of magnitude greater if connectivity is sub-critical.

Small-scale resource heterogeneity in semi-arid landscapes

DAVID J. TONGWAY and JOHN A. LUDWIG

Patchy distribution of plant populations is a hallmark of arid and semi-arid ecosystems. This has been attributed to the patchy distribution of scarce or limiting resources across the landscape and within the soil itself. Behind these descriptive properties are a range of processes which are the causal mechanisms of resource allocation, conservation and utilization with the landscape. Terrain-controlled mechanisms have been previously described in respect of groved mulga (*Acacia aneura*) communities. This paper describes a set of resource regulation mechanisms which are largely controlled by plants and plant communities and which are effective at fine scales. The actual mechanisms are inferred from field observations, and validated by looking for the net effects of defined processes acting over time.

Plant-mediated resource control is inherently more sensitive to grazing pressure than terrain-controlled processes, because herbivores are able to quickly and drastically alter the density and basal cover of plants, and so change the effectiveness of the control processes. This may lead to a long-term change in system function. This paper examines the generality of these propositions in a series of contrasting landscape types, and proposes a framework by which landscape degradation can be assessed by examining the modes of basic resource regulation.

A Flow-filter model for simulating the conservation of limited resources in spatially heterogeneous, semi-arid landscapes

JOHN A. LUDWIG, DAVID J. TONGWAY and STEPHEN G. MARSDEN

As in arid lands of the world, many semi-arid landscapes in Australia have plant and animal growth and reproduction, hence survival, severely limited by available water. For example, *Acacia aneura* (mulga) grove-intergrove landscapes are source-sink systems where water flows from low ridges and stony slopes (inter-groves) into flat areas (groves). Water can be lost from these systems, to lakes and rivers. This occurs if the water retention (filtering and storage) capacity of the sinks is too low (perhaps due to landscape degradation) or if the total area of sink is too small.

A flow-filter landscape model was developed to determine the area of sink (relative to the total area) that will maximize resource (water) conservation and plant production under conditions of low rainfall. The model was also used to examine the effect of having landscape resource sinks with low and high filtering capacities.

Simulation results indicate that when rainfall is low (160 mm) the area of sink needed to conserve all available water within the landscape was 40 per cent of the total landscape area when sinks had high resource-filtering capacities; this area increased to 60 per cent when sinks had a low filtering capacity as the case with landscape degradation. The flow-filter landscape model can provide land managers with guidelines on rehabilitating degraded landscapes by reconstruction of sink areas. To conserve the limited amounts of rainfall within a semi-arid landscape a minimal area of sink has to be reconstructed; the flow-filter model estimates this minimal area, thus reducing rehabilitation costs.

Landscape-scale disturbances and regeneration in semi-arid woodlands of southwestern Australia

COLIN J. YATES, RICHARD J. HOBBS and RICHARD W. BELL

Woodlands dominated by *Eucalyptus salmonophloia* occur both in the fragmented landscapes of the Western Australian wheatbelt and in the adjacent unfragmented goldfields area. We examined the responses of the unfragmented woodlands to landscape-scale disturbances caused by fire, floods, windstorms and drought. Sites known to have experienced disturbances of these types over the past 50 years all had cohorts of sapling-stage *E. salmonophloia* and other dominant *Eucalyptus* species. Sites disturbed either by fire, flood or storm during 1991–92 displayed adult tree mortality and extensive seedling establishment, although rates of establishment and survival varied between sites. No regeneration was observed at equivalent undisturbed sites. These results indicate that landscape-scale disturbances of several types are important drivers of the dynamics of these semi-arid woodlands. Lack of regeneration of fragmented woodlands in the wheatbelt is likely to be due to changed disturbance regimes coupled with altered physical and biotic conditions within remnants. We argue that it may be difficult to identify processes which are important for the long-term persistence of natural ecosystems in fragmented landscapes without reference to equivalent unfragmented areas.

Tree hollows as a resource for wildlife in remnant woodlands: spatial and temporal patterns across the northern plains of Victoria, Australia

F. BENNETT, L. F. LUMSDEN and A. O. NICHOLLS

Hollows in living or dead trees are an important resource for a range of animal species in Australia. They are used for diurnal and nocturnal shelter and as breeding sites, and the availability of hollows may be a limiting factor for some populations. This study examined patterns in the distribution of tree hollows at 185 sites, each of 1.0 ha, in remnant woodlands across the northern plains, Victoria, a rural region where little remains of the natural woodland cover. Spatial and temporal variation in the abundance of tree hollows is evident at several scales including that of the individual tree, the landscape and the region. For individual trees, the number of holes increased with tree diameter, and the slope of this relationship differed between tree species. The percentage of trees that are hollow-bearing also differs between species. Large trees have a higher proportion of holes with a large entrance diameter (>10 cm) and a lower proportion of small holes (≤ 2 cm diameter) than do small trees. At the landscape scale, hollow-bearing trees were not evenly distributed throughout remnant woodlands. Significant variables in a regression model of the abundance of hollow-bearing trees included: the number of large trees (>70 cms diameter), woodland tree species composition and mean annual rainfall. At the regional scale, the availability of hollows is influenced by the patchy distribution of remnant woodlands. Large tracts are mainly associated with public land along river systems and contrast with extensive areas of farmland where woodlands are sparse or absent. The abundance of hollows at the landscape and regional scale is strongly influenced by the impact of land management on two key processes; the loss of existing hollow-bearing trees and the recruitment of new trees. On privately managed land, generally grazed by domestic stock, large trees with hollows are often present, but the scarcity of saplings and small trees raises concern over the recruitment of future hollow-bearing trees, and indeed the long-term persistence of woodland vegetation. Conversely, most sites in large blocks of public land have ample regeneration but relatively fewer hollow-bearing trees due to the loss of larger trees from timber harvesting activities. In both situations, the abundance of trees with hollows is the consequence of management practices, and their future availability is directly amenable to management action. Some implications of the patterns of distribution of hollows for wildlife are discussed.

Integrating agricultural land-use and management for conservation of a native grassland flora in a variegated landscape

S. McINTYRE

Management of variegated landscapes (in which the native vegetation still forms the matrix but has been modified in a variable way) requires strategies to maintain or enhance existing vegetation within the context of human land-uses such as agriculture. Using rangelands in the New England region of New South Wales as an example, spatial patterns of land-use and modification are described. Management principles for conservation of herbaceous communities in areas of pastoral production are suggested, based on the following assumptions: 1) low intensity pasture utilization and management (i.e., limited fertilization, soil disturbance and grazing) is conducive to the maintenance of species richness at a local and regional scale; 2) stratification of management intensity on farms is compatible with viable grazing operations; 3) landscape context is important as effects of management may spread beyond the managed area; 4) spatial arrangement of land-uses could be optimized to maintain or increase diversity. Although our understanding of these issues is incomplete, there is general observational and theoretical support for them. Incorporation of principles derived from these assumptions in the farm planning process is a useful strategy for preserving grassland vegetation in landscapes where opportunities for reserve conservation are limited.

Conservation of woodland birds in a fragmented rural landscape

G. W. BARRETT, H. A. FORD and H. F. RECHER

Increasingly, conservation efforts are being extended towards agricultural and pastoral areas outside large reserves. This indicates a change from the view of the landscape as islands of native habitat in a hostile matrix, to one in which the landscape is regarded as a patchwork of differing levels of disturbance. This latter view considers the whole of the landscape as the biological resource. These trends are discussed in relation to land bird species near Armidale on the New England Tablelands, north-east New South Wales, Australia.

We assess the conservation status of 137 species of land birds. Of these, six species are locally extinct, 18 are thought to be declining and 35 are vulnerable due to their dependence on healthy woodland. Only 33 species are abundant and widely distributed on the Tablelands. The remaining 45 species tend to be habitat specialists that are marginal to the Armidale Plateau, and may never have been common in the study area. Most of the species that are dependent on large areas of continuous woodland (>400 ha) are in this last group, and it is demonstrated that an emphasis on these species may result in a conservation strategy that is inappropriate for most of the land birds in the region. Indeed, this could

result in the extinction of species that at present are secure. An alternative strategy, specific to areas outside large reserves, is proposed that aims to maintain local species richness. In this management plan, priority is given to core species that are tolerant of intermediate levels of habitat fragmentation.

Developing a strategy for rehabilitating riparian vegetation of the Hawkesbury-Nepean River, Sydney, Australia

JOCELYN HOWELL, DOUG BENSON and LYN McDOUGALL

Situated on the southeastern coast at 34°S 151°E, Sydney was established in 1788 as Australia's first permanent European settlement. Clearing of natural vegetation and environmental degradation associated with the country's largest population concentration over the past 200 years have severely affected the nearby Hawkesbury-Nepean River. A strategy for rehabilitation of the riparian vegetation to conserve and enhance the natural conditions remaining along the river, with particular emphasis on habitat and natural biodiversity, has been developed. The study area encompassed the most modified part of the river, where it passes alternately through 80 km of sandstone terrain, where the natural vegetation of waterside scrub backed by open-forest remains largely unchanged, and 135 km of floodplain terrain, where most of the indigenous tall open-forest has been cleared and associated wetlands have been greatly modified. Indigenous riparian zone vegetation was recognized as critical to the maintenance of river health, providing a reservoir of biodiversity as a major value, upon which other values, including enhancement of water quality, bank stability and erosion control, depend. As 47 per cent of study area riverbank was found to have less than 25 per cent tree cover, the strategy recommended that all remnant native vegetation and remnant native trees along the river be protected and that a substantial long-term aim should be the establishment of a 50-metre wide strip of native riparian forest vegetation on each bank among the full length of the river, to be linked ultimately with other areas of natural vegetation on the floodplain. To provide practical resources for revegetation, the strategy assembled a botanical database, including maps showing present tree cover and the past extent of floodplain vegetation types, descriptions and locations of sites where significant native riparian vegetation remains, ecological information on approximately 300 locally indigenous riparian and wetland plant species, guidelines on selection of appropriate species, replanting methods and determination of priorities at both site and landscape scale.

Volume 1 Number 4

News and Views

The Centre for Plant Biodiversity Research

JUDY WEST

Nature Conservation: the role of networks — conference report

D. A. SAUNDERS and J. L. CRAIG

Forum Essays

Biodiversity — political responsibilities and agendas for research and conservation

R. L. KITCHING

Global and national authorities have devised international conventions and national strategies for biodiversity management which commit them to a variety of courses of action in diversity inventory and management. In many instances these refer to "species", displaying a naivety about the nature of "species" and our knowledge of species' taxonomy and diversity. Questions arise about the relative importance of species and this has led to an unfortunate concatenation between the research and management agendas relating to endangered species and those concerning multi-species assemblages.

There are compelling reasons for preserving functional ecosystems and the biodiversity they contain: for the maintenance of ecological services, as repositories of biological information, and as a reflection of human conscience and responsibility. Although useful concepts have been defined for evaluating species within such species sets ("keystone species", "guilds", "indicator species", etc.) we lack basic information on the numbers of species within assemblages, which of these species play "keystone" roles, what proportion of any particular ecological guild is vital, and what biological species or sets of species are proper surrogates for measures of overall diversity.

A national research agenda must be set which matches national and international commitments with respect to biodiversity and the crucial lack of knowledge in these areas. We need a national strategy for the design and funding of such research activities.

Biodiversity management demands a landscape approach, already well developed in Australia, and an on-going involvement of government in overseeing and directing activities.

Toward an ecological framework for sustainability: considerations for ecosystem management

STEPHEN R. DOVERS and TONY W. NORTON

Increasingly, resource and environmental management issues are considered within the emerging framework of sustainability (sustainable development, ecologically sustainable development, sustainable environmental management). While this notion has great potential as an integrative framework, current mainstream approaches and definitions tend to be vague, inoperative and do not translate well to the level of management in specific ecosystems. The current debate about “sustainable development” lacks structure, clarity, and an operational direction. In particular, it is difficult to translate the general concerns of sustainability in a manner useful to a task such as ecosystem management.

This paper takes a long-term, systems view to construct an integrative approach to *sustainability*. This approach is more cognisant of ecological realities than the notion of *sustainable development* as presently construed. Extending the principles thus identified; a checklist of questions to guide considerations in ecosystem management at a more practical level is then constructed. Two examples from resource and environmental management in Australia — fisheries and the conservation of terrestrial species (particularly the Koala *Phascolarctos cinereus*) — are analysed to support the discussion.

Towards the sustainable management of southern temperate forest ecosystems: lessons from Australia and New Zealand

TONY W. NORTON and NEIL D. MITCHELL

The temperate forest ecosystems of Australia and New Zealand have had a similar history of exploitation and destruction since European settlement. This differed markedly from the previous use of these forests by indigenous peoples. Australian Aborigines are considered to have used the forests on a sustainable basis. Fire was the primary management tool and probably had its greatest effect on floristic composition and structure. The Maori of New Zealand initially cleared substantial areas of forest, but by the time of European settlement they appear to have been approaching sustainable management of the remainder. In both countries, the arrival of Europeans disrupted sustainability and significantly changed the evolutionary history of the forests and their biota.

The exploitation and destruction of temperate forests by Europeans in both countries has been driven largely by agricultural and forestry activities, based around settlement and export industries. The Australian continent never had substantial forest cover but this has been reduced by more than half in just 200 years. New Zealand has suffered a similar overall level of further loss; although in the lowlands this can reach 95 per cent. In recent times, forest production and management policies in the two countries have diverged. In both countries the majority of remaining indigenous forests are on publicly-owned land. Australia still maintains indigenous forest production as an industry exploiting old growth forests, the management being split between an emphasis on production forestry and nature conservation. New Zealand has largely abandoned indigenous forestry on public lands, the management being vested in a single conservation department. In New Zealand the production emphasis has mostly moved to sustainable plantation forestry, whereas in Australia, despite recommendations to halt or markedly reduce old growth forest logging, the transition to primary dependence on plantation production has yet to occur.

Reviews

The need for a more sophisticated approach toward wildlife corridor design in the multiple-use forests of southeastern Australia: the case for mammals

ANDREW W. CLARIDGE and DAVID B. LINDENMAYER

The native eucalypt forests of southeastern Australia are managed for wood production, water protection, human recreation and the conservation of plants and wildlife. One strategy to conserve forest wildlife within wood production areas involves the use of unlogged strips or corridors of habitat. Most corridors are situated in gullies within forest

catchments. However, a review of recent studies undertaken in southeastern Australia shows that many species of forest mammals either require habitat outside of gullies to find food and shelter, or make regular movements between forest on different parts of the topographic sequence. These findings illustrate that strategies for the design and implementation of wildlife corridors need to become more sophisticated and ensure: (i) the conservation of forest on ridges and midslopes, and (ii) the linkage of uncut stands on ridges and midslopes with forest in gullies.

Climate change and conservation policies in Australia: coping with change that is far away and not yet certain

LESLEY HUGHES and MARK WESTOBY

Projected changes in temperature and precipitation as a result of the enhanced greenhouse effect suggest that climatic zones could shift several hundred kilometres towards the poles and several hundred metres upwards in elevation over the next 50 years. The potential consequences of such changes for sustainability of natural populations are enormous due to both physiological stresses on individuals and changes in competitive regimes. Despite this, few positive policy initiatives have yet been undertaken in Australia to mitigate the changes for Australia's flora and fauna. Climate change is generally perceived as a distant problem and the uncertainties surrounding the magnitude and rate of changes, especially at a regional scale, have encouraged a wait-and-see approach. In this paper we summarize some of the likely consequences for Australia's native species and outline five directions in which vigorous action is needed within this decade if we are to ameliorate the effects of future climate changes. Four of the five directions are already recognized as important conservation strategies, and more vigorous action is a matter of overcoming political and administrative impediments. The fifth strategy is to transplant selected long-lived, habitat-structuring, plant species into their estimated future climate envelopes, beginning now in order to give them time to develop as future habitat. Such a transplantation programme implies deliberately creating novel species-mixtures, as well as increasing gene flow between related species that previously were geographically separated. While many conservationists will oppose such a transplantation programme, in the name of "community integrity", it is possible that the damage done by transplanting is likely to be less than the damage done by inaction. Among the purposes of this paper is to open a debate on the scientific issues relating to a transplantation programme, because it is now urgent to conduct that debate and to resolve it.

Research Papers

Recent contraction of wet sclerophyll forest in the wet tropics of Queensland due to invasion by rainforest

G. N. HARRINGTON and K. D. SANDERSON

Vegetation maps were prepared from aerial photographs taken in 1943–45 and 1991–92 of three, widely separated areas of sclerophyll forest adjacent to the western edge of rainforest on granitic soils in north Queensland. Nine types of sclerophyll communities could be discerned from aerial photos and characterized by field measurement. Two types of Wet Sclerophyll forest (WSFa and b) were separated on the species of tree composing the tallest stratum and these were subdivided according to whether the ground layer was dominated by grass or young rainforest. A related type showed large, residual *Eucalyptus grandis* emergent from mature rainforest. Closed canopy sclerophyll forest with no emergents (SF), sclerophyll woodland and *Acacia* forest were also discerned. WSF was defined as having more than 30 per cent of the closed crown cover contributed by trees more than 35 m tall. During the 50-year study period rainforest invaded 70 per cent of WSFa (tallest stratum dominated by *E. grandis*), which principally occurs as a narrow strip along the rainforest margin, and 57 per cent of the adjacent WSFb (tallest stratum composed of mixed species). Grass would be quickly excluded from invaded areas and thereafter they would only burn under extreme atmospheric conditions. Because sclerophyll trees are unable to regenerate in shade and usually require fire to provide the appropriate conditions, a long-term transition to rainforest may ensue. The final stages of this transition were observed in areas that exhibited full-stature rainforest with large, relictual *E. grandis* emergents in 1943, but had disappeared by 1992. The initial cause of this vegetation transition is a fire-free period of sufficient length for rainforest tree seedlings to establish and suppress the grass layer. It is not known whether these vegetation changes represent a trend, possibly caused by a change a century ago from fire management by Aboriginal people to management by the cattle industry, or whether it is a temporary phase in the fire-induced, dynamic relationship between rainforest and sclerophyll vegetation. The current loss of WSF probably endangers the survival of a range of genetically endemic biota. Most groups are poorly known but the marsupial Yellow-bellied Glider *Petaurus australis reginae* is totally dependent upon WSF and a number of vertebrates would probably go locally extinct if WSF is replaced by rainforest. WSF is the wettest part of the sclerophyll communities and probably acts as a refuge in times of unusual aridity. To maintain the WSF habitat, fire management is clearly indicated, but the intensity of fire required to reverse the advance of rainforest may be socially unacceptable to instigate or impossible to control if it occurs by accident.

The utility to birds and mammals of remnant riparian vegetation and associated windbreaks in the tropical Queensland uplands

FRANCIS CROME, JODI ISAACS and LES MOORE

Birds and mammals were censused in a ribbon of remnant vegetation along a stream connecting two rainforest fragments on a farm on the Atherton Tablelands of North Queensland. The vegetation consisted of two larger (6.5 and 19.6 ha) and one smaller forest remnant (1.1 ha) and numerous tiny disconnected patches scattered across the property and along the creek. These were classified into five types — “Forest”, “Regeneration”, “Copse”, “Lantana” and “Tobacco Bush”. Censuses were also done in four windbreak plantings. Sixty-four species of birds were recorded in systematic censuses in the patches along the creek and in the windbreaks. Along the creek, “Forest” patches had the most species and the most rainforest species followed by “Copse” and “Regeneration” sites. “Lantana” patches were surprisingly rich in species; a total of 32 were recorded including nine rainforest species. The fewest bird species were recorded in the windbreaks which were particularly poor in rainforest species. Small mammals were live trapped in the three larger patches, in the ribbon and in one windbreak. Eleven species were captured — six rainforest, three grassland and two introduced. The grassland species were not caught in the larger forest patches and two rainforest rodents were not caught along the creek. Nothing was caught in the windbreak but grassland species were caught in an adjoining abandoned orchard. Three species of arboreal mammals were recorded by spotlighting — Lumholtz’ Tree-kangaroo *Dendrolagus lumholtzi*, Coppery Brushtail Possum *Trichosurus vulpecula johnstonii* and Green Ringtail Possum *Pseudocheirus archeri*. All occurred in the stream vegetation as well as the larger forest patches. None were seen in any of the four windbreaks. It is concluded that the creek vegetation is valuable wildlife habitat. The windbreaks were less so but were still useful to the fauna on the study area.

A model for the effects of fire and fragmentation on the population viability of the Splendid Fairy-wren

L. C. BROOKER and M. G. BROOKER

Computer simulation was used to model the relationships between four environmental factors (nest predation, brood parasitism, fire and rainfall) and the probability of local extinction in hypothetical populations of Splendid Fairy-wrens in differently sized patches of habitat. The parameters of the model are based on the results of a long-term (17 year) study of the species at Gooseberry Hill, Western Australia. Two fire scenarios are modelled — wildfire and controlled burning.

The model predicts that wren populations in small patches (less than about 2 000 ha in area) stand a high risk of local extinction if exposed to environmental conditions similar to those experienced at Gooseberry Hill, in particular the frequency and extent of wildfires (Gooseberry Hill fire probability 20%). It is suggested that: (a) urban reserves aimed at conserving small sedentary species such as the Splendid Fairy-wren should contain at least 2 000 ha of suitable habitat if there is a high risk of wildfire (minimum viable population for wrens under these conditions, 500 breeding females), (b) the integrity of existing reserves and parklands should be protected from further fragmentation since the likelihood of local extinctions will increase as the carrying capacity of the habitat declines; (c) management of existing reserves and parklands should be directed toward limiting the environmental pressures impacting populations of native species, in particular the frequency and extent of fire and the numbers of feral nest predators. If the probability of fire can be limited to five per cent or less, Splendid Fairy-wren populations in patches as small as 400 ha (100 breeding females) may be viable in the long term.

Variation in flower production of nine grassland species with time since fire, and implications for grassland management and restoration

IAN D. LUNT

The impact of time since fire on flower production was examined in a temperate *Themeda triandra* grassland in Gippsland, Victoria. Flower production by nine species (*Arthropodium strictum*, *Bulbine bulbosa*, *Burchardia umbellata*, *Chrysocephalum apiculatum*, *Craspedia variabilis*, *Diuris punctata*, *Helichrysum scorpioides*, *Leptorhynchos squamatus* and *Pimelea humilis*) was compared between areas burnt six months and two years previously. Thick grass in the area burnt two years previously inhibited flowering by most species. All species except *C. apiculatum* and *D. punctata* flowered most abundantly in the area burnt six months earlier, and flower production by

B. bulbosa, *A. strictum* and *C. variabilis* was largely restricted to that area. There were over 100 times as many flowering plants of *B. bulbosa* in the most recently burnt area. *C. apiculatum* produced similar quantities of flowers in both zones, but *D. punctata* countered the general pattern for greater flower production in the most recently burnt area by flowering most abundantly in the area burnt two years previously. Some of the species studied form transient seed banks, so maximum recruitment may be attained by burning sites the year immediately after a season of high flower production, rather than delaying burning until later years, when little flowering occurs and few seeds are present for recruitment. Annual autumn burning could eliminate the threatened orchid, *D. punctata*.

Research Note

A genetic study of the Brush-tailed Rock Wallaby *Petrogale penicillata* in East Gippsland and relevance for management of the species in Victoria

R. L. CLOSE, M. D. B. ELDRIDGE, J. N. BELL and J. RESIDEPACIFIC CONSERVATION BIOLOGY

Pacific Conservation Biology

**Order Form and Subscription information appears at the end of this document —
please complete and return it to Surrey Beatty & Sons**

Volume 2 Number 1

Research Papers

The future of New Zealand conservation: Ethics and Politics

JOHN MORTON

The natural environment raises moral questions. Its evaluation calls for a concern with ethics, visible in our public decisions and having regard ultimately to some qualities intrinsic to the system itself. This need brings no irresolvable conflict with proper economic or cultural aspirations; but there is reason and necessity to look to ecology for the normative code by which environmental decisions are to be instructed and must ultimately abide. This article examines the sufficiency of the Resource Management Act as New Zealand's base-line code of practice, and the ways it is juridically evolving. It proceeds to discuss the need and scope of public intervention, with the question, how far should governments go? It advocates that environmental regulation at the commanding heights should — like the safeguarding of the monetary economy — be removed from the day-to-day intervention of executive government, into the hands of a properly chosen and resourced faculty of Guardians of the Environment; and considers what should be the character and status of such a new public estate.

Kaitiakitanga: Maori perspectives on conservation

MERE ROBERTS, WAERETE NORMAN, NGANEKO MINHINNICK, DEL WIHONGI
and CARMEN KIRKWOOD

Maori, like other indigenous peoples, are increasingly involved in attempts to provide appropriate cultural responses to environmental issues. These include efforts to translate and incorporate isolated parts of their language and traditional practises into the prevailing culture. Major problems with this process are the incommensurability of such attempts whereby the real meaning of a custom or word is frequently debased and divorced from its traditional cultural setting, so that its proper function is impaired. Added to this is the ignorance on the part of many concerning the conceptual world view, traditional beliefs and practices of the Maori — or, if knowing these things, a lack of respect for their validity. On the other hand there are some, especially among the modern conservation movement, who have a more empathetic attitude towards indigenous ecological knowledge, but who thereby assume that their environmental ethics and those of indigenous peoples are motivated by similar philosophies and share similar aims. Not only is this assumption often wrong, it may also contribute to the inability of the western conservation movement to properly serve the needs of, and to fully empower, indigenous conservation aspirations as guaranteed to Maori under the Treaty of Waitangi. This paper addresses some of these issues by providing Maori perspectives on an increasingly important environmental concept: that of kaitiaki, and kaitiakitanga.

Ko ti iwi Maori pera ano i etahi iwi tuturu ka uru whanui ki te mahi whai kia whakaratoa ai te tikanga iwi ona titiro ki nga take taiao. Ki roto nga take kia whitia ki a whakaurua etahi wahi tu mokemoke ai te reo me te tikanga tuturu ki roto i a tauwi whanui katoa. Ko nga nawenawe i enei whai ko te hautupuutanga o aua whainganga. Ka kitea rawa ake ko te tino hohonutanga o te tikanga o te kupu ranei kua whakaharahia kua noho tuwehe mai i te tikanga o te iwi, e kore pai te haere ka whara. Ka tapiri ki tenei ko te noho kuaretanga o te nuinga ki te ahua o te ao o te Maori, ona tikanga whakapono me nga tikanga tupuna tuku iho a te Maori, a, meina hoki ka mohio ano, ka takahia ano te mana. Heoi ano i tua atu ka puriti i tetahi ringa whiti atu ki nga ropu tirohanga tiaki taiao o naiane, e pa ana te aroha ki te ahua titiro me te mohioranga taiao o te Maori he whakapae ana ki te rite tonu te titiro, nga whakapono me nga whainganga. Ehara i te mea e he ke ana enei whakapae ka huri ki te kore ano pea a taea e tauwi i te tiaki taiao ana i te whai tika i nga hiahiatanga take kia whakamanahia nga wawata tikanga tiaki taiao iwi i ira, i pu, i mana mai ano hoki i raro i te mana tino rangatiratanga o te Tiriti o Waitangi. Ko tenei pepa ka ahei ka pou i nga take tirohanga a te Maori ka whakarato kanohe Maori i tenei take tino nui tino whanui ara taiao: tikanga kaitiaki, kaitiakitanga hoki.

DNA science and conservation

DAVID M. LAMBERT and CRAIG D. MILLAR

A wide array of DNA-based genetic techniques are now available for the study of many problems in conservation biology. Either directly or indirectly, such techniques are becoming increasingly available to scientists and managers alike. Although these technologies are generally known to conservationists, there is a need to clearly outline the principal characteristics of such genetic tools and to detail how they can most appropriately be used in the management of wildlife species. The essential characteristics of mitochondrial and chloroplast restriction fragment analyses are detailed, together with discussions of single locus nuclear restriction fragment length polymorphisms (RFLPs), multilocus DNA fingerprinting, microsatellite DNA, randomly amplified polymorphic DNAs (RAPDs), and DNA sequence variation. We also give relevant information about the development times for these techniques, their relative costs, and the quality of tissue required. In addition, we discuss which conservation problems are appropriate to each of these methods and give examples of their application and potential use in relation to New Zealand organisms. The following problems are considered: sex assignment; parentage and kinship; migration; species, population and strain identification; forensic applications; genetic effects of population bottlenecks; disease identification; feeding

preferences; philopatry; pest control; and understanding population extinction. Finally, we suggest that both microsatellite and minisatellite DNA techniques have particular advantages over many other currently-available techniques and conclude that these two approaches are applicable to a wide range of the conservation problems.

New Zealand translocations: theory and practice

DOUG P. ARMSTONG and IAN G. McLEAN

One of the most common tools in New Zealand conservation is to translocate species to new locations. There have now been over 400 translocations done for conservation reasons, mainly involving terrestrial birds. Most translocations have been done strictly as management exercises, with little or no reference to theory. Nevertheless, translocations always involve some underlying theory, given that people must inevitably choose among a range of potential translocation strategies. We review theory relevant to translocations in the following areas: habitat requirements, susceptibility to predation, behavioural adaptation, population dynamics, genetics, metapopulation dynamics, and community ecology. For each area we review and evaluate the models that seem to underpin translocation strategies used in New Zealand. We report experiments testing some of these models, but note that theory underlying translocation strategies is largely untested despite a long history of translocations. We conclude by suggesting key areas for research, both theoretical and empirical. We particularly recommend that translocations be designed as experimental tests of hypotheses whenever possible.

Marine conservation in New Zealand

ROBERT G. CREESE and RUSSELL G. COLE

Marine conservation in New Zealand lags behind the achievements on land. This is largely because conservation issues in the sea have not been as readily apparent until more recent times. Although the marine environment has not suffered from the same scale of degradation as the terrestrial one, there are many present and potential threats that need to be addressed. Impacts from fishing, aquaculture, species introductions, coastal developments and pollution are briefly reviewed. With one notable exception, remedial measures for these impacts are not well developed. The exception is the establishment of marine reserves in which all marine biota is totally protected. Since the mid 1970s, New Zealand has set up 10 of these marine reserves, eight of them in the past five years. Preliminary research has demonstrated that dramatic changes in the densities, population size structures and behaviours of some large fish and invertebrates can occur, presumably as a result of the protection. This has prompted a realization that marine conservation measures are achievable and desirable. Further initiatives in marine reserves, and in other forms of conservation such as active habitat restoration and species enhancement, can be expected in the years ahead. More basic research needs to be done, however, with the fishing industry in particular devoting more money and effort to evaluating the environmental effects of its fishing activities.

Conservation of marine mammals in New Zealand

ELISABETH SLOOTEN and STEPHEN M. DAWSON

New Zealand has a diverse fauna of marine mammals, comprising 35 cetacean and six pinniped species. None of these is hunted within the 200 mile Exclusive Economic Zone, but several species are killed incidentally in coastal or deep-water fisheries. Particularly affected are Hector's Dolphin, Hooker's Sea Lion, and the New Zealand Fur Seal. Detailed information on the nature and magnitude of incidental catches is patchy at best, and inadequate to assess nationally the impact on any one species. Other species are known to be caught, but a quantitative assessment of how many are caught per year is impossible. The impact of whale watching on sperm whales has attracted more attention, and impacts of tourism on other marine mammals are just beginning to be studied. We critically review the nature and management of the potential threats facing New Zealand marine mammals, including bycatch, entanglement in plastic debris, chemical pollution, and tourism. We discuss research needs and management recommendations for each conservation problem in turn.

The long-term conservation of forest diversity in New Zealand

JOHN OGDEN

The largely endemic flora of New Zealand is a remnant of the Cretaceous flora of Gondwana, supplemented by later additions from Australia and the tropics. Semi-natural plant communities cover about 50% of the country, and a scheme for the protection of supposedly representative areas is in place. Existing reserves do not adequately reflect the patterns of plant species diversity. Many are modified by introduced animals and alien plants. The latter are being actively introduced into New Zealand at the rate of c. 11 species per year. Measures of diversity are discussed and the broad pattern of (gamma) diversity and endemism in the country is described. A comparison is made between (alpha)

diversity levels in Beech *Nothofagus solandri* var. *cliffortioides* and Kauri *Agathis australis* forest. Within each of these two forest types there are similar levels of alpha-diversity over a wide range of latitude. Altitudinal alpha-diversity trends indicate an average loss of 3.4 species per 100 m of altitude. This can be accounted for by the reduction of land surface area with increasing altitude on conical or ridge-shaped mountains. The altitudinal data emphasize the importance of the lowlands in the conservation of bio-diversity. The Holocene history of the forests in New Zealand suggests that the concept of “representativeness” is flawed: forest varies continuously in time and space. It may be possible to create some “living museums” of the past biota of New Zealand, but unless there are radical changes in our ability to eradicate animal pests and introduced plants, the composition of mainland forest reserves in the lowlands will change dramatically over the next few centuries. Conservation effort on saving endangered birds may have been at the expense of long-term “habitat” survival on the mainland.

Conservation and ecological restoration in New Zealand

MICHAEL N. CLOUT and ALAN J. SAUNDERS

The introduction of alien species to New Zealand’s terrestrial ecosystems has caused rapid loss of native biodiversity since human settlement. Faced with this crisis, conservation managers and scientists have responded by developing innovative techniques such as translocation of native animals and the eradication of introduced mammals from islands. We review recent progress with conservation of New Zealand’s terrestrial flora and fauna (especially birds) and consider future prospects for ecological restoration of islands and mainland areas. We stress the value of linking species and ecosystem approaches to conservation and we reinforce the importance of maintaining a dynamic partnership between researchers and conservation managers in the development of conservation initiatives.

Conservation values, research and New Zealand’s responsibilities for the Southern Ocean Islands and Antarctica

EUAN C. YOUNG

New Zealand has direct responsibility for the conservation and protection of five subantarctic island groups (Snares, Bounty, Antipodes, Auckland and Campbell), all of which are protected within National reserves. New Zealand also claims the Ross Dependency in Antarctica sharing conservation responsibility with others within the Antarctic Treaty regime. The subantarctic islands’ ecosystems are of interest for their range of species, for their dependence on marine nutrients, for their vulnerability to introduction by alien species, and for illustrating the outcomes of independent evolutionary experiments. Each is characterized by a unique assemblage of plant and animal species, of which the diversity of oceanic birds (especially their albatrosses, petrels and penguins) and of the changes with latitude of their vegetation cover is internationally regarded. They form an interesting contrast to the sparse biota of the Balleny Islands and continental Antarctica. The fauna and flora on these subantarctic islands are now substantially catalogued and the impact of alien species in part understood, but ecological studies have been hampered by isolation and difficult access. Ecological research is needed to ensure that management strategies for each island are well founded on an understanding of their individual ecosystems. By way of contrast, ecological research has flourished in Antarctica with many long-term programmes. This difference is attributed to the way research is promoted and supported in the two regions.

The New Zealand law and conservation

KLAUS BOSSELMANN and PRUE TAYLOR

New Zealand, like many countries concerned with conservation issues, is reforming its legislation to provide more comprehensive protection of biological diversity and individual species. The basic aim is simple: if you want to protect animals and plants you have to protect their habitat. The problem is, of course, that humans share the very same habitat. How then can the right balance between use and protection be found?

Of the principal Acts guiding the protection and preservation of land, animals and plants (such as the 1953 *Wildlife Act* or the 1987 *Conservation Act*) the 1991 *Resource Management Act* (RMA) marks an important turning-point. It aims to integrate development and conservation. The RMA promotes *sustainable* management of natural and physical resources. Any destruction of, damage to, or disturbance of, the habitats of plants and animals on land, in coastal marine areas and in lakes and rivers is seen as unsustainable, thus to be avoided. The use of the concept of sustainability is a first in national legislation and makes the RMA a leader around the world. However, its successful enforcement is ultimately a matter of changed attitudes. Here the law can only give some guidance.

Conservation is not enough

EDWARD GOLDSMITH

Economic development has become the overriding priority of almost every government in the last fifty years. Over this period, social and ecological imperatives have been ruthlessly and systematically subordinated. As economic development has gone out of control, the pressures on the natural world have become immense. In fact “free trade” and economic development are fundamentally in conflict with environmental conservation. We need to oppose the new World Trade Organization and the various free trade treaties such as the General Agreement on Trade and Tariffs (GATT Uruguay Rounds), because once these have been set in place, there can be no environmental conservation. Conservation, as we know it, is not enough.

Volume 2 Number 2

Forum Essays

Ecological functioning in arid Australia and research to assist conservation of biodiversity

CRAIG D. JAMES, JILL LANDSBERG and STEPHEN R. MORTON

This discussion paper outlines what we perceive to be current conservation problems in arid Australia. We call for better land-use planning for conservation, for the integration of conservation and other types of land use, and for an agenda for research that is required to assist this planning and integration. We identify four key themes on which we believe research is imperative to assist the conservation of biodiversity. The research themes are: (1) identification of spatial and temporal patterns of distribution of native biota; (2) quantification of the impact of pastoralism on native biota; (3) identification of, and control of, potential non-native pest species; and (4) development of methods and technologies to allow regional conservation planning. For each of these themes we examine current knowledge and on-going research and provide a framework in which these research areas could be addressed. We offer this discussion to help refine and target research expenditure.

Coral reef gastropods — a sustainable resource?

ANN L. POULSEN

Large, colourful coral reef gastropods including the Giant Triton *Charonia tritonis*, helmet shells (Cassidae), cowries (Cypraeidae) and volutes (Volutidae) are exploited in an unregulated and unsustainable way throughout much of the Indo-Pacific region. The consequences for their populations, for the populations of their prey or for the ecology of their habitats are rarely considered. Serious decline in stocks of edible coral reef molluscs through unregulated harvesting demonstrates the need for controls on the collection and trade of commercially important species. Continued, unrestricted collecting will eventually lead to the local extinction of vulnerable species on substantial numbers of reefs. Research on the biology and ecology of ornamental species is urgently needed to facilitate the implementation of appropriate management strategies for long-term utilization. A co-operative effort to monitor and regulate trade will also contribute toward the maintenance of sustainable gastropod populations on coral reefs.

Review

Relationships between fluctuating asymmetry and fitness: how good is the evidence?

GEOFFREY M. CLARKE

A number of recent articles have espoused a relationship between developmental stability, as measured by fluctuating asymmetry, and individual fitness, to the extent that asymmetry has been viewed as a surrogate for more direct fitness assessment. This essay reviews the underlying assumptions and evidence for such a relationship and concludes that although asymmetry assessment may provide a useful early-warning system for detection of individuals and populations under stress, there is inadequate evidence at this stage to support its widespread application as substitute for conventional fitness measurement within conservation programmes.

Research Papers

Conservation genetics of the Parma Wallaby *Macropus parma*: a case study for Australian marsupials

L. M. McKENZIE and D. W. COOPER

The Parma Wallaby *Macropus parma*, native only to Australia, exemplifies a number of issues currently under discussion regarding the conservation of Australian Marsupials. Thought to be extinct in the earlier part of this century, an expatriate population was identified on Kawau Island, New Zealand in 1967. These animals were used to supply zoos and captive breeding colonies throughout the world. Subsequently, parma populations were rediscovered in the Great Dividing Range of New South Wales, Australia. The Australian populations are small and inhabit severely restricted localities where they are highly vulnerable to predation and further habitat loss. Strategies for the preservation of parmas in Australia include the reintroduction of parmas either directly from Kawau Island or from established captive colonies. However, the founder number of Parma Wallabies on Kawau Island is unknown, hence it is possible the New Zealand derived parmas have a restricted genetic base compromising their suitability for reintroduction programmes. Additionally, there is a possibility that introgression has occurred between parmas and Black-striped Wallabies *Macropus dorsalis* on the island. Here we report that the level of genetic variation in New Zealand derived Parma Wallabies is not markedly reduced, and that no detectable introgression has taken place between Parma and Black-striped Wallabies. Indeed, re-examination of records casts doubt upon the suggestion that Black-stripes were introduced to Kawau Island.

Conservation implications of interesting habitat use by Loggerhead Turtles *Caretta caretta* in Woongarra Marine Park, Queensland, Australia

A. D. TUCKER, N. N. FITZSIMMONS and C. J. LIMPUS

We studied interesting habitat use by Loggerhead Turtles *Caretta caretta* with radio telemetry and by visual sightings of paint-marked turtles in Woongarra Marine Park, adjacent to the major mainland nesting rookery in Queensland. A high concentration of females occurs within the Park during the early phase of the interesting period as ovulation and shelling of eggs occur. From 36–72 hr following oviposition, activity ranges and swimming rates were greatly reduced. About day 9 after oviposition, turtles resumed higher swimming rates and wider activity ranges and were as likely to be outside protected management zones as within. Movements were generally within 10 km north or south of the rookery, limited to 1–2 km of the coast rather than offshore oriented and were independent of currents. A different pattern was exhibited after the final nest of the season: females departed the region quickly, with little of the localized movement characteristic of the interesting period. Over 89% of the nesting females were susceptible to trawling at some time during their interesting period as they swam outside the Protected Management Area. The likelihood of turtle-trawler interactions along the Woongarra coast and the potential of turtle excluder devices (TEDs) as a conservation measure are discussed. TED use provides a broadly applicable management option that can be combined with spatially or temporally restricted trawling zones.

Juvenile dispersion and use of habitat by the endangered *Kakerori Pomarea dimidiata* (Monarchinae) on Rarotonga, Cook Islands

KERRY H. SANDERS, EDWARD O. MINOT and ROBIN A. FORDHAM

The Kakerori (Rarotongan flycatcher) *Pomarea dimidiata* is a small, territorial passerine, endemic to Rarotonga, Cook Islands. Now listed as endangered, the total known population in August 1991 was 48 individuals. Kakerori are found in the steep, forested inland of southern Rarotonga. Newly fledged young remain high in the canopy near the natal nest. However, 4–5 months later they occupy spurs and small ridges immediately surrounding the parental territory, while 7–8 months after fledging, these young birds are most often found on high, exposed ridges where they form small cohorts. The daily activity budget for Kakerori is dominated by calling and looking, and the most common method of feeding is gleaning. Overall, successful territories (those that produce fledged young) have a lower canopy, fewer ferns, and trees with a larger total basal area, than unsuccessful territories (those that do not produce fledged young). Survival of this species depends on continued management of the population, including further research on habitat requirements and effective predator control.

(Abstract in Cook Islands Maori) Ko te Kakerori (*Pomarea dimediata*), 'e *Rarotongan flycatcher* 'oki te ingoa Papa'a, 'e manu-rere meangiti 'ua 'a ia 'e te no'o 'aere 'ua ki vaiata'o i te nga'i i 'anau'ia mai ei 'a ia. Tei Rarotonga anake 'ua i te Kuki 'Airani te nga'i e no'o ana teia manu-rere nei. Kua 'akapapu'ia 'oki i teia nei e, ko teta'i manu teia ka viviki i te ngaro. 'I roto i a 'Aukute 1991, kua kitena'ia mai te katoa'anga o teia manu nei e, 'e 48 rai ratou. E no'o ana te Kakerori i uta i te vao rakau pa'eke'eke i te pae 'apatonga o Rarotonga. E 'akano'o 'aere 'ua ana te au punua 'ou ki runga i te au tapokipokinga-'atavatava teitei i vaiata'o i te au ko'anga 'anau'anga. 'I na ra, mei te 'a (4) ki te rima (5) marama i muri mai, kua neke atu ratou ki runga i te au 'ivi 'e te au 'ivi-maunga rikiriki tei koropini mai i te area-'enua o nga tinana-metua. Mei te 'itu (7) ki te varu (8) marama i muri ake i te rere-mua'anga, ka kitea putuputu'ia eia punupunua-manu nei ki runga i te au 'ivi teitei 'e te ateatea 'ua, 'e kua 'akapupupu rikiriki 'aere i a ratou. 'E kapikipiki 'e te 'akarakara 'aere te peu putuputu a te Kakerori, 'e ko te tu o te 'angai'anga ratou i a ratou, mari ra, ko te kai i te toetoengakai 'a eta'i manu ke.

'I tei kitea'ia mai, ko te au area e pu'apinga nei (koa 'oki, te au nga'i e, kua rere te punua), 'e 'aka'aka 'ua te tapokipokinga-'atavatava i reira 'e te iti 'ua i te tuanu'e, 'e, 'e au rakau tumu ma'atama'ata to reira. Kareka te au area pu'apingakore (koa te au nga'i kare 'e punua i rere ana), kare to runga ake nei i reira. Ko te ravenga e kore ei te Kakerori e ngaro, kia rave 'ua'ia atu rai te 'akatere'anga 'akonokono i te katoatoa'anga o teia manu nei, ma te kimikimi matatio 'aere atu i te au mea tau no te nga'i e no'o ra ratou, 'e teta'i arai'anga meitaki tikai i te au manu-'aru, me kare ra, manu-kaikiko.

Comparison of a common, rare and declining plant species in the Asteraceae: possible causes of rarity

S. McINTYRE

Three forbs of contrasting abundance were compared with the aim of identifying ecological traits that may be associated with differences in abundance in Australia. *Hypochoeris radicata* (an extremely common, exotic species), *Cymbonotus lawsonianus* (rare in some regions, moderately common in others) and *Microseris lanceolata* (once widespread but which has dramatically declined) are all species of grasslands and grassy woodlands. Habitat details and phenological observations are reported from the New England Tablelands, New South Wales where the three species co-occur. This information is synthesized with that available in the literature. Part of the success of *H. radicata* relates to its broad environmental tolerance. Although *C. lawsonianus* and *M. lanceolata* are both widely distributed in Australia, the range of habitats in which they occur is more limited. The depletion of *M. lanceolata* populations is largely attributed to a vulnerability to domestic grazing animals that may be linked to its palatability and architecture. The more common *C. lawsonianus* and *H. radicata* appear more tolerant of grazing and mowing and may be advantaged by their ability to form flat rosettes. Despite its occurrence at sites with soil disturbance, *C. lawsonianus* is still rare in comparison with *H. radicata*. It may be restricted by a lack of phenotypic plasticity that prevents plants adopting an erect leaf position under more competitive situations. A number of rare native herbs appear to be disturbance-dependent, and it is suggested that *C. lawsonianus* may share with them highly specific ecological requirements that make both undisturbed and human-disturbed sites sub-optimal for their persistence.

Changes in the status and distribution of four species of parrot in the south of Western Australia during 1970–90

PETER R. MAWSON and JOHN L. LONG

Mail surveys were sent to field staff of the Agriculture Protection Board of Western Australia to assess the distribution and status of four species of parrot in the agricultural region of south-west Western Australia in 1970, 1980 and 1990. The surveys indicated that the populations of the Regent Parrot (*Polytelis anthopeplus*) and the Western Rosella (*Platycercus icterotis*) have declined in range considerably since 1970. The populations of the Red-capped Parrot (*Purpureicephalus spurius*) and the Port Lincoln Ringneck (*Barnardius zonarius*) have suffered little or not at all during the same period. Factors which appear to have contributed to the observed changes in distribution and status include clearing for agriculture, dietary preferences, physiology, habitat requirements, altered fire regimes, grazing by exotic herbivores and reduced winter rainfall. These surveys have shown that species which were formerly considered common and widespread have declined with little comment having been made of these changes. The implications of this are serious, both for these formerly common species and for rarer bird species which have similar ecological requirements. The technique of mail surveys has considerable merit for quickly assessing the status of some species of birds, but will be limited by the expertise of the respondents and the degree to which the species in question can be observed.

Volume 2 Number 3

Forum Essay

Towards a national bat research strategy for Australia: pointers arising from a survey of participants at the Sixth Australian Bat Conference in January 1994

D. LUNNEY, B. LAW and P. BAVERSTOCK

A questionnaire distributed to the participants of the Sixth Australian Bat Conference in January 1994 sought views about priorities for Australian bat research. The results demonstrate that there is a primary requirement for the funding of broad-based fundamental research and many of the research projects proposed by the participants are listed here. Bat research was considered to be hindered by lack of funding, cost of capital equipment and inaccessible research results buried in unpublished studies. Species of the genera *Pteropus* and *Nyctophilus* and cave-dwellers were thought to be good potential subjects for research, but there was little support for research and development of an industry based on commercial utilization of flying foxes. Most importantly, the results reveal the concern of bat specialists that bat conservation in Australia be based on a thorough understanding of bat biology.

Review paper

An ecological approach to identifying the endangered fauna of New South Wales

D. LUNNEY, A. CURTIN, D. AYERS, H. G. COGGER and C. R. DICKMAN

This study used ecological criteria to evaluate systematically the conservation status of all mammals, birds, reptiles and frogs in New South Wales. The outcome was an official schedule of endangered fauna as defined under the New South Wales *National Parks and Wildlife Act 1974* as amended by the *Endangered Fauna (Interim Protection) Act 1991*. The work was modelled on the study by Millsap *et al.* (1990) which scored a range of biological variables and used expert opinion to determine priorities for conservation. The listing was undertaken by a statutory Scientific Committee and the results provided the first baseline status list for all species in New South Wales. Of the 883 faunal species (including 10 Lord Howe Island subspecies) identified in the state, 233 (26%) were recognized as endangered. Of these, 40 are considered to be extinct in New South Wales. Mammals constituted the worst affected group, with 77 (59%) of the 130 species recorded as endangered, of which 27 species are recorded as extinct in the state. The assessment of the New South Wales fauna also found that adequate ecological information exists for only 6% of the state's species. The outcome of this study not only provided the first official list of the endangered fauna of New South Wales and explained the methods and reasons for listing or excluding each species, but also furnished new material, ideas and directions for programmes to conserve the state's fauna.

Research Papers

Changes in populations of bird species in roadside softwood scrub remnants/farmland and open eucalypt forest in south-east Queensland, 1981 to 1993

G. J. LEACH

Long-term monitoring of bird species provides information on base-line populations and population trends required to ensure that habitat management is effective for their conservation. Two surveys in both spring and autumn over 12 years monitored populations at fixed points in roadside softwood scrub remnants plus adjoining farmland (softwood/farmland) and in eucalypt open forest in south-east Queensland. The main aims were to determine the status

of species in each habitat, especially whether the status of any species was changing, and to assess the usefulness of the monitoring procedure. In all, 92 species were observed; 79 in the softwood/farmland and 74 in the eucalypt forest.

From 49 to 56 species were observed each year in softwood/farmland and 34 to 46 in eucalypt forest. Annual species turnover in softwood/farmland was about half that in eucalypt forest; 39% of all species were observed every year in the former habitat, but only 19% in the latter.

The Torresian Crow was most often observed in softwood/farmland and the Noisy Miner in eucalypt forest. The Torresian Crow was the only species to be among the five most observed in each habitat. Among other common species 95% or more observations of Bar-shouldered Doves, Superb Fairy-wrens, Yellow Thornbills and Silvereyes were in softwood/farmland, whereas for Weebills, White-throated Gerygones, Buff-rumped Thornbills, White-throated Treecreepers and White-throated Honeyeaters at least 95% of observations were in eucalypt forest, confirming their strong habitat specificities.

The number of birds observed increased linearly for eight species in softwood/farmland and six species in eucalypt forest, and decreased for five and four species, respectively, over the 12 years. The most significant trends were for the Crested Pigeon (increase) and Willie Wagtail (decrease) in softwood/farmland, while Peaceful Dove and Rufous Whistler decreased in both habitats. Several species which increased adapt well to partial clearing of woody vegetation and aggressively exclude others, e.g., Noisy Miner, butcherbirds and Pied Currawong. The trends may reflect insidious degradation of habitats.

The main value of the survey method was for detecting changes of species that could be used as indicator species — those that respond most rapidly to habitat change. While the method was efficient, wildlife managers would need to use it regularly to maintain skills, especially because most observations are of bird calls.

Impact of fire on invertebrate communities in mallee-heath shrublands of southwestern Australia

G. R. FRIEND and M. R. WILLIAMS

A three-year study (1989–92) of the responses of invertebrates to fire was carried out in mallee-heath shrublands in the Stirling Range National Park, Western Australia. Abundances were measured at the Order level for major groups and at the morphospecies level for Coleoptera. Changes in floristics and vegetation structure were monitored over the same period.

At the Order level, variation in abundances was attributable more to locality, seasonal and year-to-year effects than to fire. Responses of beetles at the morphospecies level, however, reflected changes due to fire as well those attributable to season and year. Coleoptera and Diptera were most abundant 40 years after fire, Hemiptera and Orthoptera peaked in earlier seral stages, while Hymenoptera and Araneae showed relatively few fire-related trends. Coleoptera and Diptera best reflected changes due to season, year and fire, and together with some Araneae such as mygalomorph spiders, would most likely be suitable groups to consider in future studies.

Multivariate analyses indicated that classification to morphospecies level is essential to elucidate changes due to fire. These analyses also indicated that changes in invertebrate abundance and composition did not accord with changes in floristics or vegetation structure. Each set of data therefore represents different facets of change over time, including those due to fire.

Comparing our data with contemporaneous information collected in upland areas of the Park indicates that there is a clear dichotomy in the fire sensitivity of species inhabiting the wet gullies and thickets of the mountains and those occupying the seasonally dry lowland mallee-heaths. Fire management strategies need to take account of this dichotomy by protecting relicitinal fire sensitive species and habitats.

The relative conservation value of remnant patches of native vegetation in the wheatbelt of Western Australia: I. Plant diversity

M. G. BROOKER and C. R. MARGULES

Accurate assessment of the relative conservation value of remaining areas of native vegetation is of primary importance to both land planners and land managers wishing to conserve the biodiversity of an area. Selection procedures aimed at identifying sets of patches for nature reserve networks stress the importance of retaining beta diversity (or diversity of habitats).

This paper describes a new procedure that incorporates a measure of relative alpha diversity (or within habitat diversity) of plant species, as well as beta diversity, using the Kellerberrin area of the Western Australian wheatbelt as an example. The inclusion of such an algorithm in selection procedures is justified since beta and alpha diversity, together with genetic diversity, determine the overall biotic heterogeneity of an area.

A five-step ranking method is used to prioritize remnant patches of native vegetation with respect to plant diversity, both at regional and local scales. Ranking at a regional scale is important for state authorities able to deal with only a

limited number of widely dispersed sites such as nature reserves; whereas ranking at the local scale provides a guideline for the conservation of biodiversity at a level where many land use and management decisions are made by local government and private citizens.

The influence of plant diversity on the resilience of harvester termites to fire

MAX ABENSPERG-TRAUN, DION STEVEN and LYN ATKINS

The harvester termites in floristically rich mallee-heath of southern Western Australia appear resilient to high-intensity fire. This contrasts with the temporary extinction of harvesters occupying a narrow food niche in floristically simple, intensely burnt spinifex *Triodia angusta* grassland in tropical Western Australia. The present study examines the effects of high-intensity fire on harvester termites *Drepanotermes tamminensis* in vegetation of intermediate floristic diversity and compares its findings with these earlier studies. We sampled 20 mounds (termitaria) in both an unburnt and (adjacent) burnt stand of *Allocasuarina campestris* shrubland. Although partially regenerated three years after the fire, 40% of mounds in the burnt area were abandoned, contrasting with 10% in the unburnt stand. No harvested chaff was found in any of the abandoned mounds. The extent of mound occupation by *D. Tamminensis* was considerably lower, and ant invasion higher, in the burnt stand.

These findings are consistent with the hypothesis that high floristic diversity enhances the resilience of harvester termites to fire. The most likely mechanism is the availability of a range of plant (food) species with different regenerative responses to high-intensity fire.

The death of spinifex and the associated harvester termites after fire may be atypical. We argue, however, that temporary extinction of harvester populations in arid Australia may not be exceptional, particularly where fire coincides with drought and high livestock grazing pressure. Rigorous experimental studies are necessary to enhance our understanding of the long-term effects of fire on harvester termite populations in different vegetation types and climatic zones.

Changes in habitat use by lizards on a New Zealand island following removal of the introduced Pacific Rat *Rattus exulans*

DAVID R. TOWNS

On Korapuki Island (Mercury Islands group, northeastern New Zealand) lizard capture frequencies increased following the removal of Pacific Rats *Rattus exulans* in 1986 and rabbits *Oryctolagus cuniculus* in 1987. This increase was dominated by diurnal Shore Skinks *Oligosoma smithi*. Increases in Shore Skink captures were proportionally greatest where beach particle sizes exceeded 25 cm dia (50-fold in five years). In sites where particles were large the Shore Skink population became dominated by adults. These changes in Shore Skink distribution and size were found in areas unlikely to have been either directly or indirectly affected by rabbits. The changes are therefore attributable to removal of Pacific Rats which apparently had greatest effect on lizards where interstices between rocks allowed the rats access. The selective natural recovery of Shore Skink populations on Korapuki Island indicates that the effects of Pacific Rats on island lizard faunas depends not only on the presence of refuge areas, such as rocky beaches, but also on the particle sizes within them.

***Protasparagus densiflorus*: an environmental weed of coastal vegetation reserves**

D. BOWDEN and R. W. ROGERS

Protasparagus densiflorus, a native of southern Africa, has become established in Australian coastal vegetation from Noosa Heads to Batehaven, a range of at least 1 200 km of the coast of eastern Australia. Plants fruit prolifically, the seeds have no endogenous dormancy, and are viable while the fruit is still immature. Germination is retarded in the light when compared with that in the dark, but temperature fluctuations appear not to influence germination rates. When exposed to a 9°C day-night temperature variation germination was successful in the range of minimum temperatures from 9° to 26°C, with an apparent optimum at 23°C. Temperatures suited to germination are therefore available to the species in every month of the year in a coastal subtropical climate. Tubers formed on the roots of seedlings 9–14 days after germination. Tubers increased the probability of plants surviving air-dry for six days on plants which were 16 days old. Detailed studies in two small coastal conservation reserves in southeastern Queensland showed different distribution patterns. Dispersal of the species appears to be anthropogenic, by birds and perhaps by lizards. *Protasparagus densiflorus* is a threat to the conservation value of coastal vegetation in some of the most densely populated regions of eastern Australia.

The conservation and ecology of rainforest pigeons in northeastern New South Wales

E. M. DATE, H. F. RECHER, H. A. FORD and D. A. STEWART

A survey of conservation reserves, rainforest remnants and agricultural districts in northeastern New South Wales was conducted to determine the abundance, movements and habitat requirements of rainforest pigeons, to evaluate the extent and use of suitable habitat in conservation reserves, and to provide guidelines for the conservation and management of rainforest pigeons. Eight species of rainforest pigeon occur in northeastern New South Wales. Commencing with the clearing of rainforest in the 1860s for agriculture, rainforest pigeons declined in abundance throughout New South Wales and by the 1970s five species were thought to be threatened in the state. Since then, rainforest pigeons have apparently increased in abundance and distribution, but the Wompoo, Rose-crowned and Superb Pigeons continue to be listed by the New South Wales National Parks and Wildlife Service as vulnerable and rare. However, populations of all species of rainforest pigeons in New South Wales are relatively small and vulnerable to further loss of habitat. Most rainforest pigeons show a preference for subtropical rainforest habitat, but moist eucalypt forests, gardens and weedy exotic vegetation along roads and on abandoned farmland are also frequented to varying degrees by different species.

To investigate recent trends in pigeon abundance we used data collected for up to 12 years from eight sites and during 1988, 1989 and 1990 from 17 rainforest remnants in northeastern New South Wales. The data suggest that rainforest pigeons now occur more frequently in lowland agricultural areas than in the recent past and tend to confirm an increase in abundance since the 1970s. Nesting and foraging habitats for rainforest pigeons are extensive in the conservation reserve system of northeastern New South Wales, but these habitats, which are largely at high elevations, lack winter food resources. Instead, pigeons congregate in remnant rainforest and exotic berry-bearing trees and shrubs in agricultural areas at lower elevations and near the coast. They rely on these habitats for food during winter and it is the restricted extent of this habitat that probably limits their abundance, not the area or quality of habitat at higher elevations. The conservation and management of rainforest pigeon requires the protection of low elevation and coastal rainforest remnants. As development of northeastern New South Wales proceeds, to avoid a decline in the abundances of rainforest pigeons it will be necessary to protect sclerophyll forest with native or exotic fruit bearing trees and shrubs and to extend the area of suitable habitat by the regeneration of rainforest and by the planting of native species used by pigeons as a food source. This will become increasingly important as the control and removal of exotic plants, such as *Lantana camara* and Camphor Laurel *Cinnamomum camphora*, on which some pigeons depend as a winter food source, becomes more successful.

Volume 2 Number 4

News and Views

Should Redclaw Crayfish be introduced to Fiji?

ROGER LOWERY

Forum Essays

Broadening Environmental Management in Fiji

S. WEAVER

There is a pressing need for a social dimension to be built into environmental planning and management programmes in the Pacific, due to the fact that conservation occurs within the context of a social and cultural world, and that many environmental management failures are underwritten by social problems. The political strength of the environment sector in Fiji will determine the degree of central government support for environmental dimensions of national planning. Such strengthening can be facilitated through improving the social context of the practice of environmental

management and planning. A social dimension is built into an environmental planning model which incorporates social as well as biological criteria for the selection of ecologically sensitive areas in need of environmental protection.

Does our lack of vision threaten the viability of the reconstruction of disturbed ecosystems?

DENIS A. SAUNDERS

There is widespread acceptance that in the extensive wheat-sheep zone of Australia, development for agriculture and associated changes to ecological processes have resulted in major problems of loss of species, land degradation and potential decreases in agricultural productivity. Present agricultural practices are not sustainable. There has been a range of responses to these changes, from community action through Landcare and revegetation projects, to legislative action. Unfortunately, these responses and the actions that follow, are usually carried out without any long-term context or any clear understanding of what we want our agricultural landscapes to look like in 150–200 years. While phrases such as “achieve the conservation of biological diversity through the adoption of ecologically sustainable agricultural practices” are being widely used, they will never become reality without the development of a vision of what we as a society want these landscapes to look like and how we want them to function.

As a matter of urgency, we should develop a collective vision for the future of our agricultural landscapes and use that vision to provide the framework to integrate conservation of the biota with management for agricultural production, while addressing the environmental problems we face now or which may arise as we adapt management to changing environmental conditions.

Review Papers

Distributions and biodiversity of the terrestrial vertebrates of Australia's Wet Tropics: a review of current knowledge

S. E. WILLIAMS, R. G. PEARSON and P. J. WALSH

This paper presents a review and collation of the current knowledge on vertebrate distributions and patterns of diversity within the Wet Tropics biogeographic region. Data are collated from a large range of published and unpublished sources. A summary of broad diversity patterns is presented and the collated distributional data are included. The data contained in this paper will be used as the basis for analyses on the determinants of diversity and assemblage composition in the Wet Tropics, as a means of receiving further feedback on distributional data and as baseline information to guide management, conservation and future research on vertebrates within the Wet Tropics.

The highest species diversity of vertebrates within the Wet Tropics is found in sclerophyll habitats (approximately 388 species). Rainforest is considerably less species-rich with about 259 vertebrate species; however, regional endemism is much higher in rainforest (25%) than in the combined sclerophyll habitats (4%). The Atherton Uplands are identified as being the most species rich area within the Wet Tropics, with species richness declining both to the north and south of these central uplands. Although there is no consistent latitudinal or altitudinal cline in diversity between taxonomic groups, there is a consistent turnover in the assemblage composition of vertebrates, both altitudinally and latitudinally. These patterns are consistent in all major terrestrial vertebrate taxa.

The importance of the Wet Tropics region is emphasized by the identification of 143 species of terrestrial vertebrates (23% of the total vertebrate fauna of the region) which are very important species for biological conservation: that is, those species or sub-species which are endemic to the region and/or have a recognized rare and threatened status.

Several areas are identified as being poorly known due to insufficient sampling effort, including the Finnegan Uplands, Thornton Uplands, Malbon-Thompson Range and the Lee Uplands. The latter two zones present the most significant gaps in knowledge, as they have been very poorly sampled and are important in the interpretation of biogeographic and evolutionary patterns within the region. Probably the most significant ecological gradient in need of detailed examination is altitude, because of the significant effect it has on assemblage composition in all subsets of the terrestrial vertebrate fauna.

The ecology of bats in south-east Australian forests and potential impacts of forestry practices: a review

BRADLEY S. LAW

Bats are important contributors to Australia's mammal diversity and are ecologically diverse, feeding on insects, fish, small vertebrates, nectar, pollen and fruit. As such they are likely to play key ecological roles as regulators of invertebrate populations and pollinators of forests. Although somewhat contradictory, current evidence suggest that logging impacts on the species richness and activity of insectivorous bats when forest structural complexity and the

number of available roosting hollows are reduced. Inconsistent results concerning impact on species richness stem from methodological problems with bat surveys. "Rare" species are often recorded in low numbers, preventing habitat preferences and disturbance impacts from being determined. Radio-telemetry has demonstrated that roosts in hollows of mature trees are a critical resource for any species of bats due to species specific requirements. However, it is not yet possible to state whether bat populations are directly limited by the availability of hollows in areas where a mosaic of logged and unlogged forest exists. Although data on foraging areas are extremely limited, some species appear to be flexible, capable of flying across open areas and exploiting those rich in invertebrates. Some species (e.g., *Vespadelus*) show a high degree of site attachment, possibly indicating a susceptibility to logging, however, the extent of site fidelity for most species is unknown. As pollinators, megachiropteran bats are likely to play a key role in maintaining the genetic diversity currently present in eucalypts by facilitating long-distance movement of pollen. Areas that are productive in nectar and pollen have a high conservation value for these bats and many other nectarivores, however, the age at which important nectar-producing trees flower is generally not known. The extent to which wildlife prescriptions, such as habitat trees and mosaics of small reserves, mitigate these impacts on bat species requires urgent research.

Research Papers

Biodiversity indicators in semi-arid, agricultural Western Australia

M. ABENSPERG-TRAUN, G. W. ARNOLD, D. E. STEVEN, G. T. SMITH, L. ATKINS,
J. J. VIVEEN and M. GUTTER

The predicted future loss of native Australian species of plants and animals, in part as a result of adverse land management strategies, has led to attempts to identify areas of high biotic richness (numbers of species). Bioindicators are measures of the physical environment, or of a subset of the plants or animals, that best predict biotic richness. Ideally, bioindicators should aim at predicting as large a component of the plant or animal fauna as is possible at minimum cost. For two contrasting vegetation types, were examined remnant area, vegetation structural diversity, species richness of plants, lizards and terrestrial arthropods, and the relative abundance of individual arthropod species, as indicators of faunal richness, using correlation, principal component regression and stepwise regression analyses. The study was carried out in gimlet *Eucalyptus salubris* woodlands (29 sites) and shrublands (27 sites) in semi-arid, agricultural Western Australia. Sites varied considerably in grazing history (woodland) and in farming history (shrubland). Fauna sampled were lizards (woodland), scorpions (woodland), isopods (woodland), cockroaches (woodland), termites (woodland, shrubland), earwigs (woodland), hemipterans (shrubland), beetles (woodland, shrubland), butterflies (shrubland) and ants (woodland, shrubland).

None of the indicator variables in any analyses effectively predicted total faunal richness for either vegetation type (<35% of variation in total richness explained). In correlation analyses for woodlands, vegetation structural diversity and plant richness, but no fauna variable, explained a high percentage of the variation in the richness of lizards (56% explained by richness of native plants, +ve), scorpions (48%, richness of native plants, +ve), termites (55%, vegetation structural diversity, +ve) and beetles (59%, litter, -ve). The richness of the shrubland fauna was poorly predicted by all indicator variables (<25% explained).

When using the total richness and abundance of ant functional groups, the abundance of a subset of species within ant functional groups, and of termite and beetle species, in principal component regressions, various ant functional groups explained 42% each of the richness of scorpions and beetles, and eight beetle species explained 50% of termite richness.

When remnant area, vegetation structural diversity and the richness of native plants in woodland were tested in stepwise regressions as indicators of total faunal richness, remnant area was the only significant indicator variable, explaining 33% of total richness. The richness of native plants and vegetation structural diversity explained a total of 76% of the pooled richness of lizards + scorpions + termites. No significant indicator variable was found by regression procedures for total richness, or for a subset, of the shrubland fauna.

We argue that differences in the predictive qualities of vegetation structure and plant richness between the vegetation types was due, in part, to differences in the spatial heterogeneity of biotic richness, and possibly the scale at which structure was measured. The use of structural diversity or plant richness as predictors of faunal richness for different woodland types, or those with different disturbance histories, or in different geographic or climatic regions, should not be adopted without verification of their efficiency at predicting the richness of the local fauna.

Absence of Ship Rat *Rattus rattus*, and Norway Rat *Rattus norvegicus*, on Ouvea (Loyalty Islands, New Caledonia): consequences for conservation

OLIVIER ROBINET and MICHEL SALAS

A rat trapping campaign was conducted from July to December 1994 on Ouvea in the Loyalty Islands, New Caledonia. Locations of rat traps took into account different geographic sectors (North, Centre, South and Islets) and different habitats (forest, crop fields, coconut plantations, houses). The campaign encompassed a total of 1 363 trap nights and autopsy data were collected on rodents that were captured. Vertebrate remains from Barn Owl roosts were also collected and examined to determine which rat species were present. For the whole campaign the corrected trap success rate was 9.5 rodents per 100 trap nights. No significant variations in the trap success rate were observed in relation to geographic sector or habitat. Ninety-eight rodents were captured and 64 identified: six *Mus musculus* and 58 *Rattus exulans*. No *Rattus rattus* and no *R. norvegicus* were caught. Similarly, the only species identified from material found in Barn Owl roosts were *M. musculus* and *R. exulans*. Observation of the fauna and environment on Ouvea provided some indirect evidence to confirm the absence of both *R. rattus* and *R. norvegicus*. The history and geographical characteristics of Ouvea, and certainly chance, could explain the fact that these two species never reached the island. With regard to rat species, Ouvea's situation is remarkable and unique in the Pacific for inhabited islands of comparable size and level of development. Considering the dramatic and well known effects resulting from the introduction of rat species such as *R. rattus* and *R. norvegicus* on small Pacific Island environments, the authors have alerted local authorities and the population of Ouvea, and have proposed initial measures as part of an action plan.

Fire studies in Mallee (*Eucalyptus* spp.) communities of western New South Wales: spatial and temporal fluxes in soil chemistry and soil biology following prescribed fire

J. C. NOBLE, D. J. TONGWAY, M. M. ROPER and W. G. WHITFORD

The effects of prescribed fires on nutrient pools, soil micro-organisms, and vegetation patch dynamics were studied in three semi-arid mallee shrublands in western New South Wales. Repeated sampling of surface soil strata (0–2 and 2–4 cm) was undertaken at strategic times (immediately before and after the fire, after opening autumn rain, mid-season in the winter, and at the end of the spring) in five microsites (inner, middle and outer mallee litter zones, bare soil, and *Triodia* hummock). These samples were later analysed for pH, electrical conductivity, organic carbon and available nitrogen. The effect of fire on soil micro-organisms in these microsites was also examined by measuring nitrogenase activity and enumerating soil Acari.

Carbon and nitrogen levels were consistently higher in the inner mallee microsites whereas bare soil sites provided the lowest values. Significant microsite × soil depth interactions were recorded in two shrubland sites while highly significant ($P < 0.001$) depth × sampling time interactions were recorded in three sites. The most sensitive soil parameter with respect to microsite was electrical conductivity, particularly in the surface 0–2 cm stratum. Highest values were again recorded from the inner mallee microsites and the lowest from bare soil sites.

Nitrogenase activity was highest in soil samples associated with mallee litter and, where litter was removed by fire, activity decreased markedly except in the bare soil samples where activity was higher in the burnt samples. Soil micro-arthropod populations also declined notably following fire. Mites from the Prostigmata greatly outnumbered those from other suborders, a total of 12 families (15 genera) being enumerated in control sites compared with three families (three genera) only of Cryptostigmata. Nonetheless the most abundant mites were cryptostigmatids (*Aphelacarus* spp.) found in unburnt hummocks beneath *Triodia* plants.

The ecological and management implications of these spatial and temporal fluxes in soil chemistry and soil biology are discussed in relation to their effects on landscape processes, particularly water and nutrient redistribution.

Conservation and status of *Lutra provocax* in Chile

GONZALO MEDINA

A survey was made of the Southern River Otter's (*Lutra provocax* Thomas) present distribution and its decline during the last century. North of 36°S the otter's decline began after 1880. Between 39°S and 43°S the decline is patchy. South of 43°S the decline began around 1930. The reasons for the decline are a combination of habitat destruction, disturbance and hunting. Between 39°S and 43°30'S otter populations were found in seven discrete regions. Re-establishment by the otter is unlikely owing to the separation of the basins and habitat destruction. Tourism and settlement in regions with permanent otter populations could have a significant impact if the density of vegetation cover on river and lake banks is not maintained. Conservation of river otters in Chile should involve three approaches; education, recovery and re-establishment.

Pacific Conservation Biology

Order Form and Subscription information appears at the end of this document —
please complete and return it to Surrey Beatty & Sons

Volume 3 Number 1

News and Views

National Biodiversity Council

HARRY RECHER

Forum Essay

The 10 Lords of the Universe — the New South Wales TSC Act's Scientific Committee

LEONG LIM

The question as to whom should the authority to determine listing and delisting of species, populations, ecological communities and key threatening processes that affects the state's wildlife (flora and fauna) be delegated, for what purpose and what priority we should place them in relation to all of society's needs, is a fundamental and an important one. The authority for setting up the Scientific Committee of the *Threatened Species Conservation Act (New South Wales) 1995* is examined. Its functions and the individuals that make up this Committee, who they represent and the determinations this Committee has reached so far are discussed. The implications for the listing of species, populations and ecological communities with some of the more serious problems such listings have caused are outlined with particular reference to the application of the 8-Point Test under s 5A of the *Environmental Planning and Assessment Act 1979*. These practical difficulties aside, the fundamental question still remains; Can the New South Wales State Parliament delegate its legislative powers for peace, welfare and good government, to a lower authority that is not directly elected by the people, accountable to no one and that has no propriety interest in the subject matter? Thus a question of Constitutional validity of all or part of the TSC Act arises.

Research Papers

Ecological attributes of the threatened fauna of New South Wales

D. LUNNEY, A. L. CURTIN, D. FISHER, D. AYERS and C. R. DICKMAN

The aims of this study were to identify common ecological patterns among threatened fauna in New South Wales, and to identify priority areas for research and management by determining which regions and habitats contain high numbers of threatened fauna. Threatened and non-threatened fauna were taken from the listings of Lunney *et al.* (1996, 1997). Species were categorized into weight classes, diet groups, habitats and regions and by level of knowledge available about them. All regions and habitats of the State contain threatened species. The northeastern region of New South Wales contains the greatest number of threatened species but the western region has suffered the most extinctions, especially of mammals. Species that historically inhabited a greater number of regions are less likely to be currently threatened or to be extinct than those with restricted distributions, and large species are more likely to be threatened than smaller species. The best predictors of a threatened mammals species were seeds and vegetation in the diet, heavier body weight, and ground-dwelling, burrowing, and rock pile/cave-dwelling habits. The Critical Weight Range (35–5 500g), although strongly associated with extinction of non-volant mammals, was not the most important predictor. Lord Howe Island held the highest proportion of threatened and extinct birds. Factors showing the strongest associations for threatened birds were carnivory, large size, and distribution in the southeastern region. The most poorly-known region for birds was the north-east, and the least known habitat was shrubland (including mallee, heath and chenopod shrubland). The status of reptiles was poorly known in all regions, especially the western region. Frogs were also poorly known in all regions. Frogs were most at risk if they were large, inhabited closed forest or occurred in the central or northeastern region. The study further revealed little association between particular ecological attributes and conservation status. This indicates that there are complex and pervasive threats affecting the status of New South Wales fauna. Research and management priority status could be argued for all regions and most habitats in the State, but the western or northeastern regions may face the most problems depending on the criteria used (e.g., past extinctions, number vs proportion of threatened species). Further, the conservation status of birds, reptiles and frogs is in particular need of attention from researchers.

The impact of planting for restoration of remnant bushland on its scientific and educational values: implications for conservation planning

LYNNE McLOUGHLIN

Large amounts of time and money are currently being expended in “restoring” damaged bushland in many parts of Australia, particularly those remnants in or near large centres of population such as Sydney. This paper argues that it is time to critically examine policies and practices of bushland conservation for the range of bushland values they are serving. Since the introduction of minimum intervention “bush regeneration” in Sydney in the 1960s “restoration” has developed to encompass a much broader range of disturbed areas from lightly weed invaded bush to totally cleared sites, and there has been a blurring of distinctions between regeneration and other restoration practices. In particular, both restoration and regeneration now include planting as widely accepted practice.

Focusing on New South Wales, particularly the Sydney region, this paper reviews the role of values in current conservation planning and bushland management in New South Wales, the development of “regeneration”, and “restoration” and the nature of scientific and educational values of remnant bushland, and examines how the practice of planting in bushland is degrading those values. Alternative methods to achieve natural regeneration, particularly the use of fire, are discussed. The paper concludes with an emphasis on the importance of developing a planning process for bushland conservation management which establishes significance and ensure that restoration does not degrade the values for which the bushland is being preserved and restored.

Translocation of the Palila, an endangered Hawaiian honeycreeper

STEVEN G. FANCY, THOMAS J. SNETSINGER and JAMES D. JACOBI

The Palila *Loxioides bailleui* is an endangered Hawaiian honeycreeper that is restricted to high-elevation dry woodlands on Mauna Kea volcano, Hawaii. Palila are absent or occur in small numbers throughout most of their historic range because of habitat loss, predation and avian disease. The Palila's habitat is regenerating as a result of feral ungulate control, but the species is likely to be slow in recolonizing former ranges because of strong site tenacity. In March 1993, we translocated 35 Palila to Kanakaleonui on the eastern slope of Mauna Kea to determine whether we could speed recovery by releasing adult birds in new areas where predators were controlled. At least two pairs of translocated Palila successfully nested at the release site during their first breeding season, and two other pairs constructed nests. The density of Palila at Kanakaleonui in the three years following the translocation was higher than that before translocation. Approximately half of the translocated birds remained at the release site for 2–6 weeks and then homed back to their capture site >20 km away. Translocations of adult birds and release of captive-reared juvenile Palila, in combination with additional habitat restoration, may be an effective management tool for speeding the recovery of this species.

The Kangaroo Rats of California: endemism and conservation of keystone species

ROSS L. GOLDINGAY, PATRICK A. KELLY and DANIEL F. WILLIAMS

This review describes the great diversity and endemism of Kangaroo Rats *Dipodomys* spp. in California. Many species are formally listed as endangered and others are likely to be listed in the near future. We review recent efforts to conserve these small bipedal rodents. We argue that they deserve special emphasis because they have been shown to play key roles in ecosystem structure and composition. Indeed, many of the plant communities occupied by Kangaroo Rats have now been identified as at risk because of excessive habitat destruction and fragmentation. It is clear that preservation of Kangaroo Rats and their plant communities will not be achieved through simply setting aside blocks of habitat as reserves. Conservation areas will require active management in order to maintain existing biodiversity, but further studies are required to ascertain how best to manage these communities. We believe that Kangaroo Rats are important subjects for management studies and ecosystem monitoring. Preliminary studies of the size of reserves required to maintain viable populations of one species show that despite the often high abundance of Kangaroo Rats (35 animals/ha), large areas (>5 000 ha) will be required. Therefore, considerable biodiversity is likely to be protected by focusing on these species, particularly if conservation and recovery efforts are applied on a regional scale.

Threats on Pacific islands: the spread of the Tramp Ant *Wasmannia auropunctata* (Hymenoptera: Formicidae)

HERVÉ JOURDAN

Colonizing Cane Toads cause population declines in native predators: reliable anecdotal information and management implications

SCOTT BURNETT

This paper presents compelling, anecdotal evidence of severe population declines in five predator species, *Dasyurus hallucatus*, *Varanus gouldii*, *V. mertensi*, *V. panoptes*, and *V. timorensis similis*, in almost immediate response to Cane Toad colonization of their habitat in three widely distributed areas of northern Queensland. Furthermore, risk assessment of all quoll and monitor taxa whose distributions overlap the potential distribution of the Cane Toad in Australia (Sutherst *et al.* 1996), indicates that at the continental scale, three of the four quoll taxa and eight of the 20 monitor species examined are at high risk of severe population declines following Cane Toad colonization. One quoll taxon and seven monitor species are at moderate risk and five monitor species are at low risk.

The definition of the threat which Cane Toads pose to native predators have received very little research attention, and fundamental questions including; which predator species are most at risk (testing of the risk assessment hypotheses presented here), the extent of these risks (is there a need to manage Cane Toad impacts upon predators?), and the contexts of intraspecific variation in relative extinction risk (for example, interactions of extinction risk with predator and Cane Toad population demography, climate, landscape, and land use), need to be assessed.

Assuming that Cane Toads are found to have an impact across a range of taxa and landscapes (which I propose to be likely), management of the impact of this species on predators can be approached from two not necessarily exclusive directions; management of Cane Toad populations and management of predator populations, through both population and habitat management. At this stage, however, management from either viewpoint is constrained by a lack of published information relevant to autecology and fine scale distribution of predators.

Volume 3 Number 2

News and Views

National Biodiversity Council

HARRY RECHER

Forum Essay

Is biodiversity really the link between conservation and ecologically sustainable management? A reflection on paradigm and practice

JIM DAVIE

Nature conservation practice is increasingly required to stand within a context of multiple use as land and its resources come under greater pressure of use by people. Although biodiversity conservation is now universally adopted as the banner under which international and national conservation programmes march, it is not clear that it has widespread support based on an understanding of all its ramifications. Conversely land users in Australia and in tropical countries do indicate an understanding and acceptance of conservation objectives which focus on the processes which support ecosystem productivity. A focus on conservation of the ecological processes which perpetuate vegetation as habitat, water and the fertility of soil, may better integrate nature conservation into other land uses.

This essay explores some of these questions in relation to two wetland areas in Indonesia. The Pantai Timur Mangrove Nature Reserve in Jambi Province, Sumatra is valuable for the conservation of certain migratory birds; however, it is so dynamic that species diversity is not significant. Despite this, ecological functions which have created the ecosystem may be critical to the continued productivity of the land and the quality of life of the people who live in it. In contrast the coastal wetland forest of Bunaken National Park are remarkable stable and while they are critical to ecological regulation of the quality and productivity of that environment, they also offer very special biodiversity values.

The implications of these examples are examined in relation to conservation practice and to ecologically sustainable management. Design is proposed as a means through which local communities might take some control of land

management in order to retain, restore or create landscapes which have sustainable, rich and productive natural and human attributes.

Research Papers

Predation at nests of two New Zealand endemic passerines; implications for bird community restoration

KERRY P. BROWN

Predation at North Island Robin *Petroica australis longipes* and North Island Tomtit *Petroica macrocephala toitoi* nests was studied in New Zealand over the 1993/94 breeding season to determine impacts of predators. Infra-red, time-lapse video photography and sign left after predation were used to identify predators at nests. Accurate estimates of predation rates depended on early detection of nests. Previous studies of predation may have greatly under-estimated predation rates and therefore predation impacts. Predation was patchy and intense, resulting in failure to produce young in some territories despite up to ten nesting attempts. A maximum of 82% of nests were preyed on ($n = 65$; 95% confidence interval 72.4%–90%) and Ship Rats *Rattus rattus* were probably responsible for at least 72% (95% confidence interval 57.4%–84.4%) of predations. Nine of 24 territories lost breeding females, mainly to Ship Rats, which significantly impacted on population productivity. Ship Rat predation was equally intense at exposed and concealed nests (at the site and patch levels). Predation attributed to avian predators was strongly correlated with exposed nests (at the patch level). Restoration of New Zealand's threatened forest bird communities is dependent on a commitment to further research into the significance of different predators and predation impacts on bird populations.

Restoration of New Zealand islands: redressing the effects of introduced species

DAVID R. TOWNS, DANIEL SIMBERLOFF and IAN A. E. ATKINSON

Introduced species of mammals have now been removed from many islands around New Zealand, thus providing singular opportunities for ecological restoration. If island restoration is to be attempted, the way island biota originate and the precise effects of introduced organisms must be identified. Plants introduced to the New Zealand archipelago may have transitory effects, but others may modify forest structure and disrupt succession. Goats have been the most destructive introduced herbivore on islands. Among introduced predators, cats have extirpated colonies of seabirds, and rats (depending on species) affect invertebrates, lizards, and birds. Ecological theories and concepts that may help with island restoration projects include: the keystone species concept, in which the effects of one species on others is disproportionate relative to its abundance; the "intermediate predator" hypothesis, where removal of the top introduced predator may lead to rebound effects of intermediate predators; and ecological chain reactions, where local extinction of some species can cause complicated multiple effects. Problem with restoration of islands may be encountered because of meagre data on the previous effects of pests (such as predators), use of non-seral species in revegetation projects, proliferations of indigenous or introduced species that have unforeseen community effects, and inexplicable difficulties with some trans-locations. A restoration case study in the continental Mercury Islands and on Cuvier Island showed success with removal of introduced mammals and demonstrates the various effects of introduced browsers, grazers, and predators. A contrasting case study is provided by oceanic Mangere Island in the Chatham Islands where 22 species of avifauna have been lost, seven as permanent extinctions.

Restoration targets for some New Zealand islands can be clarified by palaeoecological studies of Maori (Polynesian) middens and natural deposits. Understanding the role of disturbance in island systems may also help clarify restoration targets. When exotic keystone species are introduced, physical disturbance may be overridden by biotic disturbance. This replacement in turn has implications for trophic structure. With high levels of biotic disturbance, continental islands may be changed from relatively species-rich bottom-up food webs to species-poor top-down trophic cascades. These possibilities can be tested with an experimental approach to restoration, although such experiments may be hard to interpret because of difficulties with replicates and controls. Ecological restoration on New Zealand islands has potential to replace damaged or lost communities, expand the ranges of relict populations, reduce the selective influence of exotic (keystone) species on indigenous species, help in understanding how the systems are formed, provide opportunities for educational and scientific investigation, and act as a testing ground for new technologies against pests.

How secure is the Lord Howe Island Woodhen? A population viability analysis using VORTEX

**BARRY W. BROOK, LEONG LIM, ROBERT HARDEN
and RICHARD FRANKHAM**

The Lord Howe Island Woodhen is a flightless rail endemic to Lord Howe Island that became endangered due to human over-exploitation and predation from wild pigs. It has recently recovered from a population size of 20–30 to around 200 as a result of a captive breeding and reintroduction programme. Its classification has been downgraded from endangered to vulnerable, but no quantitative assessment of its future prospects had been undertaken. A population viability analysis (PVA) was performed on the Lord Howe Island Woodhen to project its possible fate using VORTEX, a package that realistically reflects the woodhen's recent history. Prospective analyses showed the woodhen to be acutely sensitive to minor changes in mortality and fecundity, and to catastrophes, due to exotic species, inbreeding, or disease. A remote population needs to be established if the likelihood of the woodhen's extinction is to be minimized. According to the most recent IUCN Red List categories, the woodhen satisfies the criteria for endangered status.

Natural history of the New Georgia Monkey-faced Bat *Pteralopex* sp. nov. from the Solomon Islands

DIANA FISHER and ELIZABETH TASKER

The megachiropteran bat genus *Pteralopex*, Monkey-faced bats, is restricted to the Solomon Islands and Fiji. No other field study has been conducted on any of the five known species. From February to May 1992, the New Georgia Monkey-faced Bat was studied to determine its distribution, assess its conservation status and to provide ecological data for management.

We found New Georgia Monkey-faced Bats *Pteralopex* sp. nov. at four sites on the islands of Vangunu and New Georgia, but not on Kolombangara. Bats were most common around an old village site abandoned approximately 90 years ago, in undisturbed rainforest, and adjacent gardens. *Pteralopex* sp. nov. was absent from areas of regrowth after logging or cyclone damage. It roosts in the hollows of tall canopy or emergent trees (particularly *Ficus* spp.), either singly or in small groups.

Like other megachiropterans, *Pteralopex* sp. nov. eats a wide range of fruit and flowers. Young were born throughout the study, from February to May. This species' restricted range and susceptibility to hunting make it vulnerable, especially in the short term if its habitat is affected by logging or cyclones. Old village sites may be important for *Pteralopex* and other wildlife in the Solomon Islands.

Distribution and response of rats *Rattus rattus*, *R. exulans* to seedfall in New Zealand beech forests

CAROLYN M. KING and HENRIK MOLLER

Ship Rats *Rattus rattus* were much more abundant in Silver Beech-dominated *Nothofagus menziesii* forest in the Hollyford Valley than in Red Beech-dominated *Nothofagus fusca* forest of the Eglinton Valley, northern Fiordland National Park, in 1974–78. The Hollyford also supported a small population of Kiore (Pacific Rat) *R. exulans*, but no Norway Rats *R. norvegicus*. A moderate beech seedfall in 1976 was followed by a short-lived, six to seven fold increase in a relative index of abundance of Ship Rats in both valleys. This increase, not matched by Kiore, showed up more clearly in long lines of Fenn traps set for Stoats *Mustela erminea* than in standard rodent snap-trap lines. Analysis of 122 carcasses showed a significant upward shift in age structure of Ship Rats after the seedfall, consistent with overwinter breeding. Conservation management programmes already aiming to protect threatened species in beech forests from post-seedfall irruptions of Stoats might need to be extended to include Ship Rats. Elsewhere in New Zealand, Ship Rats were much more abundant in mixed podocarp-hardwood forests than in pure beech or pine forests.

Research Note

Effects of undergrowth removal on the species diversity of insects in natural forests of Okinawa Hontô

SEIJI AZUMA, TAKESHI SASAKI and YOSIAKI ITÔ

Volume 3 Number 3

Research Papers

Managing bird populations: for whom and at what cost?

JOHN L. CRAIG

Conservation is a necessary component of sustainable development. Human activities have had and continue to have a negative effect on natural ecosystems. There is a need to move to a more co-operative, effective and accountable management of “communal resources” including fauna and flora. Many issues negatively influence the ability of conservation managers to perform well and for all stakeholders. Society’s underlying philosophic and economic attitudes are important. Most contemporary Southern Hemisphere societies see nature as separate from people and manage with a welfare mentality. Most financial incentives favour degraders of natural values and penalize those who conserve or behave sustainably.

The other major issue which precludes effective management is the approach of government managers. Performance tends to be patchy, unaccountable and often based on simplistic single factor notions. There appears to be a general failure to provide diversified products to different stakeholders. These issues with suggestions for improvement are discussed with special reference to the management of rare bird populations and of fire.

Impact and response: a review of the effects of fire on the Australian avifauna

J. C. Z. WOINARSKI and H. F. RECHER

The literature concerning the impact of fire on avian communities and the response of birds to fire is reviewed for the Australian continent. There are few detailed long-term studies of the effects of fire on avian communities, but there is sufficient information on fire effects from a broad cross-section of Australian habitats to identify patterns of response to individual fires and to predict likely long-term effects. Some birds respond immediately to fire, taking advantage of temporarily increased availability of food. These birds include predators that are attracted to fires to feed on exposed, disoriented and fire-killed prey and seed-eaters that congregate in burnt habitats to feed on seeds released by the fire or on the seeds of rapidly maturing post-fire ephemerals. At least in eucalypt forests, there is an increase of arthropod abundance on the rapidly regenerating vegetation that may lead to increased abundance of some bird species. Depending on the severity of the fire and the amount of vegetation killed, most avian communities recover rapidly following single fires regardless of fire intensity. However, such fires may pose a significant threat to species with a restricted distribution, limited reproductive potential, poor dispersal ability and/or narrow habitat requirements. Birds persisting in fragmented habitats are particularly at risk. However, of greatest significance as a threatening process to avian communities are increases in fire frequency.

Of the threatened species in Australia whose relationships with fire have been comparatively well-documented, almost all show a clear preference for less frequent fires. Detrimental fire regimes contributed to the extinction of two of the three bird species and three of the four subspecies which have disappeared from Australia since European colonization. Inappropriate fire management is now a factor in the threatened status of at least 51 nationally recognized threatened Australian bird taxa. In many environments (notably heath and mallee), inappropriate fire regimes are the main threat to declining bird species. In temperate eucalypt forest and woodland, as well as in heathlands, control burning is widely used to reduce the threat of wildfire. While, in general, the immediate impact of controlled burns is less than that of wildfire, the frequency of these fires can lead to floristic and structural changes in the vegetation. Although not well-documented, these vegetative changes adversely affect the avifauna. In Australia, the most detailed long-term studies suggest that frequent, low-intensity fires may lead to the decline and loss of some species which are now perceived as common and little affected by mild fires.

Fire and its impact on avian population dynamics

G. BARRY BAKER, E. BELINDA DETTMANN and STEPHEN J. WILSON

Survival rate, population size, recruitment and probability of capture, derived from a long-term study of 20 passerine species in wet sclerophyll forest near Canberra, were used to measure the impact of a high intensity wildfire which burnt 70% of the study area. The wildfire significantly affected the population size of 13 species for a period of up to six years following the fire. Survival and recruitment were the least sensitive measures of impact and indicated a significant response to fire for only 2 of 10 species. We detected measurable effects of the fire for 17 of the 20 species studied. Many of these species had returned to prefire levels within three years, but for nine species the effects were still apparent six years later. Mark-recapture methodology provides an effective way of measuring the impact of fire regimes in forest environments. Long-term monitoring programmes should be established in fire-prone forest environments to contribute towards our understanding of fire, and its effect on avian populations. Such programmes

have resource implications and researchers are urged to encourage the participation of the amateur bird banding community to contribute to such projects.

Responses by birds to fire regime and vegetation at the wet sclerophyll/tropical rainforest boundary

ANGELA CHAPMAN and GRAHAM N. HARRINGTON

Changes in fire regime have been identified as the cause of the loss of nearly 50% of wet sclerophyll forest in north Queensland in the last 50 years. In the absence of fire, rainforest invades and eventually eliminates the specialized wet sclerophyll forest biota. Bird populations and foraging behaviour were monitored in areas selected to encompass both recent and advanced rainforest invasion. Foraging guilds are discussed in relation to increasing rainforest biomass. Some species, such as the Pale Yellow Robin *Tregallasia capito nana* were advantaged by the expansion of rainforest. Other species, such as the Golden Whistler *Pachycephala pectoralis* showed no significant response, whereas the endemic subspecies of the Eastern Yellow Robin *Eopsaltria australis magnirostris* was clearly disadvantaged. The latter species is of particular concern because in north-east Queensland it is dependent upon wet areas adjacent to rainforest and requires open ground in which to forage. Over the longer term the White-naped *Melithreptus lunatus* and White-cheeked *Phylidonyris nigra* Honeyeaters are also threatened by habitat loss. These honeyeaters favour the wetter areas adjacent to the rainforest which are gradually being lost to the invasive process. To maximize biological diversity in the wet tropics of north Queensland, it is necessary to maintain the full spectrum of natural habitats. Fire management is therefore required to maintain the wet sclerophyll forest and its dependent fauna.

Effects of an extensive wildfire on birds in far eastern Victoria

RICHARD H. LOYN

A major wildfire burned 228 400 ha of forest in East Gippsland (Victoria, Australia) in February and March 1983, including Cooagalah forest block where flora and fauna studies had just commenced. Bird abundance was assessed on 13 sites immediately before and after the fire, and annually for three years to 1986. The sites represented a range of habitats including rainforest, heaths and eucalypt forest, all of which burned.

Total bird abundance was reduced to 60% of initial levels by the fire, but recovered within three years. These changes differed significantly between habitats. Initial decreases were greatest and subsequent recovery least in heaths where most above-ground vegetation had been killed. Post-fire increases were greatest in rainforest and on granite ridges, and in each case bird abundance rose to levels substantially higher than before fire. Some changes may have involved recovery from drought as well as fire.

Changes over time were highly significant for many groups of birds (e.g., honeyeaters), while others showed little change (e.g., bark-foragers and insectivores that inhabit dense understorey or damp ground below shrubs). Honeyeaters and seed-eaters suffered the greatest initial declines, and some species in these groups were slow to recover (e.g., New Holland and Crescent Honeyeaters and Beautiful Firetail). Some species that feed from open ground increased quickly to levels greater than before fire (Flame and Scarlet Robins, Buff-rumped Thornbill and Superb Fairy-wren), but all except the latter then declined as shrubs regenerated.

The main loss of birds immediately after the fire was of highly mobile species, and the composition of the remaining bird fauna appeared to depend on resource availability rather than the capacity of species to survive the fire front. Initial responses of species to fire were poor predictors of their responses after three years. Hence, the effects of fire should be considered in terms of habitat changes over several years. Many forest types including rainforest can provide continuing habitat even when they burn, but populations of mobile birds such as honeyeaters depend on access to alternative habitats on a broad regional scale.

The decline, response to fire, status and management of the Eastern Bristlebird

JACK BAKER

The Eastern Bristlebird *Dasyornis brachypterus* is a threatened passerine, endemic to southeastern Australia. It is a cryptic, ground dwelling, semi-flightless inhabitant of dense, fire-prone vegetation and is usually only detected by its calls. The disjunct distribution suggests that they were once more numerous and their population continuous from southern Queensland to western Victoria. Their decline has been documented in historic and recent times. Habitat loss, nest desertion and fire have been implicated in the decline and extinction of local populations. Strongholds for the species are Barren Grounds Nature Reserve and Bherwerre Peninsula, 100 and 150 km south of Sydney respectively. At Barren Grounds, in the absence of recent fire, there were significant increases in the population between 1992 and 1996. There was a trend of increasing Eastern Bristlebird density with increasing fire-age of habitat and average density

plateauing at two birds per 5 ha, 10 years after fire. At Nadgee, a coastal Nature Reserve on the New South Wales/Victorian border, the population appears to be recovering very slowly from severe wildfires in 1972 and 1980. At the beginning of 1996 there were less than 2 000 individual Eastern Bristlebirds occupying an area of approximately 100 km². For the management of Eastern Bristlebirds, habitat manipulation using prescribed fire should not be undertaken unless site-specific population monitoring data demonstrate that it would be beneficial. Concentrations of Eastern Bristlebirds and potential fire refuges should be protected from unplanned fire. For prescription burns, potential escape routes need to be planned for Eastern Bristlebirds. The threatened status should be changed from Vulnerable to Endangered.

Land use, habitat change and the conservation of birds in fragmented rural environments: a landscape perspective from the Northern Plains, Victoria, Australia

ANDREW F. BENNETT and LEIGH A. FORD

Studies of the effects of habitat fragmentation on birds have mainly been carried out at the patch scale, by censusing birds in patches of different size, shape or composition. Here, we use data collected by observers for the Atlas of Australian Birds from 10' latitude/longitude grid cells (landscapes), each 277 km² in size, to examine the effects of land use and habitat change at the landscape scale in the northern Plains region of Victoria, Australia. Land birds were tallied for 63 such landscapes and species were classed as "woodland" or "other" species. Attributes measured for each landscape represented natural environmental variation, tree cover and the intensity of human settlement. The Northern Plains has experienced profound environmental change over the last century of agricultural settlement and tree cover now occupies only 6.2% of the region, mostly as large riverine forests. Eighty per cent of landscapes have less than 10% tree cover. Woodland birds showed substantial variation in richness between landscapes and, after accounting for sampling effort, species richness was best predicted by total tree cover and measures of environmental variation (e.g., number of streams). "Other" birds were more evenly distributed between landscapes. Species richness was best predicted by the environmental gradient in rainfall and temperature, although this accounted for only a small amount of variance after correcting for sampling effort. The predictive model for woodland birds indicates that this group is sensitive to habitat change, and implies a substantial loss of species in landscapes that have been almost entirely cleared of woodland habitat. The logarithmic depletion. With median tree cover of 3.7% for landscapes in the region, this relationship supports the contention that a major decline in woodland birds is underway and that species are being lost from whole landscapes across the region. Attributes associated with landscapes of high conservation value for birds include: extensive overall tree cover, large blocks of woodland habitat, and stream systems with associated habitat connectivity. In this region, these attributes are more likely to occur in areas with broad-acre agriculture rather than intensive irrigation. The analysis suggests that at least 10% tree cover is a minimum goal for an infrastructure of natural vegetation in rural landscapes to prevent serious decline and loss in the woodland avifauna.

Use of remnant forest habitat by birds during winter in subtropical Australia: patterns and processes

CARLA P. CATTERALL, MARK B. KINGSTON and KATE PARK

The south-east Queensland region of subtropical Australia supports a high diversity of landbird species, many of which are migrants which visit lowland areas during winter. However, lowland habitats have been impacted by clearing and fragmentation of native forest types within the past 170 years. This paper considers the implication of loss and fragmentation of lowland eucalypt forests for birds in winter, by comparing the proportionate density of twelve selected species across 49 different cases representing a variety of structural habitat differences. There was little fragmentation effect on forest-dependant winter immigrant species down to about 10 ha. The smallest remnants had reduced proportionate abundances of forest-dependent species together with elevated abundances of two other species: Noisy Miner and Australian Magpie. Similar shifts in species composition occurred in association with a variety of types of change in native eucalypt forest, all involving alteration to physical structure incorporating reduction of foliage cover (at forest edges, in areas without understorey, in regenerating forest, on slopes and ridges, and after fires). We consider the ecological processes that might underlie these patterns, and suggest that: (1) habitat selection, possibly mediated and/or reinforced by interference competition from Noisy Miners, is a key process in the study system in winter; (2) habitat loss, rather than fragmentation, is likely to be the main cause of regional declines in forest-dependent winter migrants; and (3) the management of habitat for winter migrant birds within lowland eucalypt forests of their region should focus on maintaining and improving; (a) the overall percentage of lowland area covered by native forest, and (b) factors associated with the structural integrity (canopy and understorey cover, fire frequency, retention of complete microtopographic gradients) of remnant forest areas irrespective of their size, at least down to about 10 ha.

Use by birds of riparian vegetation in an extensively fragmented landscape

ANDREW M. FISHER and DAVID C. GOLDNEY

The bird communities of six riparian woodland sites are described and compared with those of eight terrestrial woodland sites in the Central Tablelands near Bathurst, New South Wales, Australia. Riparian woodland, where still present in the Central Tablelands, is dominated by either relatively narrow strips of *Casuarina cunninghamiana* along stream banks or the less restricted *Angophora floribunda* trees associated with *Eucalyptus melliodora*–*E. blakelyi* woodlands. Four of the riparian sites were located within cleared agricultural land and two were located within a relatively large nature reserve. Bird censuses along a strip transect were conducted twice per season from spring 1993 to summer 1996. The riparian woodland communities contained within the cleared landscape of the Bathurst basin were found to support a diverse avifauna, a mix of woodland-forest and species associated with agricultural landscapes. Extensive observations of individual birds at riparian sites indicate that the tree canopy is the most widely used microhabitat stratum. While native riparian woodlands are generally degraded, their connectivity and stabilizing function (actual potential) identifies them as a critical landscape component in maintenance or restoration programmes. Hence it is suggested that riparian strips could form the basis for rehabilitation initiatives within this landscape. Fenced plantings of endemic tree species supplemented by native understorey species could be linked with existing vegetation to enhance landscape connectivity. It is crucial that landholders become aware of the importance of riparian vegetation for nature conservation and stream stabilization. Incentives should be provided to landholders to encourage these areas to be fenced from stock in order to protect them from further degradation in a significantly disturbed ecosystem.

Species interactions between the White-winged Chough and Australian Magpie in a fragmented landscape

S. J. COX and J. J. BAUER

We studied the ecology of the White-winged Chough and its interaction with the Australian Magpie on the Central Tablelands of New South Wales, Australia, over seven months. Both species are ground foragers and significant prey overlap was assumed. Invertebrate biomass as an index of habitat quality, showed grasslands to be the most valuable of the three habitats, followed by edge and forest habitats. Magpie territories were positioned around the grasslands and therefore were of higher quality than chough territories which were dominated by forest and edge. Magpies actively exclude chough groups from most of the highly valuable grassland habitat, through repeated and persistent attacks. Despite an apparently effective defensive strategy we concluded that the chough was largely excluded from the most attractive habitat in our study area by the magpie. This study highlights the implications of species interactions on the responses of individual species to habitat fragmentation across a landscape. Implications of this study for the validity of present vertebrate habitat models, which ignore the dynamic nature of population behaviour are discussed.

Dispersal of the Blue-breasted Fairy-wren in fragmented habitat in the wheatbelt of Western Australia

MICHAEL BROOKER and LESLEY BROOKER

Dispersal of the Blue-breasted Fairy-wren *Malurus pulcherrimus* was studied in an agricultural landscape in which 93% of their preferred habitat has been cleared for farming and the remaining 7% is highly fragmented. In these conditions, the wrens were still capable of dispersing through non-breeding habitat for distances in excess of 10 km. Most long dispersals were by juvenile females moving between habitat patches, although shorter movements were made within habitat patches by breeding females and juvenile males. While it would seem that the population in this area is not entirely limited by the ability to disperse at the present time, persistence may depend more on the rigorous maintenance of existing habitat and inter-connecting corridors than on the revegetation of farmed land.

Extinct and introduced vertebrate species in New Zealand: a loss of biodistinctiveness and gain in biodiversity

KERRY-JAYNE WILSON

During the 1 000 years that people have lived in New Zealand 50 vertebrate species have become extinct. Other species are extinct on the mainland but survive on island refugia. In the 150 years since European colonization 95 vertebrate species have been introduced and habitat changes have allowed 10 additional bird species to colonize. All but one of the extinct species were endemic and 24 belonged to families or orders endemic to New Zealand. All but one of the introduced and colonizing species are common in their homelands. Although there are now more vertebrate species in New Zealand than there were at the time of human settlement, the previously highly distinctive fauna is becoming

increasingly cosmopolitan. The impact faunal change has had on terrestrial ecosystems is poorly known. It is important that conservation priorities be based on an appreciation of faunal and ecological changes rather than responding to crises one species at a time.

Genetics and the conservation of Australian birds

JANETTE NORMAN and LES CHRISTIDIS

Molecular genetic techniques can be used to address a wide array of contemporary conservation problems encountered in the management of captive and wild bird populations. Most applications pertain to issues relevant to the management of populations or species. These range from sex identification in breeding programmes involving species in which the sexes are phenotypically monomorphic, to the identification of taxonomic diversity at the level of species, subspecies and populations. Additionally, comparative analyses of intra-population variation provide a means of identifying populations more at risk from inbreeding and a loss of diversity. This provides a more tractable approach for the conservation and management of genetic diversity than derived from theoretical considerations about the genetic consequences of small population size. A recent development away from these traditional species-based approaches is the use of information revealed by studies of comparative phylogeography to address issues relevant to the management of entire communities and ecosystems. Molecular studies of non-threatened taxa are also an important tool for wildlife management. Non-threatened species can be used as indicators of regional biodiversity or to provide information which will assist in the conservation of a closely related species. Molecular studies of apparently widespread and abundant species may also reveal previously unrecognized taxonomic diversity of significance for conservation. With the impressive array of molecular tools now available for addressing issues in conservation biology it is important that they not be applied indiscriminately. Careful consideration needs to be given to the specific needs of wildlife management and the appropriateness of genetic studies should be evaluated on a case by case basis. In some instances molecular studies may not be warranted, providing little information beyond that which has been obtained from ecological and demographic studies or contained in traditional taxonomies.

Volume 3 Number 4

Forum Essay

The 10 Lords of the Universe respond to Lim

PAUL ADAM, TONY AULD, DOUG BENSON, PETER CATLING, CHRIS DICKMAN, MIKE FLEMING, ROBIN GUNNING, PAT HUTCHINGS, DAVID KEMP and JIM SHIELDS

Research Papers

Conservation of the endangered Gould's Petrel

Pterodroma leucoptera leucoptera

DAVID PRIDDEL and NICHOLAS CARLILE

The only population of Gould's Petrel *Pterodroma leucoptera leucoptera* has declined substantially during the last few decades. Adult mortality has been high, and has exceeded potential recruitment. Breeding success has been low. Entanglement in the sticky fruits of the Birdlime Tree *Pisonia umbellifera* and predation by Pied Currawongs *Strepera graculina* and Australian Ravens *Corvus coronoides* have been the major causes of petrel mortality on land. Experimental management actions aimed at ameliorating these threats were implemented, and their efficacy assessed.

The removal of *Pisonia* and the control of avian predators dramatically lessened the mortality of Gould's Petrels ashore on Cabbage Tree Island. Instigation of these management actions in 1993 was coincident with a 68% rise in the number of birds brooding eggs in mid-December. Further small increases in the breeding population occurred in subsequent years. Management of the colony was also coincident with a substantial increase in breeding success (up from 25% to 45%). Breeding success increased to 59% in the 1994–95 season, but declined to 26% during 1995–96. Prior to management of the colony, an average of 30 birds fledged per annum (range 23–40; $n = 4$); after management, this rose to 167 per annum (range 105–233; $n = 3$). Management of the colony appears the most likely cause of this turnaround, but the possibility of it being due to extraneous factors such as weather or oceanographic perturbations cannot be excluded.

The threats posed by *Pisonia umbellifera* and avian predators were, together, sufficient to account for the decline of Gould's Petrel. The demonstration that these two threatening processes can be ameliorated successfully suggests a high potential for recovery of the species.

Status and management of the Palila, an endangered Hawaiian honeycreeper, 1987–1996

THANE K. PRATT, PAUL C. BANKO, STEVEN G. FANCY, GERALD D. LINDSEY and
JAMES D. JACOBI

A single, relictual population of Palila *Loxioides bailleui*, a Hawaiian honeycreeper, survives on the slopes of Mauna Kea volcano on the island of Hawai'i, where it feeds principally on flowers and green seeds of the mamane tree *Sophora chrysophylla*. The Palila was listed as an endangered species by state and federal governments because of continuing damage to its habitat by browsing Feral and Mouflon Sheep *Ovis aries* and *O. mumimon* and Goats *Capra hircus* and because of the bird's restricted range and low numbers. Ecology of the Palila was studied from 1987 to 1996. Annual population estimates fluctuated between 1 600 and 5 700 and averaged 3 400 birds. Estimates varied with availability of mamane seeds, which are less abundant in drought years. In drought years, most birds did not attempt to breed, and survival rates were lower because of a shortage of food. Availability of mamane seeds also showed large seasonal variability. While some nests were preyed upon by Owls *Asio flammeus*, Cats *Felis catus* and Rats *Rattus rattus*, losses were high at the end of the season from unexplained death of eggs and chicks. Genetic studies did not implicate inbreeding depression. Neither avian malaria nor avian pox appeared at this site, where the mosquito vector was absent. However, weather and food shortage worsened towards the end of the nesting season. Availability of food and habitat remain the principal factors limiting increase in the Palila population. Recovery efforts now focus on reducing numbers of feral ungulates, fire management, removing mammalian predators, and developing techniques for captive propagation and introduction to currently unoccupied sites within the bird's former range. Reforestation adjacent to the Mauna Kea Forest Reserve would allow the Palila population to expand and grow.

Conservation of the Noisy Scrub-bird: a review of 35 years of research and management

ALAN DANKS

The Noisy Scrub-bird is a small, semi-flightless insectivore which forages in leaf litter and the lower stratum of dense vegetation. More widespread when discovered last century the species declined rapidly after European settlement of Western Australia due to habitat clearing and large scale, uncontrolled wildfires. A small, remnant population survived in dense low forest and thickets on Mt Gardner at Two Peoples Bay. Exclusion of fire from scrub-bird habitat allowed the population at Two Peoples Bay to increase through natural breeding. Translocations to new sites, where successful, have provided more habitat for the scrub-bird resulting in seven sub-populations in the area between Oyster Harbour and Cheyne Beach east of Albany. Rapid increases in numbers have occurred in the Mt Manypeaks area in recent years. The whole population has now increased to 10.5 times its size at rediscovery. This paper reviews Noisy Scrub-bird conservation efforts during the 35 years since its rediscovery and focuses on recent progress, population trends, and the current status of the species. Successful conservation management has been based on research into the scrub-bird's biology and ecology and has involved habitat reservation and protection, fire management, population monitoring, and translocation. Scrub-bird conservation has also provided benefits for other threatened species.

Integrating management of *Pittosporum undulatum* with other environmental weeds in Sydney's urban bushland

STEFAN ROSE

Natural bushland is a dwindling resource in the Sydney Metropolitan Area, not only because of direct clearing, but also because uncontrolled impacts from surrounding development have caused increasing degradation over time. Community change has been characterized by invasions of environmental weeds, and consequent displacement of many indigenous species. A few locally native species, *Pittosporum undulatum* in particular, have emerged as environmental weeds. Invasion of new habitats within a species' natural geographic range must be recognized, since their impact on natural communities can be as serious as that of the worst exotic invaders. Factors implicated as the immediate cause of environmental weed invasions include increased human-induced dispersal by birds, anthropogenic disturbance, suppression of fire and increased moisture and nutrients.

Management of plant invasions often includes mitigation to reduce impacts of the immediate causes. Strategies to maximize the success of mitigation by identifying and ameliorating the factors which impact bushland from remote sources are discussed. Practical recommendations for restoration of degraded sites are given. Native weeds such as *P. undulatum* require specialized treatment within an integrated environmental weed management strategy. It is stressed that application of the best management strategies available will be wasted if more fundamental issues related to current planning practices are ignored. Uncoordinated and *ad hoc* decisions are continuing to reduce urban bushland to mere remnants with high edge-to-interior ratios. Only when these practices are recognized and addressed can long-term

success in the treatment of environmental weed invasions be achieved by the many excellent restoration techniques being developed.

The protection of forested coastal wetlands in Southern Sumatra: a regional strategy for integrating conservation and development

JIM DAVIE and EFFENDY SUMARDJA

The coastal wetland ecosystems of South-east Asia are seriously threatened by increasing population pressure and by conversion to a range of uses from urban to forestry, agriculture and aquaculture. These ecosystems include mangroves, but also encompass coastal peat swamp forest and freshwater swamp forest. Solutions to the conservation problems require strategies which put individual areas into a regional and biogeographic context and address not only pressure within each area, but also attempt to solve the causes of these pressures. The coastal wetlands on the east coast of southern Sumatra provide an example of the types of problems that are widespread in the region. They are also of considerable ecological significance for their biodiversity and in regulating the ecological conditions of the productive inshore waters of the Java Sea. The Berbak National Park is perhaps the best representation of original peat swamp forest remaining in SE Asia, while the mangrove communities of Sembilang and associated rivers immediately to the south are of paramount value not only because they represent substantially intact natural communities, but also because they contain intact ecological gradients inland to palmswamp and peat swamp communities above the saltwater/freshwater interface. The three locations considered in this paper are of international importance as waterbird and wader habitat and Berbak is a Ramsar site. Nevertheless, human pressure is rapidly increasing. Intense pressure on the northern coastline of Jambi Province is driving a growing population along the coastal fringe adjacent to the Berbak National Park, while commercial forestry and a transmigration settlement to the south-west of Sembilang is also a source of increasing human activity. Extensive forest fires during the long dry season of 1994 resulted in widespread destruction of peat swamp forest on the borders of Sembilang and Berbak and allowed further encroachment to occur there. In this paper a set of proposals for conservation of the coastal wetland communities of southern Sumatra are presented. These proposals emphasize a range of land use approaches which contemporary conservation planning have available. They provide examples of local area multiple use and resource substitution techniques, zoning approaches, and potentially significant ecotourism opportunities. Taken together it is argued that these approaches are not only appropriate for site management, but will also relieve pressure associated with a continuing process of ad hoc and planned settlement and conversion which has characterized the region since the 1960s.

Population numbers, response to weather, movements and management of the threatened New Zealand skinks *Oligosoma grande* and *O. otagensense* in tussock grassland

EMMA J. CODDINGTON and ALISON CREE

The threatened skinks *Oligosoma grande* and *O. otagensense* currently exist in small, fragmented populations inhabiting rock outcrops among subalpine tussock grassland in southern New Zealand. This habitat is disappearing as farm production increases. Population numbers in three prime sites on Emerald Creek are low in absolute terms (11–56 individuals of each species; 15–78/ha). Low numbers and habitat fragmentation place populations at demographic and genetic risk. Emergence of both species from outcrops is highly weather-dependent, being negatively correlated with cloud cover and positively correlated with vapour pressure deficit and either air or rock temperature. Although higher numbers of both species emerge in warm, dry and sunny weather, *O. grande* is more likely than *O. otagensense* to be seen in marginal conditions. Many animals showed site fidelity but some moved between outcrops; maximum distances between sighting were 139 m for *O. grande* and 79 m for *O. otagensense*. Pair bonding may occur in *O. otagensense*. We recommend that annual censuses with moderate-low confidence intervals be carried out at a range of sites, that future surveys and censuses consider weather variables explicitly, and that the effects of habitat degradation and habitat enhancement on dispersal between outcrops be investigated.

Comment on the efficacy of Queensland nature conservation legislation in relation to *Acrodipsas illidgei* (Waterhouse and Lyell) (Lepidoptera: Lycaenidae: Theclinae)

J. P. BEALE

This discussion paper highlights shortcomings of the conservation regulations with respect to Illidge's Ant-blue *Acrodipsas illidgei* (Waterhouse and Lyell). The legislation has many deficiencies which are not fully realized until they have been experienced first hand. *A. illidgei* provides a case study of an unforeseen practical effect of Queensland conservation legislation, namely the actual hindering of conservation through the regulations controlling scientific

activities and amateur collecting and study. The permit regulations appear virtually impossible to enforce and probably have no significant effect on collecting activity. Moreover, the legislation discourages the study and monitoring of listed species. A number of suggested measures to improve the efficacy of conservation legislation are indicated.

Past and Present Distribution of the Eastern Barred Bandicoot (*Perameles gunnii*) in the Midlands, Tasmania

S. A. MALLICK, M. HASELER, G. J. HOCKING and M. M. DRIESSEN

The Eastern Barred Bandicoot, *Perameles gunnii*, is still relatively widespread and abundant in Tasmania, in contrast to the situation on mainland Australia where the species has declined to a single wild population. However, despite its relative security in Tasmania, there is evidence that a significant shift in the species' distribution has occurred since European settlement.

The original range of *P. gunnii* in Tasmania can be postulated from the pre-European distribution of its original habitat (native grasslands and grassy woodlands), which occurred almost exclusively through the midlands region of the state. We present anecdotal data collected from residents throughout the Midlands and adjoining regions which indicate that *P. gunnii* is now absent from the majority of its original range. The removal of >80% of the original Midlands native vegetation through clearing for agriculture and stock-grazing is suggested as the principal cause of this decline.

Pacific Conservation Biology

Order Form and Subscription information appears at the end of this document —
please complete and return it to Surrey Beatty & Sons

Volume 4 Number 1

News and Views

National Biodiversity Council

HARRY F. RECHER

Forum Essay

**Aspects of ecologically sustainable forestry in temperate eucalypt forests
— beyond an expanded reserve system**

D. B. LINDENMAYER and H. F. RECHER

The utilization of native forests is one of the most contentious and socially-divisive issues in Australia. Much of the recent conflict over the conservation and exploitation of Australia's temperate forests has focussed on the expansion of the reserve system. Even if this aspect of forest conflict is resolved, there will be a number of major changes required before the forest sector can be regarded as having made the transition to ecological sustainability. The expansion of the reserve system must **not** result in a reduction in off-reserve conservation efforts as most of the nation's forest biodiversity will still occur outside the protected area network. This means that progress toward ecological sustainability will involve an overall reduction in timber and pulpwood production from native forests. There needs to be a concerted research and monitoring effort to better understand forest ecosystems targeted for management. Such efforts must not only provide better knowledge of forest biota, but they should assist foresters to develop more ecologically-sensitive silvicultural systems — including the partial replacement of traditional cutting methods with new ones. As part of this effort, there is a need for better stand inventory to assist more accurate resource and yield estimates, and the implementation of mechanisms to assess adherence to environmental codes for timber harvesting.

Research Papers

**Co-existence and cultural difference:
postcolonial ecology in the contemporary Pacific**

SEAN WEAVER

The causes, symptoms and remedies of environmental disharmony in the contemporary Pacific are modern phenomena and need to be understood in their cultural context. This context is problematic for the integrity of the indigenous cultures of the Pacific and the prospect of ecological sustainability as a condition of culture. Modern dualistic and individualistic rationalities underpin environmental research and practice, which contribute to neo-colonialism through the subversion of the world views of indigenous peoples as part of conservation management. Such neo-colonialism is extended to the rest of nature where ecological salvation is delivered only if these environments and local people comply with modern environmental goals. A transformation in environmental research and practice is advocated where ethnographic analyses of modern institutions are subject to critical scrutiny in a socially and culturally enriched praxis of cultural ecology.

**Exotic plant invasion and understorey species richness: a comparison of
two types of eucalypt woodland in agricultural Western Australia**

MAX ABENSPERG-TRAUN, LYN ATKINS, RICHARD HOBBS and DION STEVEN

Exotic plants are a major threat to native plant diversity in Australia yet a generic model of the invasion of Australian ecosystems by exotic species is lacking because invasion levels differ with vegetation/soil type and environmental conditions.

This study compared relative differences in exotic species invasion (percent cover, spp. richness) and the species richness of herbaceous native plants in two structurally very similar vegetation types, Gimlet *Eucalyptus salubris* and Wandoo *E. capillosa* woodlands in the Western Australian wheatbelt. For each woodland type, plant variables were measured for relatively undisturbed woodlands, woodlands with >30 years of livestock grazing history, and woodlands in road-verges.

Grazed and road-verge Gimlet and Wandoo woodlands had significantly higher cover of exotic species, and lower species richness of native plants, compared with undisturbed Gimlet and Wandoo. Exotic plant invasion was significantly greater in Gimlet woodlands for both grazed (mean 78% cover) and road-verge sites (mean 42% cover) than in comparable sites in Wandoo woodlands (grazed sites 25% cover, road-verge sites 19% cover). There was no significant difference in the species richness of exotic plants between Wandoo and Gimlet sites for any of the three situations.

Mean site richness of native plants was not significantly different between undisturbed Wandoo and undisturbed Gimlet woodlands. Undisturbed woodlands were significantly richer in plant species than grazed and road-verge woodlands for both woodland types. Grazed and road-verge Wandoo sites were significantly richer in plant species than communities in grazed and road-verge Gimlet. The percent cover of exotics was negatively correlated with total (native) plant species richness for both woodland types (Wandoo $r = -0.70$, Gimlet $r = -0.87$). Of the total native species recorded in undisturbed Gimlet, 83% and 61% were not recorded in grazed and road-verge Gimlet, respectively. This compared with 40% and 33% for grazed and road-verge Wandoo, respectively. Grazed Wandoo and grazed Gimlet sites had significantly fewer native plant species than did road-verge Wandoo and road-verge Gimlet sites. Ecosystem implications of differential invasions by exotic species, and the effects of grazing (disturbance) and other factors influencing susceptibility to exotic plant invasion (landscape, competition and allelopathy) on native species decline are discussed. Exclusion of livestock and adequate methods of control and prevention of further invasions by exotic plants are essential requirements for the conservation of these woodland system.

Identifying threatened species in the “south” using new criteria

A. J. STATTERSFIELD

The first application of the new IUCN threatened species categories to birds is reviewed. The advantage of this system is that it is characterized by clear, objective, quantitative criteria. However, for many species, requisite numerical data are lacking, and the magnitude of potential threats has to be inferred. Numbers of threatened species are compared for South America, sub-Saharan Africa, and Indo-Pacific Islands. Further analysis identifies the most important countries in terms of priority for conservation action for threatened species, the key habitats for their survival and the main dangers faced. The changes between successive Red Lists indicate a possible extinction crisis of considerable magnitude, whereby half the world's birds could disappear in 800 years. Averting this crisis requires identifying and protecting sites where suites of threatened species co-occur.

The reappearance of *Taudactylus* (Anura: Myobatrachidae) in north Queensland streams

CHRISTOPHER J. MARSHALL

Seven species of frog are currently considered to be missing from the eastern seaboard of Queensland, Australia. Two species of these missing frogs were rediscovered in streams in the wet tropics of north Queensland in November 1996. One individual of *Taudactylus acutirostris* was observed calling in a small tributary of the South Johnstone River, five individuals of *T. rheophilus* were heard calling in a small, high altitude tributary of the Mulgrave River, and a further seven individuals of *T. rheophilus* were heard calling and one captured, in a small, high altitude tributary of the Mitchell River. Implications for the declining frog phenomenon are raised and the need for continued monitoring is emphasized.

Mound springs in the Dawson River Valley, Queensland. Vegetation-environment relations and consequences of a proposed impoundment on botanical values

R. J. FENSHAM

Boggomosses are perennial mound springs in the Dawson River Valley, Queensland, an area subject to seasonal and often more prolonged drought. The results of a vegetation survey of the boggomosses are presented and assessed in relation to an impoundment proposed for the area. A classification of site-species data defined four boggomoss communities having distinct associations with soil texture and fertility, landscape position and possibly the age of springs. A measure of biogeographic significance was assigned to the plant species on the basis of rarity, isolation,

affinity with the coastal flora and latitudinal limits. An impoundment at the maximum proposed height of 185 m would: a) inundate about 58% of the total number of springs; b) inundate 62% of significant community 1 springs that have high conservation significance; c) inundate all boggomoss populations of 26% of native plant species; d) inundate 30% of the boggomoss populations of the species that currently have two or more boggomoss populations to a level of one or less boggomoss populations; e) inundate all boggomoss populations of two out of 25 biogeographically significant species; f) inundate six out of 12 boggomoss populations of the vulnerable species *Arthraxon hispidus*; g) not inundate the single population of the vulnerable species *Thelypteris confluens* although the population would be within 1 m altitude of the maximum water height; h) not inundate the two populations of the endangered species *Eriocaulon carsonii* and *Myriophyllum* sp. (Aramac B. Wilson 110). Substantial lessening of impact on community 1 sites are achieved at dam water levels down to 177 m altitude and this trend is reflected in a progressive increase in the security of individual species. For example at the latter level, 88% of species would remain intact in more than one population and all known populations of *Arthraxon* would remain intact.

Influence of the Noisy Miner *Manorina melanocephala* on avian diversity and abundance in remnant Grey Box woodland

MERILYN J. GREY, MICHAEL F. CLARKE and RICHARD H. LOYN

The abundance of an aggressive Australian honeyeater, the Noisy Miner *Manorina melanocephala*, was reduced at four small (<8 ha) Grey Box *Eucalyptus microcarpa* woodland remnants by experimental removal. The diversity and abundance of small insectivorous and nectarivorous birds increased at three of the four sites (relative to matching control sites) over the twelve months following the removal of the Noisy Miners. The one exception occurred at a pair of sites where eucalypts began flowering at one site and finished at the other during the Noisy Miner removal period. These results, taken together with those from three earlier experiments where the abundance of Noisy Miners was reduced in Mugga Ironbark *E. Sideroxylon* woodland remnants, demonstrate that Noisy Miners affect avian diversity and abundance by aggressive exclusion of other species. In five out of seven experiments, Noisy Miners did not reinvade the small woodland remnants during the ensuing twelve months. When Noisy Miner abundance was reduced, increased populations of small insectivorous and nectarivorous birds used small degraded woodland remnants.

Colonizing populations of small birds have the potential to reduce insect infestations and may assist in the recovery of dieback-affected woodland remnants. Research is continuing to test this hypothesis. Reducing the abundance of Noisy Miners in remnant eucalypt woodlands may also be a useful, short-term measure, which could assist in the recovery of threatened or endangered bird species.

Towards integrating farming and conservation: the role of native pastures

CHRISTOPHER NADOLNY

Agriculture has almost certainly contributed to the decline of native vegetation and wildlife in rural Australia. A prevalent culture supports agricultural systems that rely on the use of exotic plants and animals and greater use of chemicals and machinery. In general, these systems do not fully utilize or take account of the indigenous biota. The full implications of implementing such farming systems on a landscape scale are seldom considered.

I use the grazing industry on the Northern Tablelands of New South Wales to illustrate two contrasting approaches: (1) "pasture improvement" involving replacement of native with exotic species versus (2) retention and management of existing native and naturalized pasture species. Pasture improvement has been refined by extensive agronomic research, plant selection and field testing of techniques. Nevertheless, the approach is losing support among farmers because of high inputs required to maintain "improved" pastures, the fragility of these pastures during droughts, low commodity prices, long-term declines in soil structure and increases in soil acidity. Other side-effects include tree decline, reduced diversity of indigenous herbaceous plant communities and loss of wildlife. Using native pastures may offer some solutions to these problems, but the level of understanding required to manage them effectively is limited.

Exotic sown pastures have no clear advantage in areas with poor soils and irregular rainfall, and the environmental impacts of new developments involving large-scale pasture improvement can be unacceptable. I conclude that native and naturalised pastures are the best option for most of the region and sown pastures should be used strategically.

Powerline easements through forests: a case study of impacts on avifauna

JACK BAKER, ROSS L. GOLDINGAY and ROBERT J. WHELAN

Powerline easements are typically a strip cleared of trees and tall vegetation to a width of approximately 50 m. They may affect avifauna by modification and fragmentation of forest habitat. We investigated the responses of the bird community to easements at three sites in southeastern Australia using 25 m radius point-counts spaced at 50 m intervals from the easement to 300 m inside the forest. The easements caused an absolute loss of habitat for forest avifauna, with abundance and species richness at the easement less than 20% of the forest values. Four species of easement opportunist and one easement specialist provided evidence that the easement represented a new type of habitat for avifauna. A barrier effect of fragmentation may occur for four species of easement avoiders. These were small to medium-sized terrestrial birds associated with dense ground and/or understorey cover. The edge effect of fragmentation was an adverse impact on forest avifauna. At the margin (25–125 m from the easement) of the forest, bird abundance, mean species richness and total species richness were significantly less than the corresponding values for the interior (225–325 m) of the forest. The mean abundance at the sites varied from 13.0–17.7 birds/ha and the species richness varied significantly among sites. The adverse impacts of powerline easements on native avifauna could be minimized by site-specific management which includes strategies to minimize the loss of forest habitat and to ameliorate the effects of fragmentation.

Volume 4 Number 2

Research Papers

Handing on the right to fish: the law of the land and cross-cultural co-operation in a gulf community in Australia

NONIE SHARP

Long time before white people come here, the black people looked after the land, the rivers and lagoons. Come to this day, we still want to look after this country. For our young people. They going to live on and on and on . . . We gonna take care of this land, we gonna look after him. We don't want the Government to look after him, because, long before, our ancestors looked after it.

Colin Lawrence,
Kunjen Elder, Kowanyama, 1993

Drawing on oral and written sources, this paper discusses an Aboriginal community's experience in taking primary responsibility for land and waters on behalf of the generations. It explores the reasons why Aboriginal people's distinctive relationship to the environment and to future generations forms a framework for their management practices. Respect for the law of the land became the pre-condition for more than a decade of co-operation with neighbouring commercial fishermen and others. Given a recognition of important cultural differences in the way relationships to land and sea are constructed, it is suggested that these experiences may offer some guidelines on sharing lands and coasts in Australia.

Taxonomy, genetics and conservation: a preliminary study of the variation in *Actephila lindleyi* (Euphorbiaceae) a rainforest shrub

A. SHAPCOTT

Actephila lindleyi is a highly morphologically variable species. It occurs in disjunct populations in rainforests from Cape York to central New South Wales. Preliminary tests have shown variation between populations is matched by genetic variation at the enzyme and chromosome levels. Thus, taxonomic revision of this species should take this into account. Such taxonomic decisions have implications for conservation and management. For example, the overall conservation status of a widespread species with endangered populations might be much lower than the conservation status of each population when elevated to species status.

Birds in patches of old-growth ash forest, in a matrix of younger forest

RICHARD H. LOYN

Birds were studied at 57 sites in Mountain Ash forests in the Central Highlands of Victoria, Australia in spring and summer 1995/96. The sites represented 41 patches of old-growth forest (up to 390 ha in size) in a matrix of regrowth mostly from severe fires in 1939 (57 years previously), with multiple sites in the four largest patches of old-growth and

eight sites in 1939 regrowth. Relative bird abundance was assessed by an area-search technique. Generalized linear modelling was used to develop predictive models by regressing abundance of groups of bird species against patch size, isolation and some basic habitat and context variables.

Total bird abundance (of all species combined) tended to be higher in old-growth patches than in 1939 regrowth, but not significantly. There was no trend in total abundance with patch size or isolation. Fruit-eating birds tended to be commonest in small patches. Bark-foragers and uncommon birds favoured large patches, though the latter were most common in 1939 regrowth. More variation was explained by habitat and context variables such as aspect, altitude and forest structure. Uneven-aged forest structure was often associated with small patches.

It was concluded that old-growth forest patches can have similar values per hectare for forest birds whether they are large or small. The regrowth forest matrix appears to protect small patches from factors which reduce densities of forest birds in small forest patches in farmland. The data support the current policy of retaining all old-growth ash forest patches. A range of factors should be considered in selecting regrowth stands of various sizes to regrow as old forest of the future, including their intrinsic potential to develop particular habitats and produce a mix of forest structures in the landscape.

Local extinction and nestedness of small-mammal faunas in fragmented forest of central Victoria, Australia

J. N. DEACON and R. MAC NALLY

A survey of small mammals was undertaken in eight forest fragments of three sizes (2.5, 10 and 40 ha) and in five "pseudofragments" within a large area of State Forest. The latter were used to provide "reference" results against which the fragments could be compared. There was a paucity of dasyurid marsupials in fragments and pseudofragments, but arboreal "herbivores" (possums and a glider) were 7.5 times more abundant in fragments than in pseudofragments. The Short-beaked Echidna *Tachyglossus aculeatus* was recorded in both fragments and pseudofragments. All sites were impoverished, with a maximum of four native species of small mammals recorded at any one site, and six native species recorded overall. There was significant faunal "nesting" as a function of fragment size, with the small-mammal fauna of smaller fragments being subsets of larger fragments. The extant fauna in fragments appears to be a result of a sequence of local extinctions such that some species are more vulnerable to habitat loss, fragmentation and degradation and become locally extinct earlier than other, hardier species. The impoverishment within pseudofragments seems to be a function of broad-scale habitat modifications and especially timber harvesting, which maintains the forest as a dense array of small, pole-sized trees with few large, old trees. Several of the arboreal mammals are dependent on hollows found in larger trees, so the absence of the latter probably constrains the occurrence and density of the hollow users.

Vegetation change in the grasslands and grassy woodlands of east-central Cape York Peninsula, Australia

GABRIEL M. CROWLEY and STEPHEN T. GARNETT

The vegetation of 64 grassland and grassy woodland sites in east-central Cape York Peninsula, surveyed by CSIRO in 1966, was re-surveyed in 1995. While the original vegetation communities had persisted at most sites, a change in species dominance was recorded at 14% of sites. *Melaleuca viridiflora* (ti-tree) had invaded eight sites, and increased in abundance in at least 16 of the 35 sites in which it had occurred in 1966. This had led to four out of 13 grassland sites, and three out of four mixed evergreen sites being re-classified as ti-tree woodlands. Analysis of aerial photographs covering 415 km² showed a 10% net loss of grasslands between 1969 and 1988. These changes are attributed to a reduction in the use of fire as a management tool since European settlement. Changes were also found in perennial grass composition consistent with grazing or over-grazing, particularly in the eucalypt/ironwood communities. A shift from *Themeda triandra* to *Heteropogon contortus* parallels earlier, grazing-related changes in southern Queensland. Evidence of a decline in *Heteropogon triticeus* and isolated losses of *Sorghum plumosum* are more suggestive of localized, unsustainable over-grazing. An increase in *Sorghum plumosum* in wet habitats appears to be associated with recent lack of burning. These changes suggest that further intensification of cattle grazing in the area may not be possible without significantly reducing both conservation values and pasture condition.

Distribution of the Western Petalura dragonfly *Petalura hesperia* Watson in Western Australia

MICHELLE DIANNE BARRETT and MATTHEW RUSSELL WILLIAMS

A comprehensive survey of the Western Petalura dragonfly *Petalura hesperia* Watson was conducted in December 1995 and January 1996 during the annual flight period. This represents the first systematic survey of the distribution of this dragonfly, which is restricted to the south-west of Western Australia. Survey effort was concentrated around the

headwaters of permanent streams with the aim of identifying those habitats most important for the long-term survival of the species. Twelve individuals representing six isolated populations were recorded, raising the total number of recorded localities to 19, although one population (at the type locality) is believed extinct and a further four are under threat from urbanization. The populations are scattered along the eastern fringe of the Darling scarp, between 31° and 32°S latitude and 115° and 116°E longitude.

The effects of isolation, habitat fragmentation and degradation by livestock grazing on the use by birds of patches of Gimlet *Eucalyptus salubris* woodland in the wheatbelt of Western Australia

G. W. ARNOLD and J. R. WEELDENBURG

The numbers of species, and the frequency of occurrence of individual species, in patches of Gimlet *Eucalyptus salubris* woodland in remnants of native vegetation in the central wheatbelt of Western Australia were recorded over a year. These values were examined in relation to the structural characteristics of the patches and the biogeographic attributes of the remnants (i.e., size and various indices of isolation from other native vegetation). There were five patches in large remnants (>100 ha) and 24 patches in small remnants (0.5–27.0 ha). Most of the small remnants were grazed by livestock and had lost much or all of the shrub understorey.

The Galah *Cacatua roseicapilla* and Port Lincoln Ringnecked Parrot *Platycercus zonarius* were found in all patches, but the remaining large species of birds (Australian Raven *Corvus coronoides*, Pied Butcherbird *Craicticus nigroregularis*, Crested Pigeon *Ocyphaps lophotes*, and Yellow-throated Miner *Manorina flavigula*) were found more frequently in patches in small remnants. Conversely, with the exception of the Striated Pardalote *Pardalotus striatus*, small passerine species were found less frequently in patches in small remnants. Remnant size was significantly negatively correlated with frequency of occurrence of six of the eight common large species, indicating that these species concentrated in patches in small remnants, and significantly positively correlated with frequency of occurrence of two of four small passerine species. Having taken out the effect of remnant area, a stepwise regression procedure was used to see whether other biogeographic attributes of the remnants or habitat structure in the patches influenced the frequency of occurrence of individual species and species richness. As area of native vegetation within a 5 km radius increased so did the frequency of occurrence of the Galah and Port Lincoln Parrot, indicating that local numbers of the species affects their presence. Of the large birds only the Yellow-throated Miner was influenced by patch structural attributes whereas all species of small passerines showed responses to various structural attributes of the patches. Frequency of occurrence of the Striated Pardalote and the number of species of small passerines in a patch decreased with increasing distance to the nearest native vegetation. Overall frequency of occurrence of small passerines increased with the number of linear strips of native vegetation linked to a remnant.

In this study a majority of the small remnants were too small to support resident birds. The Gimlet patches, if used, would be part of a home range. Loss of the shrub understorey through grazing and loss of canopy cover through tree deaths had a significant impact on numbers of species of small passerines using the Gimlet patches. The conservation value of the patches in small remnants would be enhanced by increasing remnant size and by the linking of remnants to nearby native vegetation.

Research Note

The genetic diversity and distinctiveness of the Yellow-footed Rock-wallaby *Petrogale xanthopus* (Gray, 1854) in New South Wales

LISA C. POPE, ANDY SHARP and CRAIG MORITZ

Volume 4 Number 3

News and Views

Recent trends in amphibian conservation: a report from the Third World Congress of Herpetology

RAYMOND C. NIAS

Forum Essay

Wilderness and its place in nature conservation in Australia

B. G. MACKEY, R. G. LESSLIE, D. B. LINDENMAYER and H. A. NIX

Research Papers

Determining the distribution of Koala habitat across a shire as a basis for conservation: a case study from Port Stephens, New South Wales

DANIEL LUNNEY, STEPHEN PHILLIPS, JOHN CALLAGHAN
and DIONNE COBURN

The Australian National Koala Conservation Strategy recognizes the importance of conserving Koalas in their existing habitat, particularly through the integration of Koala conservation into local government planning (ANZECC 1998). The aim of this study was to define, rank and map the distribution of Koala habitat in Port Stephens Shire, New South Wales. The procedure was to merge the results of two independent survey techniques, each of which was interpreted using a vegetation map specifically prepared for this study. A field survey used a plot-based sampling protocol to determine tree species preferences based on the presence/absence of Koala faecal pellets. Data were obtained on 8 764 trees comprising 19 eucalypt and 12 non-eucalypt species. A high-profile community survey obtained 2 756 Koala records. Koala habitat maps from both survey methods were examined as overlapping GIS layers. Combined Koala habitat categories were then devised, ranked and mapped across the Shire. This study provides a practical and repeatable means of identifying and conserving Koala habitat in existing remnant vegetation over which local government has planning jurisdiction.

The effects of fire on a population of Red-winged Fairy-wrens *Malurus elegans* in Karri forest in southwestern Australia

E. RUSSELL and I. ROWLEY

In April 1994, an intense fire burnt part of Smith's Brook Nature Reserve near Manjimup, Western Australia where we had studied an individually marked population of the Red-winged Fairy-wren *Malurus elegans* in Karri *Eucalyptus diversicolor* forest since 1980. We estimated the population size in a 25 ha area at the start of the breeding season each year 1980–95, including two years post-fire. In the 32 territories present in 1993, the entire area of 26 was almost completely burnt to a height of 10 m, with few remaining unburnt patches. The mean population size for the 13 years 1981–93 was 119 birds in a mean of 29 groups. In November 1993, 126 birds were present in 32 groups. In November 1994, following the April fire, there were 114 birds in 31 groups, but nesting substrate was very scarce, breeding was delayed, and only 0.18 yearling males per group were produced, compared with 0.52 for the years 1981–93. By November 1995, the population had fallen to 73 birds in 23 groups with nine territories vacant. The time necessary for the population to recover to its prefire level was estimated from long-term demographic data to be at least 10 years, longer than the present cycle of 7–9 years for prescribed burns in the southern (Karri) State Forests of Western Australia.

Density of the burrowing scorpion *Urodacus armatus* (Scorpiones; Scorpionidae) in relation to vegetation types: implications for population decline following agricultural clearing

G. T. SMITH

The density of the burrowing scorpion *Urodacus armatus* in relation to vegetation type was assessed by counting the number of burrows, both the annual cohort of dispersing second instar and all older scorpions. The counts were made in 18 two metre wide transects across a 730 ha portion of Durokoppin Nature Reserve in the central wheatbelt of Western Australia. Densities were highest in woodlands (593/ha to 1950/ha), whereas in shrub and mallee associations densities were considerable lower (47/ha to 382/ha). Productivity, as measured by the ratio of second to older instar scorpions, ranged from 0.42 in low, open heath to 2.68 in Wandoo/Salmon Gum *Eucalyptus capillosa*/*E. salmonophloia* woodland. However, the correlation between productivity and the density of older scorpions in the vegetation associations was not significant. Total population in the study area was 254 954, of which 165 934 were second instar scorpions. Biomass estimates for second instar and older scorpions were 12 kg and 156 kg respectively. Observations throughout the wheatbelt indicated that the relationship between density and vegetation was comparable to that found in the study area. Using the data on the areas of the vegetation associations in the Avon Botanical District, before and after agricultural clearing (Beard and Sprenger 1984), and the densities in the present study, the abundance and biomass, pre- and post-clearing were calculated. The standing population (excluding the annual cohort) would have been of the order of 1.2 billion, with an annual influx of 2.6 billion. The biomasses would have been 690 tonnes and 210 tonnes respectively. Clearing reduced the area of habitat by 86% and the standing population by 92% and in woodland by 97%. The implications of these results for other species are discussed.

An estimate of the Plumed Frogmouth *Podargus ocellatus plumiferus* population size in the Conondale Ranges

GEOFFREY C. SMITH, BENJAMIN J. HAMLEY and NADYA LEES

Marbled Frogmouths are rare, cryptic, shy, nocturnal birds restricted primarily to rainforest and wet sclerophyll forest. Two sub-species are recognized in two isolated areas on the east Australian coast. A stronghold for the southern subspecies (Plumed Frogmouth) occurs in the Conondale Ranges. This area has been subject to forestry practices for the past 100 years. Because of public concerns and a perceived need to undertake planning and management to assist in conserving the species, a study was undertaken to assess its population status. Radio-tracked adults associated primarily with rainforest and wet sclerophyll along drainage lines, although gullies containing rainforest species within dry sclerophyll were also utilized. Taped playback of Plumed Frogmouth calls revealed a distribution within core habitat (rainforest and wet sclerophyll) across the Conondale Ranges. Individuals radio-tracked in the Conondale Ranges occupied home ranges from 5 to 18 ha. Estimates of the combined home ranges of pairs ranged from 12 to 19 ha. Home range overlap between pairs was minimal. An assessment of the area of currently suitable core habitat (14 508 ha) within the Conondale Range forested area suggests that conservatively, 755 pairs currently exist; if potential future habitat (i.e., regenerating) of 1 954 ha is taken into consideration, this figure will rise to 857 pairs. If use of dry sclerophyll by birds is also taken into account then these estimates may be as high as 858 and 974 pairs respectively. There is currently no reliable estimate of the amount of suitable habitat, which is not occupied by Plumed Frogmouths or of habitat only occupied by single unpaired birds or non-breeding pairs. Future research should aim to redress this lack of information which could severely reduce any estimates of the numbers of breeding pairs.

Determination of the presence of *Mycobacterium avium* on Guam as a precursor to reintroduction of indigenous bird species

ILSE SILVA-KROTT, M. KELLY BROCK and RANDALL E. JUNGE

Eight of 11 native forest bird species on Guam were extirpated by the introduction of the Brown Tree Snake *Boiga irregularis*. Emergency measures necessary to rescue the Guam subspecies of Micronesian Kingfisher *Halcyon cinnamomina cinnamomina* from extinction involved translocation and captive breeding in American mainland zoos. Soon after the establishment of a captive breeding population, the kingfisher demonstrated a high degree of susceptibility to avian tuberculosis (ATB), a disease that proved to be a major threat to the preservation of the species. The cause of ATB is *Mycobacterium avium* which produces a prolonged course of infection in kingfishers and other birds. Kingfishers infected with *M. avium* are difficult to detect until late in the course of the disease, thereby potentially posing a risk of transmitting ATB to the Guam captive population of Guam Rails *Gallirallus owstoni*, if

kingfishers are repatriated. *M. avium* is considered to be ubiquitous in nature. However, there are no reported mortalities due to ATB in any bird species on Guam. In this study, six of twenty-one cultures yielded *Mycobacterium* spp., two of which were further identified as *M. avium*. Since this study demonstrates that *M. avium* already exists on Guam, repatriating kingfishers to Guam poses no threat of introducing a new pathological agent to the island's ecosystem. Strict quarantine procedures along with rigorous animal husbandry protocols should minimize risks of repatriating infected kingfishers to Guam, and prevent transmission of ATB to the captive population of Guam Rails and other bird populations on Guam.

Colony sizes, roost use and foraging ecology of *Hipposideros diadema reginae*, a rare bat from tropical Australia

CHRIS R. PAVEY

Hipposideros diadema reginae is a rare subspecies of Diadem Leafnosed Bat confined to tropical Queensland. Few data are available on its population size or ecology. From July, 1990 to December, 1993, I conducted colony counts at Chillagoe and Iron Range to assess its abundance, and radio-tagged six males at Chillagoe to provide data on roosting and foraging ecology for management purposes.

I recorded the subspecies in nine of 18 caves surveyed at Chillagoe. Two or more bats were regularly observed in only four caves, each of which had ≥ 250 m of passage, large chambers with high domed ceilings, and multiple entrances. The largest colony was found in Trezkinn Cave (range of 6–65 bats). Both Trezkinn and a nearby cave, Donna, were fully developed tourist caves, but were frequently used as day roosts by radio-tagged bats. Each cave had a gate at its entrance. At Iron Range, between 70 and 250 bats roosted in Gordon's Mine.

Bats used multiple day roosts, but did not change roost every day. The main foraging behaviour was perch hunting, with continuous flight as a secondary behaviour. The mean foraging range of tagged bats was 1.08 km from the day roost (range of 0.3–2.5 km). Foraging occurred within all available types of vegetation; use of vegetation showed intraspecific variation.

Hipposideros d. reginae exhibits flexibility in its foraging ecology, but has specific roost requirements. Recommended management actions are: prevent or regulate human access to roosts, search for additional colonies at Chillagoe by targeting potentially suitable caves, and ban scientific collecting at both sites.

Carabid Beetle and vegetation associations in the Tasmanian Eastern Tiers: implications for conservation

KARYL MICHAELS and LOUISE MENDEL

The distribution and abundance of the carabid beetle fauna of selected grassy ecosystems, wet and dry sclerophyll forests, and wet heaths in the Eastern Tiers, Tasmania was examined using pitfall traps. The conservation values of the sites were assessed by applying evaluation criteria typically used for vegetation (i.e., representativeness, typicalness, diversity and rarity) to both the carabid fauna data and the vegetation data. Sites of high conservation value for carabids and vegetation were identified and compared. Sites that ranked highest in terms of the carabid fauna on all conservation criteria were not the sites that ranked highest based on the vegetation. Classification of sites produced different results depending on whether plant or carabid data were used. Conservation based solely on vegetation attributes will therefore not necessarily conserve a rich and/or representative carabid fauna. If the objective to conserve a representative range of all biota is to be met, the use of additional taxa such as carabids in conservation assessments is desirable.

The Big-headed Ant *Pheidole megacephala*: a new threat to monsoonal northwestern Australia

BENJAMIN D. HOFFMANN

The Big-headed Ant *Pheidole megacephala* is a major threat to native invertebrate assemblages and to agricultural production world-wide. This paper reviews its known biology including its foraging ecology, colony founding and dispersal behaviour. A case study is presented to illustrate its potential conservation significance for northern Australia. At Howard Springs Nature Park in the Darwin region of the Northern Territory, an infestation of *P. megacephala* was found to cover 25 ha and is continuing to spread, with its distribution centred on a rainforest patch. The abundance of *P. megacephala* within the rainforest was 37–110 times that of total native ant abundance at uninfested sites. Only two

individuals of a single native ant species were found in the highest abundance of *P. megacephala* and abundance of other invertebrates was only 15% of natural levels. *Pheidole megacephala* is a serious potential threat to native biodiversity in monsoonal Australia. Successful eradication on a large scale is a realistic option and control methods are discussed, including chemicals and fire.

Effectiveness of the detector dogs used for deterring the dispersal of Brown Tree Snakes

**RICHARD M. ENGEMAN, DANIEL S. VICE, DANNY V. RODRIGUEZ,
KENNETH S. GRUVER, WILLIAM S. SANTOS and MIKEL E. PITZLER**

The accidental introduction of the Brown Tree Snake *Boiga irregularis* to Guam has resulted in the extirpation of most of the island's native terrestrial vertebrates, has created a health hazard to infants and children, and has resulted in economic losses. Cargo inspections using teams of handlers and their detector dogs form a last line of defense for preventing Brown Tree Snake dispersal from Guam. To assess the efficacy of the teams of handlers and their dogs for locating stowed Brown Tree Snakes, we planted Brown Tree Snakes (in escape-proof containers) in cargo without the knowledge of the handlers inspecting the cargo. We found that when an observer attended the inspection to monitor procedures, 80% of the planted snakes were located. Without an attending observer present, 70% of the planted snakes were discovered, but only after such plantings had become a routine procedure. Prior to the routine planting of snakes, efficacy was nearly 50% less (38%). The reasons some planted snakes were missed by the dog teams were split between: an insufficient search pattern by the handler, or the dog giving no discernable indication that a snake was present.

Twenty-eight years of monitoring a breeding population of Carnaby's Cockatoo

DENIS A. SAUNDERS and JOHN A. INGRAM

The breeding population of Carnaby's Cockatoo at Coomallo Creek in the northern kwongan (sandheath) of southwestern Australia was monitored from 1969 to 1996. The cockatoos breed in hollows in trees in a belt of woodland through the centre of the study area and feed in adjacent kwongan. During the period, the study area was progressively and rapidly cleared for broad-scale cereal and sheep farming. The area of native vegetation cover was reduced from 90% in 1959 to 25% in 1996.

The number of breeding attempts fell over the period of the study from around 80 attempts in the early part of the study to less than 40 by 1996. The initial decline was due to a combination of loss of habitat and increased mortality of the birds due to the use of wing tags to mark them individually. The subsequent decline was most likely due to loss of habitat.

The importance of the northern kwongan and associated woodland patches to the conservation of animals like Carnaby's Cockatoo that breed in tree hollows is discussed. Unless areas of woodland on private land and adjacent kwongan are afforded more protection, the future for hollow nesting species that feed on native vegetation like Carnaby's Cockatoo is bleak.

Volume 4 Number 4

Forum Essay

Correspondence

Forum Essay — Response

KEITH MORRIS and MATT WILLIAMS

Rebuttal

HARRY F. RECHER

Correspondence

Jarrah Forest Birds

JOHN N. HUTCHINSON

Research Papers

**The Thevenard Island mouse: historic and conservation implications
from mitochondrial DNA sequence-variation**

D. MORO, N. J. H. CAMPBELL, M. S. ELPHINSTONE and P. R. BAVERSTOCK

The level of mitochondrial differentiation between Thevenard Island and mainland populations of the short-tailed mice *Leggadina lakedownensis* was determined using DNA sequencing of the Control Region. Using temperature gradient gel electrophoresis, outgroup heteroduplex analysis detected eight haplotypes. These were sequenced for 362 base-pairs. Our results show that the Thevenard Island Short-tailed Mouse is indeed *L. lakedownensis*, and is most closely related to *L. lakedownensis* in the Pilbara in Western Australia. Together, Thevenard Island and adjacent mainland populations are sufficiently divergent from those in northern Australia as to be recognized as two clearly distinct mitochondrial DNA lineages. Conservation and taxonomic implications arising from a phylogeny of haplotypes suggest that two Management Units exist within *L. lakedownensis* — a northern unit that includes individuals from the Kimberley (Western Australia) to Kakadu National Park (Northern Territory), and a western unit comprising individuals from Thevenard Island and the Pilbara (Western Australia). These conservation units should be managed as separate sub-species of *L. lakedownensis*, and a high conservation priority should be given to the Thevenard Island population because it provides an important refugium for *L. lakedownensis* not just in the Pilbara, but in Australia.

**Systematic affinities of island and mainland populations of the Dunnart
Sminthopsis griseoventer in Western Australia: data from allozymes and
mitochondrial DNA**

A. LABRINIDIS, S. J. B. COOPER, M. ADAMS and N. BACZOCHA

The systematic affinities of Boullanger Island and Western Australian mainland populations of the Grey-bellied Dunnart *Sminthopsis griseoventer* were investigated using allozyme electrophoresis and phylogenetic analysis of a 404 bp region of the mitochondrial DNA (mtDNA) control region. Forty-six allozyme loci were screened for variation and found to be monomorphic in *S. griseoventer* from both Boullanger Island and one mainland population. Low levels of variation were also detected in the control region sequence, with just one haplotype observed among eight island individuals and three haplotypes among 10 mainland individuals, each differing at between two and four nucleotide sites (0.5–1.0% divergence). Phylogenetic analyses using maximum parsimony of control region sequence from mainland and island taxa, and four species of the “*murina* complex”, *S. aitkeni*, *S. murina*, *S. gilberti* and *S. dolichura*, indicated that the island and mainland taxa formed a monophyletic group to the exclusion of the other “*murina* complex” species, but were paraphyletic at the level of the individual haplotypes. These results are consistent with the hypothesis that mainland and island populations of *S. griseoventer* comprise a single species, and suggest that there has been no long-term barrier to gene flow between these populations. Analyses of molecular variation provided evidence the island population represents a separate management unit for conservation, but are insufficient to determine whether there has been inbreeding or a recent bottleneck in the island population.

Conservation status of mammals and birds in southwestern Australian forests. I. Is there evidence of direct links between forestry practices and species decline and extinction?

M. C. CALVER and J. DELL

Sixteen mammal species and 22 bird species whose distributions extended into southwestern Australian forests before European settlement have been listed as threatened at some time in Commonwealth legislation, State legislation, or action plans of Environment Australia or its predecessors. Confident assessment of the causes of conservation status is hampered by poor base-line data, few studies of putative impacts and a preponderance of circumstantial or anecdotal rather than experimental evidence. However, introduced foxes were implicated in the current conservation status of 62% of the mammal species recognized, while 44% of them were negatively impacted by feral cats, 44% by agricultural clearing and 44% by changed fire regimes. Forestry practices were implicated in the conservation status of only one mammal species. For the bird species recognized, changed fire regimes had the greatest negative impact (45% affected), agricultural clearing affected 41%, draining of wetlands affected 32% and grazing by livestock affected 22%. Forestry practices were not directly implicated in the conservation status of any bird species. While these results suggest that forestry has had minimal direct impact on the mammals and birds of the forests, the conclusion should be treated cautiously because of the poor data. While awaiting a rigorous evaluation, we argue for a strong precautionary approach to forestry in the region.

With proper forest management and sound sylvicultural [sic] treatment there is no reason why there should not be built up on the wreckage of the once splendid forests of Western Australia tended forests which will yield for all time 100 cubic feet of timber per acre per year. Lane-Poole (1920).

There are many reasons why Australian environmentalists would like to end logging in native forests. The preservation of wilderness, aesthetics, an almost religious identification with old growth forests and the conservation of forest wildlife figure importantly in environmental efforts to restrict logging. Wilderness and a personal identification with trees and undisturbed forests are fundamentally incompatible with logging. Recher (1996).

Conservation status of mammals and birds in southwestern Australian forests. II. Are there unstudied, indirect or long-term links between forestry practices and species decline and extinction?

M. C. CALVER and J. DELL

There is little evidence in the literature for past or current negative impacts of forestry practices on the mammals and birds of the south-west forests of Western Australia, although there are few relevant, detailed studies. For the conclusion of no major negative impact of forestry practices to be accepted, it must be shown that there are no indirect connections between forestry practices and established causes of fauna decline and that it is unlikely that forestry practices will have delayed impacts on the conservation status of mammals and birds. This paper reviews the literature relevant to these issues and concludes: (i) past forestry practices are linked to the changed fire regimes implicated in the decline of several species, indirectly connecting forestry practices with an established cause of fauna decline, (ii) there are plausible links between forestry and long-term causes of fauna decline that have not been investigated thoroughly. However, these findings need not mean that a native timber industry is incompatible with conservation in the south-west forests. Rather, they highlight the need for mediation between parties in the forest management debate, perhaps using some of the approaches developed recently in eastern Australia and North America. Concurrently, research effort could be directed towards determining the effectiveness of management initiatives already in place to ameliorate forestry impacts, while identifying actions successful elsewhere and setting research priorities to enable their effective implementation in the south-west.

Forest managers, past and present, have good reason to be proud of their efforts. Even during earlier eras, when the focus of forest management was largely on timber supply, the need to ensure successful regeneration after logging has acted to conserve the whole jarrah and karri forest ecosystem. Abbott and Christensen (1994).

The challenges posed by old growth eucalypt forest management in Australia are unique and by virtue of historical events, lie with our generation. To our advantage is an appreciation of what reforms are required, the availability of adequate knowledge and technology, and an understanding of what is at stake. A move towards ecologically sustainable forest use in Australia's remaining eucalypt forests requires a combination of initiatives including an enhanced conservation reserve network, and markedly enhanced protective measures in unreserved forest ecosystems,

irrespective of land tenure. Significant reductions in logging quotas and major changes to current codes of forest practice are required if stated biodiversity conservation goals are to be achieved. Institutional reforms are required to support these changes as is support for long-term ecological research and monitoring. Norton (1996).

Effects of variable-intensity logging on mammals, reptiles and amphibians at Waratah Creek, southeastern New South Wales

RODNEY P. KAVANAGH and GARRY A. WEBB

Populations of arboreal marsupials, small ground-dwelling mammals, reptiles and amphibians were assessed in forest before and after logging. Different levels of canopy retention were specified to estimate the effect of varying intensities of logging on these fauna. The logging treatments imposed were; unlogged, and the retention of approximately 72%, 58% and 30% of the original canopy cover. This corresponded to 62%, 52% and 21% retention of the original tree basal area on each logged area. The objectives of the study were to determine the sensitivity of species to logging, both in terms of the intensity of the initial impact and in terms of the time to recovery following disturbance, and to develop methods for managing areas within wood production forests where special wildlife values have been identified.

A total of 53 species was recorded in the 500 ha study area, only 18 (34.0%) of which were abundant enough for assessments to be made about the effects of logging. The arboreal marsupials, in particular the Greater Glider *Petauroides volans*, were among the species more sensitive to logging disturbance. The small, ground-dwelling mammals and the reptiles that were sampled adequately in this study appeared to be relatively unaffected by logging or they recovered quickly (most within eight years, and probably all within 10–15 years) following logging. Despite a large survey effort, insufficient data were available to assess the effects of logging on most species of frogs, although two species may have been advantaged.

The species requiring management consideration include those that declined as a result of logging, but which had not recovered within eight years (the Greater Glider, the Yellow-bellied Glider *Petaurus australis*, the Sugar Glider *P. breviceps*, and the skink *Niveoscincus coventryi*), the species that declined in both logged and unlogged areas (the frogs *Pseudophryne bibronii*, *Limnodynastes peronii*, *Geocrinia victoriana* and *Heleioporus australiacus*), and the species for which the data were too sparse to make any assessments.

It is unclear when the species most disadvantaged by integrated logging, that is, the large gliding possums, will recolonize the logged areas. The persistence of these gliders was attributed to the retention of unlogged forest within and adjacent to logged areas. This highlights the role of riparian reserves (“wildlife corridors”) and filter strips in retaining residual populations of the Greater Glider and the Yellow-bellied Glider until the logged areas are suitable for recolonization, and the importance of determining the effective size for these unlogged reserves. The data were not sufficient to determine conclusively whether reduced logging intensity at the levels applied was a better option than standard logging practices for managing populations of gliding possums in these forests. The results of this study, which was conducted in a forested landscape that was multi-aged but predominantly unlogged, may not be comparable to intensively-managed forests in which there is a lower proportion of unlogged forest and where multiple logging events have occurred.

Trapping strategies for deterring the spread of Brown Tree Snakes from Guam

RICHARD M. ENGEMAN and MICHAEL A. LINNELL

The accidental introduction of the Brown Tree Snake *Boiga irregularis* to Guam has resulted in the extirpation of most of the island's native terrestrial vertebrates, has presented a health hazard to infants and children, and also has produced an economic problem. Prevention of its dispersal through Guam's cargo traffic to other Pacific islands has become a high environmental priority. Trapping around ports and other cargo staging areas is central to an integrated pest management programme designed to deter dispersal of the species. In this study, perimeter trapping of forested plots characteristic of those found in port areas was found to be the most effective trap placement strategy, although trap lines cut through the plot interior or placed along a single plot boundary were also effective. Snake removal potentially can be modelled using an exponential decay over time, providing the manager with a planning tool. Population recovery of Brown Tree Snakes in trapped plots was found to be slow in the fragmented forested habitats found around ports.

An ecological history of Koala habitat in Port Stephens Shire and the Lower Hunter on the Central Coast of New South Wales, 1801–1998

TIFFANY KNOTT, DANIEL LUNNEY, DIONNE COBURN
and JOHN CALLAGHAN

This paper describes the vegetation of Port Stephens Shire and environs at the time of European settlement, defines the sequence of vegetation clearance since that time, and estimates the extent to which the pre-European vegetation represented Koala habitat. A study of historical records, newspapers, documents and reports was undertaken in conjunction with interviews with long-standing Port Stephens residents. The historical records show that Koalas were widespread and common during early settlement. Reconstruction of the original vegetation was based on descriptions by early explorers and settlers from the early 1800s, when settlement commenced. Most of the land on either side of the Hunter River was vegetated by Shrubby Tall Open Forest intermingling with either Open Swamp Forest, or Vine-Fern Closed Forest, or cedar brush. The first area to be settled was the alluvial land on the banks of the rivers where the soil was fertile and well watered. Settlement proceeded rapidly in the western part of the Shire from the early 1800s, concentrating on the Lower Hunter and Williams Rivers, but not progressing to the east until much later (mid to late 1800s). The historical record was sufficiently detailed to allow reconstruction of Koala habitat distribution at the time of settlement. Ecological history is now emerging as a discipline that has far more than curiosity value. It can provide the essential framework for conserving and restoring those landscapes exploited in the first century of European settlement.

Pacific Conservation Biology

**Order Form and Subscription information appears at the end of this document —
please complete and return it to Surrey Beatty & Sons**

Volume 5 Number 1

Forum Essay

Integrating demographic and genetic studies of the Greater Glider *Petauroides volans* in fragmented forests: predicting movement patterns and rates for future testing

D. B. LINDENMAYER, R. C. LACY, H. TYNDALE-BISCOE,
A. C. TAYLOR, K. L. VIGGERS and M. L. POPE

Research Papers

Conservation status of New Caledonia palms

J.-C. PINTAUD, T. JAFFRÉ and J.-M. VEILLON

An assessment of the conservation status of the palm species occurring in New Caledonia is provided, based on the new IUCN Red List categories. To determine the conservation status of each species, their extent of occurrence was determined using locality data on herbarium collections. Area of occupancy, number of adults, regeneration, and threats were evaluated on 62 localities throughout the Territory, including all types of palm habitats and all localities of species occurring at less than five sites. Among the 37 palm species known in New Caledonia, all are endemic and 13 are in a threatened category, including four critically endangered, one endangered, and eight vulnerable. Only four of the threatened species are represented in a reserve. Six species are listed as LRcd since they are adequately protected in a reserve despite an acute restriction of their range. Recommendations are given to improve the network of protected areas to include more threatened species.

Effects of habitat and introduced mammalian predators on the breeding success of Yellow-eyed Penguins *Megadyptes antipodes*, South Island, New Zealand

HILTRUN RATZ and BRIAN MURPHY

The endemic Yellow-eyed Penguin *Megadyptes antipodes* is threatened by habitat loss and introduced predators on mainland New Zealand. Nine colonies in the Catlins (south-east coast of South Island) were studied to measure breeding success, penguin abundance, and predator abundance in three successive breeding seasons (1991/92 to 1993/94). Nest numbers increased in all nine colonies in the three years despite predation (probably by Stoats *Mustela erminea*) being the most important cause of breeding failure. Larger colonies with higher breeding success were in small gullies with limited shrubs and bushes rather than in the most intact mature forest colonies hitherto assumed to be optimal habitat for the birds. Penguin nests were concentrated near the forest edge, but predators were not, so the predation risk was not elevated near the forest edge. Fragmentation of the original forest habitat had no observable adverse effect on breeding success. Stoats dominated the predator guild, while Ferrets *M. furo* and Feral Cats *Felis catus* were rare. Trapping to kill predators early in the season had no marked effect on subsequent predation losses, but trapping intervention when a predation outbreak occurred curtailed further chick deaths. A simple population model predicts that Yellow-eyed Penguins populations will grow provided the average total chicks loss is less than 43% per season, or at least 0.85 chick per nest fledges each year. This requires predation losses to be less than 34%.

Assessment of the economic and ecological impacts of remnant vegetation on pasture productivity

S. C. WALPOLE

The decline of remnant native vegetation in Australia is a national concern, with mounting community pressure on private landholders to actively manage and conserve the remaining vegetation on their properties. One of the major concerns of landholders in retaining and managing remnant vegetation in the agricultural landscape is the lack of information and understanding about the costs and benefits potentially associated with remnant vegetation, and how these values are linked to ecological functions. This paper focuses on the impacts of remnant vegetation on pasture productivity. Knowledge of the economic impacts of remnant vegetation on pasture productivity and associated agricultural output is currently limited, while the ecological relationships are better known but may vary with species and environment.

Based on a study area near Gunnedah in northern New South Wales where farm survey data and GIS information were available, a model that incorporates agricultural and biophysical attributes to explain pasture productivity was developed. The results indicate that the value of pasture output per farm may be increased by having a certain proportion of pasture area under dry sclerophyll or woodland vegetation. Gross value of pasture output was at its highest level when the proportion of tree area across the farm was at 34%, with no further increases in output being achieved beyond this point. These results suggest that the competitive influences of trees present in the pasture system may begin to outweigh the stimulatory effects when this proportion of tree area is exceeded.

Biodiversity and conservation of river macroinvertebrates on an expanding urban fringe: western Sydney, New South Wales, Australia

BRUCE C. CHESSMAN and SIMON A. WILLIAMS

As in many growing urban areas, the prevention of environmental damage as Sydney spreads westward into the Hawkesbury-Nepean River basin is a major challenge for planners, managers and the local community. We surveyed macroinvertebrates at 45 river and stream sites in April–June 1996, and reviewed data from other sources, in order to assess the issues involved in conservation of the lotic macroinvertebrate fauna. Regional richness is high with 443 recorded species and morphospecies. Cluster analysis showed community patterns related mainly to waterway size (separating the Hawkesbury-Nepean River from tributary streams), geology (tributaries on shale or sandstone), tidal intrusion and urbanization (impoverished faunas in urban streams). The ability of genus richness of mites and major insect orders to reflect overall genus richness at a site was limited, and Diptera and Trichoptera appear to have the greatest value as biodiversity predictors.

Urban expansion is the major threat to lotic macroinvertebrate communities in the region, but agriculture, flow regulation, sand and gravel extraction and introduced species have probably also impacted on the fauna. Streams with high conservation value for macroinvertebrates include those few on the Cumberland Plain and surrounding slopes that retain substantial indigenous vegetation in relatively undeveloped catchments. The Hawkesbury-Nepean River still harbours a rich faunal community and is also important for conservation.

The development of effective strategies for conservation assessment and management is problematic for several reasons. Some species in the region are known to be vulnerable, but the status of most cannot be assessed because of a lack of taxonomic and zoogeographic information. Most “biodiversity indicator” concepts are of dubious value for aquatic macroinvertebrate conservation. A multi-faceted management approach emphasizing subcatchment reserves, riparian restoration and the control of threatening processes is required.

Preliminary predictions of the impacts of habitat area and catastrophes on the viability of Mahogany Glider *Petaurus gracilis* populations

STEPHEN M. JACKSON

The population viability analysis (PVA) program VORTEX was used to examine the viability of different sized populations of the Mahogany Glider *Petaurus gracilis*, and to examine the impact of a one in a hundred year catastrophe (each requiring a different reserve size) of different severities on different sized populations. The PVA showed that populations up to 300 individuals (1 500 ha) have a negative population growth rate, high losses of genetic diversity and a greater than 5% chance of extinction within 100 years. Populations of 400–700 individuals (2 000–3 500 ha) showed a decreasing trend in population size suggesting they are likely to become extinct after 100 years. A population of 800 individuals (4 000 ha) was needed for the population size to stabilize. Sensitivity analysis showed adult mortality of greater than 25% to be important in decreasing the viability of populations. Populations of 400 were resistant to a one in 100 year catastrophe which had a 20% mortality and 20% decrease in reproduction. When the mortality was 70%, with 70% decrease in reproduction, a population of 1 000 still had a 12% chance of extinction. As only approximately 50% of the available habitat appears to be occupied, an area up to 8 000 ha (800 individuals) is suggested to be required to maintain viable populations of Mahogany Gliders. A number of management options are recommended including the retention of habitat, establishing corridors between key populations, and using fire to minimize rainforest expansion.

Towards scientific contributions in applying the precautionary principle: an example from southwestern Australia

M. C. CALVER, J. S. BRADLEY and I. W. WRIGHT

Scientific suspicion of the widely stated precautionary principle is based largely on confusion as to procedures for incorporating scientific data into a philosophical-political process. Here we take published guidelines on applying the precautionary principle and illustrate how they allow scientific input to the question of whether or not current multiple-use forestry takes a precautionary approach to conserving threatened or vulnerable marsupials in the jarrah forest of Western Australia. The scientific input involves (i) identification of outcomes in similar situations elsewhere in Australia, (ii) selection of indicator species for monitoring based on predictions made on the basis of (i) above and published accounts of the species’ biology, and (iii) a prescription for monitoring/experimentation that includes a quantitative requirement for a probability of detecting impacts based on statistical power analysis. On the standards suggested, contemporary management falls short of a quantitative definition of precaution that involves adherence to measurable standards.

Research Note

**Gene pool management of hatchery Barramundi *Lates calcarifer*
for production and stock augmentation programmes**

ROB DOUPÉ and HARRY RECHER

Volume 5 Number 2

Forum Essay

Correspondence

**Environmental Management:
the Precautionary Principle and Null Hypotheses**

DAVID W. GOODALL

Response

M. C. CALVER, J. S. BRADLEY and I. W. WRIGHT

Research Papers

**Survival of Mount Eden Bush, an urban forest remnant
in Auckland, New Zealand**

M. C. SMALE and R. O. GARDNER

Mount Eden Bush is the only reserved fragment of primary broadleaved forest on basaltic lava on the Auckland isthmus in northern New Zealand. An edaphic variant of northern coastal short forest, the reserved forest of 0.7 ha is approximately 1–2% of the estimated original <50 ha tract and contains 84% of the vascular species recorded in it. The canopy is dominated by *Griselinia lucida*, *Litsea calicaris*, and *Pseudopanax lessonii*, the subcanopy by *Meliccytus ramiflorus*, and the understorey by *Coprosma macrocarpa* and *Macropiper excelsum*. A depauperate vascular flora compared with other basaltic lava forests in the district may result from long isolation of the original tract in a deforested landscape remote from seed sources. Low tree density, low basal area, and a strongly rupestral/xerophytic ground layer reflect the drought-prone lava substrate (mean boulder cover 38%). It has probably been dominated by the adventive trailing herb *Tradescantia fluminensis* for >60 years (mean cover 38%), which reduces abundance of woody native seedlings and cover of native ground layer herbaceous species. Over two-fifths of the vascular flora is now alien native (all planted) or adventive, the latter almost all garden escapes from the surrounding suburban matrix and including many of the most threatening weeds of urban Auckland. Despite widespread *T. fluminensis*, currently important canopy/subcanopy and understorey dominants appear to be replacing themselves. In the absence of intervention, however, indigenous species are likely to become less important in the canopy and adventive *Ligustrum lucidum* and *Prunus serrulata* more important; the latter two species are respectively the second and third commonest canopy-forming species regenerating in gaps. Future extinction of some indigenous species with critically small populations cannot be ruled out.

**Population structure and movements of introduced rats
in an Hawaiian rainforest**

GERALD D. LINDSEY, STEPHEN M. MOSHER, STEVEN G. FANCY
and TY D. SMUCKER

We studied populations of introduced rats in three areas in Hawaiian rainforests as part of a larger study to determine the factors limiting endangered bird populations. Species composition among 1 264 rats live trapped was Black Rats *Rattus rattus* 60.8%, Polynesian Rats *R. exulans* 38.1%, and Norway Rats *R. norvegicus* 1.0%. Capture rates did not differ among the three study areas or four seasonal periods for any of the species. Males comprised 53.0% of 921 Black Rats and 55.3% of 783 Polynesian Rats that were sexed. Juvenile rats comprised 26.2% of Black Rats and 31.7% of Polynesian Rats captured and weighed. Black and Polynesian Rats reproduced throughout the year, but the highest

proportion of juveniles in the population was captured in September–November and the lowest proportion in April–June. Mean home range size was 3.6 ha for four Black Rats (three males and one female) and 3.0 ha for three Polynesian Rats (two males and one female). All daytime nests of Black Rats found were above ground, generally in cavities within tree canopies. Mean annual rat activity in tree canopies as measured with tracking tunnels was 43% (range 21–80%). Of 44 rats captured in trees, 43 were Black Rats and one was a Polynesian rat.

Notes on breeding and conservation of birds on Niufo’ou Island, Kingdom of Tonga

ANN GÖTH and UWE VOGEL

Niufo’ou lies very isolated in the Pacific, is well forested and not densely populated by humans. These facts as well as the lack of larger rat species make it a refuge for birds rare elsewhere in the region. This paper covers all 17 breeding species and gives breeding data for 14 of them, collected from October 1991 to December 1992. Ten species had a well-defined breeding season of 2–7 months somewhere between September and April, which often differed from other adjacent islands: Audubon’s Shearwater *Puffinus lherminieri*, Pacific Black Duck *Anas superciliosa*, Banded Rail *Rallus philippensis*, Spotless Crake *Porzana tabuensis*, Purple Swampphen *Porphyrio porphyrio*, Barn Owl *Tyto alba*, Red-vented Bulbul *Pycnonotus cafer*, Polynesian Starling *Aplonis tabuensis nesiotes*, and Jungle Myna *Acridotheres fuscus*. The Blue-crowned Lorikeet *Vini australis* nested in October, November and July. It did not only breed in tree hollows, but also inside a rotten log on the ground. Other observations suggest that it visits ground holes as well, either for nesting or resting. A breeding colony of Audubon’s Shearwater is the first one confirmed for Tonga. Four species nested in the wet and dry season: White-tailed Tropicbird *Phaethon lepturus*, Pacific Reef-heron *Egretta sacra*, Pacific Pigeon *Ducula pacifica* and Polynesian Megapode *Megapodius pritchardii*.

Since September to March is the main breeding season for birds on Niufo’ou, it is proposed that hunting and egg collecting, both important parts of the local tradition, are restricted to the other months of the year. In case of the endangered Polynesian Megapode we suggest a restriction of egg collecting and propose a translocation programme to another island. Additionally, we suggest that the islets in the crater lake become protected as they are free of feral cats, and some birds occur in higher densities there. Niufo’ou also deserves attention as resting place for six vagrant and migrant species; large numbers of Wedge-tailed Shearwaters *Puffinus pacificus* are hunted when they visit between October and June.

COPY: A new technique for evaluation of biodiversity protection projects

R. CULLEN, G. A. FAIRBURN and K. F. D. HUGHEY

New Zealand, like many other countries, is troubled by introduced animal and plant species which attack, damage, or displace indigenous species. Considerable amounts of taxpayer funds are spent each year attempting to combat these invasive species and some research has been conducted into the “cost effectiveness” and the efficiency of various conservation activities. Research into the cost effectiveness of biodiversity protection projects is hindered by the absence of satisfactory measures of output. A new output measure, Conservation Output Protection Years (COPY) is proposed for use in a cost utility evaluation of biodiversity protection projects. This paper outlines this approach and reports on the use of COPY in evaluation of six New Zealand biodiversity protection projects. The paper demonstrates that COPY provides a practical output measure, and reports on the comparative output per dollar spent on each biodiversity protection project.

Development and application of procedures to identify and conserve threatened ecological communities in the South-west Botanical Province of Western Australia

V. ENGLISH and J. BLYTH

A two year project was conducted to: (i) produce definitions, criteria and procedures for identifying threatened ecological communities (TECs) and assigning them to categories that define conservation status; (ii) develop a minimum data set for allocating TECs to one of these categories; (iii) establish a database and enter on it TECs, and

associated data, of the South-west Botanical Province of Western Australia; and (iv) assess each community and make recommendations for actions to conserve them.

The procedures described allow assessment of whether a particular biological assemblage can be described as an ecological community, and whether it meets the definitions and criteria for a TEC. "Threatened" (with destruction) includes "totally destroyed", "critically endangered (CR)", "endangered (EN)" and "vulnerable (VU)". Ecological communities that do not meet the criteria as "threatened" may be classified "data deficient" if there is insufficient information to assign a category, or "lower risk" if the community is not under significant threat. Other assemblages are termed "not evaluated". The terminology, categories and criteria are adapted from those recommended for threatened species by the World Conservation Union (IUCN).

Thirty-eight ecological communities, including those based on assemblages of terrestrial and aquatic plants, cave and mound-spring invertebrates, and structure-forming microbes were entered on the database. Of these, 16 were assessed as CR, seven as EN, ten as VU and five as data deficient.

The project established methods that are applicable to data on a broad range of community types at a broad range of scales. It also initiated many recovery actions including preparation of interim recovery plans, land acquisition, fencing, weed control and public liaison. Such actions are intended to cause allocation of communities to a lower category of threat when reevaluated against the criteria.

A test of the variable circular-plot method where exact density of a bird population was known

JAY T. NELSON and STEVEN G. FANCY

Variable circular-plot (VCP) counts are statistically more sound than point counts because they are adjusted for the probability of detecting birds at different distances and under different conditions. However, many ornithologists use point counts rather than VCP counts because they believe that assumptions of the VCP method are almost always violated, leading to poor results, and because earlier field tests using *ad hoc* analysis methods gave variable and relatively poor results. We conducted the first field test of the VCP method where the exact density of a forest bird was known as part of re-establishing the `Oma`o *Myadestes obscurus* in former range. All `Oma`o in the new population were intensively monitored by radio telemetry so that the number present during four VCP censuses was known. Excluding the first census, when three of the four detections were of the same individual, differences in VCP density estimates ranged from -34% to +24% (mean 0%) even though ≤ 18 `Oma`o were detected per survey. We review critical assumptions of the VCP method and make recommendations for data analysis based on our experience with the method on Pacific islands.

Uncertainty in assessing the viability of the Powerful Owl *Ninox strenua* in Victoria, Australia

MICHAEL A. MCCARTHY, ALAN WEBSTER, RICHARD H. LOYN
and KIM W. LOWE

A model of the metapopulation dynamics of Powerful Owls *Ninox strenua* in Victoria, Australia is described, and its parameters were derived from available data. Sensitivity analysis indicates that the survival rate of adult owls is the most important parameter in the model. Because estimates of this parameter are uncertain, the predictions of the model are uncertain and unreliable. Using the best estimates of the parameters, the predicted risk of decline across Victoria is low, and local populations larger than 100 pairs have a low risk of extinction. If the lower estimates of adult and sub-adult survival are used, the abundance of Powerful Owls across Victoria is predicted to decline exponentially and faces extinction from deterministic forces. A prohibitively large field programme involving monitoring of individually-recognizable owls would be required to obtain an improved estimate of adult survival, and so further use of population viability analysis to assess the adequacy of particular management strategies is unlikely to be useful for this species. An alternative is to establish a long-term monitoring programme to document changes in abundance of the species in logged and unlogged landscapes.

Volume 5 Number 3

Research Papers

Recovery of shrubland communities on abandoned farmland in southwestern Australia: soils, plants, birds and arthropods

G. W. ARNOLD, M. ABENSPERG-TRAUN, R. J. HOBBS, D. E. STEVEN,
L. ATKINS, J. J. VIVEEN and D. M. GUTTER

Passive recovery of land formerly used for agricultural production may be an inexpensive and rapid method of ecosystem recovery, and may provide an alternative method to active revegetation. Passive recovery may also contribute to sustainable agriculture (soil salinity). For undisturbed and disturbed areas of the central wheatbelt of Western Australia, this paper reports the effects of farming history (clearing only, cultivation, duration of farming, and time since farming ceased) on the soil nutrient content, plant floristics (richness and composition) and structure, and the abundance, species richness and species composition of birds and arthropods. Only one site was cultivated for >6 years.

We summarize as follows: (1) Previous clearing and cultivation has left no residual effects on the nitrogen or phosphorus content in the sandy soils. (2) There were no significant differences in terms of plant species richness but some differences in cover of woody plants, grass cover and plant species composition for farming history or time since farming ceased. (3) There were no significant differences in bird species richness but differences in species composition for time since farming ceased. (4) Arthropods showed few (and low) significant differences in their abundance, richness or species composition across different farming histories and time periods since farming ceased.

Farming of these shrublands has left only minor changes in the composition and structure of the vegetation, and in the abundance, species richness and species composition of the passerine bird and arthropod assemblages. Abandoned parcels of land on the sandy soils which support shrubland may yield useful conservation benefits with relatively little input.

Reproductive biology, ecology and conservation of *Carmichaelia williamsii* (Fabaceae), a vulnerable legume from New Zealand

PETER B. HEENAN and PETER J. DE LANGE

Carmichaelia williamsii is a threatened leguminous shrub that is most common on the Poor Knights Islands and Aldermen Islands, northern New Zealand. Flower morphology and structure of *C. williamsii* is suited to a bird pollination syndrome as the floral parts are stout, the petals yellow, the nectar source is distant from the stigma, and the flowers lack scent. The stigma is covered by a protective cuticle that prevents pollination until it is ruptured, which would usually be by foraging birds. Experimental self- and cross-pollinations demonstrated that if the cuticle is not ruptured fertilization will not occur, and that the species is self-compatible. Field observations on Aorangi Island, Poor Knights Islands, confirmed that *C. williamsii* is probably bird pollinated as plants in full flower were being systematically worked by the native passerine honeyeater the Bellbird (*Anthornis melanura*; Meliphagidae). *C. williamsii* mainly grows in seral habitats, and populations often comprise plants of a similar height class. Introduced rats and the loss of pollinating birds could pose conservation and management problems for the species.

Conservation status of forests and vertebrate communities in the Vava`u Island Group, Tonga

DAVID W. STEADMAN, JANET FRANKLIN, DONALD R. DRAKE,
HOLLY B. FREIFELD, LESLIE A. BOLICK, DARREN S. SMITH
and TIMOTHY J. MOTLEY

Based on field work in 1995 and 1996, we assess the distribution, relative abundance, and habitat preferences of forest plants, lizards, birds, and mammals on 17 islands in the Vava`u Group, Kingdom of Tonga. The islands vary in habitat composition, land area (0.02–96 km²), elevation (20–215 m), and distance (0–10.1 km) from the largest island of `Uta Vava`u. Two major forest types are recognized — coastal and lowland. They are similar in composition to forest communities described for the southern Tongan island group and for lowland Samoa, but with unique patterns of species dominance. The most mature category of lowland forest persists mainly in areas too steep for cultivation and covers about 10% of the land area. The greatest variation in plant species composition appears to be related to the degree of human disturbance. Among lizards, six species are widespread and at least locally common, whereas three

others are localized and typically rare. Among landbirds, 11 species are widespread and at least locally common, one (West Polynesian Ground-Dove *Gallicolumba stairi*) is extremely rare, and three others have been extirpated in the past century. The overall species richness and relative abundance of indigenous plants and vertebrates among islands in Vava'u have been affected more by deforestation and other human activities than by the classic physical variables of island biogeography — area, elevation, or isolation. Small islands (<1 km²) may be very important for conservation purposes, especially given the propensity for secondary succession to indigenous forests following agricultural abandonment.

Preliminary investigation of roosting habitat preferences of the large forest bat *Vespadelus darlingtoni* (Chiroptera, Vespertilionidae)

A. HERR and N. I. KLOMP

This study reports the roosting habitat preferences of a large forest bat, *Vespadelus darlingtoni*, on the western slopes of the Australian Alps. *V. darlingtoni* selected older and larger trees for roosts and displayed a preference for older smooth-barked trees. The areas the bats covered for foraging and commuting between roost sites ranged from less than 10 ha to over 300 ha. These calculated home ranges were larger than previously recorded for the species, but probably smaller than the actual area used by the bats. The data reported in this study enable some of the roosting requirements of *V. darlingtoni* to be incorporated in the planning and establishment of forest reserve systems in southeastern Australia. For example, areas designated for logging should retain unlogged stands of older trees and refuges of at least 45 ha connected by corridors of native vegetation.

The need for more stringent requirements in Environmental Impact Assessment: Shell Cove Marina case study

K. BENKENDORFF

An examination of Environmental Impact Statements (EIS) points to a clear need for change in the current process of Environmental Impact Assessment (EIA) in Australia. The recent approval of a Boatharbour/Marina at Shellharbour, New South Wales, Australia, serves as an example that underscores some of the problems common to most EISs. Budgetary constraints imposed on the ecological consultants can lead to the use of inappropriate methodology and the collection of inaccurate biological data. The limitations in methodology must be taken into consideration in EISs and all conclusions should be substantiated with data or reference to the literature. There is a need for stricter guidelines for ecological studies and monitoring programmes. A comprehensive list of potential impacts requiring consideration in an EIS should be provided for all designated developments. Novel mitigation methods should always be subject to monitoring. The consequences of not proceeding with the development should be considered in conjunction with alternatives to the proposed development and it should be essential to consider ecotourism as an alternative to all purely tourist oriented proposals. There is a need for peer review in the EIA process. Many of the flaws in the Shell Cove EIS might have been negated by more input from independent scientists. The future of ecologically sustainable development in Australia depends on our ability to learn from, and improve on, mistakes from the past.

Habitat of the Regent Honeyeater *Xanthomyza phrygia* and the value of the Bundarra-Barraba region for the conservation of avifauna

DAMON L. OLIVER, ANDREW J. LEY, HUGH A. FORD and BETH WILLIAMS

Five types of woodland and forest in the Bundarra-Barraba region of northern New South Wales were surveyed for Regent Honeyeaters *Xanthomyza phrygia* and other birds over two years. Regent Honeyeaters were found in 24 of the 93 transects, at a density of 0.09 birds/ha. Most were found in box-ironbark woodland (34% of 62 sites), with single records from box-gum woodland, box-stringybark woodland and dry plateau complex woodland. No Regent Honeyeaters were found in riparian gallery forest during censuses, but they were found breeding there at other times. All habitats contained a high density of birds, compared to other wooded regions in southern Australia, with riparian gallery forest and box-ironbark woodland being particularly rich in species and numbers. These habitats had greater flowering indices, larger trees and more mistletoes than other habitats. Sites used by Regent Honeyeaters supported significantly more birds and bird species than unoccupied sites. The region supports a total of 193 species, four of which are nationally threatened and seven which are threatened in New South Wales. The richness of the bird

community in the region is partly because it retains a higher proportion of native vegetation cover (43%) than many other parts of rural Australia.

Protection and rehabilitation of box-ironbark woodland and riparian gallery forest is of high priority in a regional conservation plan. However, all habitats in the Bundarra-Barraba region should be protected from clearing and degradation, because they are also used at times by Regent Honeyeaters and support a wide range of bird species. Wise management should retain many sensitive bird species that have disappeared from or declined in other regions of southeastern Australia.

Volume 5 Number 4

Forum Essay

1998 Edith Cowan University Research Lecture

The challenge to conserve and manage Australia's marine biodiversity

PAT HUTCHINGS

Research Papers

Variation in the recruitment behaviour of seagrass seeds: implications for population dynamics and resource management

GRAEME J. INGLIS

Effective conservation of marine organisms requires an understanding of the processes that affect the establishment, persistence and extinction of local populations. Our knowledge of the recruitment of seagrasses comes largely from studies done at small spatial and temporal scales within extant meadows. Descriptions of the demography of local populations, therefore, typically emphasize prolific ramet production and only a minor role for sexual propagules. Recent genetic and field studies, however, have shown greater variation in recruitment behaviour than previously suspected. In this paper, I review what is known about the seeds of seagrasses — including their dormancy, dispersability and requirements for germination and establishment — and examine the utility of recent conceptual models, developed for terrestrial clonal plants, to explain the long-term dynamics of seagrass populations. Sizable variation among species in seed size and dispersal strategy appears to be related predictably to variation in life-history and rates of recruitment. Species with small, poorly-dispersed fruits (e.g., *Halophila*, *Halodule*) are more likely to form persistent seed reserves and be rapid colonizers of disturbances within established meadows. Genera with large, buoyant fruits, capable of moderate dispersal (e.g., *Thalassia*, *Posidonia*), in contrast, appear to recruit rarely within existing meadows of conspecifics. Our ability to model long-term changes in demography and community structure is likely to benefit from a better knowledge of the importance of seed supply and microsite availability to recruitment.

The role of sexual reproduction in maintaining populations of *Halophila decipiens*: implications for the biodiversity and conservation of tropical seagrass ecosystems

W. JUDSON KENWORTHY

In subtropical and tropical communities, seagrass species commonly range over an order of magnitude in size and biomass. This biodiversity corresponds with differences in the relative importance of sexual (seed production) and asexual (clonal growth) life history strategies in the maintenance of seagrass populations. Clonal growth and vegetative reproduction are important in maintaining populations of larger-bodied species. As size of species and degree of clonality decrease, the importance of sexual reproduction increases. World-wide, the smallest species in tropical seagrass ecosystems are represented by the most taxonomically diverse, sexually fecund genus, *Halophila*. A four-year study of the submarine light regime and seasonal growth cycles of *Halophila decipiens* and other seagrasses in the Indian River Lagoon, Florida, USA provides a comparative context in which to illustrate the relative importance of different life history strategies in tropical seagrass ecosystems world-wide. While sexual reproduction is critical for maintaining some geographically extensive small-bodied seagrass systems in disturbed and extreme environments, there is also evidence to suggest that the quantitative importance of sexual reproduction may be underestimated for larger, highly clonal species like *Thalassia testudinum*. Future efforts to conserve tropical seagrass ecosystems

necessitates a more comprehensive understanding of the evolutionary consequences of sexual reproduction and a more quantitative evaluation of the population dynamics resulting from the sexual life history strategies of different species.

Genetic factors in the conservation of seagrasses

MICHELLE WAYCOTT

Increasingly our awareness of seagrass conservation issues requires an understanding of population dynamics and knowledge of the ability of different species to recover from disturbance. Seagrass populations may recover vegetatively or through the establishment of sexually derived seedlings. Some understanding of the processes of population formation and maintenance can be obtained through population genetic surveys. With the advent of molecular genetic markers even genetically depauperate populations can be studied. Patterns of genetic variation can vary over the range of seagrass populations and with the type of marker used. A case study is presented which demonstrates the importance of surveying a significant range of species to better understand the patterns of genetic diversity present. Seagrass phylogeny needs to be improved before reliable taxonomic interpretations can be made in many seagrass groups. Uncommon or rare seagrass species require special attention to ascertain their evolutionary origins and the nature of their extant distributions. Studies of genetic factors may enhance our understanding of how seagrass populations survive over both short and long time scales and can provide considerable insight to the seagrass conservation strategist.

Impact of Dugong grazing and turtle cropping on tropical seagrass communities

LEMNUEL ARAGONES and HELENE MARSH

The impact of grazing by two megaherbivores, the Dugong *Dugong dugon* and the Green Turtle *Chelonia mydas* on the community structure of intertidal seagrasses was investigated experimentally over two time frames (shorter-term: 1–4 months; longer-term: 10 and 13 months), at three levels of grazing intensity (leaf cropping, light grazing, intensive grazing), at two seagrass meadows in tropical Queensland, Australia: (1) a mixed species bed of *Zostera capricorni*, *Halophila ovalis*, *Halodule uninervis*, *Cymodocea rotundata* and *Cymodocea serrulata*, and (2) a monospecific bed of *Halodule uninervis*. From the perspective of the megaherbivores, grazing improved the structure and dynamics of the tropical seagrass communities by altering their biomass, volume of detritus, net aboveground biomass productivity and the species composition of the mixed-species bed. Recovery from grazing disturbance occurred after several months to a year.

Characterizing Manatee habitat use and seagrass grazing in Florida and Puerto Rico: implications for conservation and management

LYNN W. LEFEBVRE, JAMES P. REID, W. JUDSON KENWORTHY
and JAMES A. POWELL

The Indian River Lagoon on the Atlantic coast of Florida, USA, and the east coast of Puerto Rico provide contrasting environments in which the endangered West Indian Manatee *Trichechus manatus* experiences different thermal regimes and seagrass communities. We compare Manatee feeding behaviour in these two regions, examine the ecological effects of Manatee grazing on a seagrass community in the Indian River Lagoon, describe the utility of aerial surveys, radio tracking, and seagrass mapping to study Manatee feeding patterns, and develop hypotheses on sirenian feeding strategies in temperate and tropical seagrass communities. In both the Indian River Lagoon and Puerto Rico, Manatees were typically observed grazing in water depths = 2.0 m and more frequently on the most abundant seagrasses present in the community: *Halodule wrightii* in the Indian River Lagoon and *Thalassia testudinum* in eastern Puerto Rico. Where both *H. wrightii* and *Syringodium filiforme* were consumed in the Indian River Lagoon, Manatees tended to remove more *S. filiforme* than *H. wrightii* rhizome + root biomass. Even though 80 to 95% of the short-shoot biomass and 50 to 67% of the rhizome + root biomass were removed, grazed patches of *H. wrightii* and *S. filiforme* recovered significantly between February and August. *H. wrightii* may be both more resistant and resilient than *S. filiforme* to the impacts of Manatee grazing. Despite the significantly greater abundance of *T. testudinum* in Puerto Rico, Manatees exhibited selective feeding by returning to specific sites with abundant *H. wrightii*. They also appeared to feed selectively on *T. testudinum* shoots associated with clumps of the calcareous alga *Halimeda opuntia*. We hypothesize that Florida Manatees are less specialized seagrass grazers than Manatees in tropical regions like Puerto Rico.

Continued research on Manatee grazing ecology in temperate to tropical seagrass communities will enable better protection and management of these vital and unique marine resources.

Seagrass management in Indian River Lagoon, Florida: dealing with issues of scale

ROBERT W. VIRNSTEIN

The major theme of this paper is that management of seagrass must deal with issues of geographic scale. Approaches at several scales are needed. Examples are drawn primarily from management programmes for the 250 km long Indian River Lagoon system on the south-east coast of Florida. The Lagoon has several attributes of spatial variation that require approaches at various scales (e.g., from 1:1 000 000 to 1:1). Risks and errors of scaling up and scaling down are described.

For large-scale approaches, remote-sensing mapping methods are generally appropriate. In the Indian River Lagoon, true-colour aerial photographs are typically taken every 2–3 years at 1:24 000 scale. Such Lagoon-wide maps have fuzzy boundaries and cannot be scaled down to fine scale, but they can be scaled up. At large scale, seagrass restoration/protection targets (to a depth of 1.7 m) are reasonable, but are unreasonable at fine scale. For monitoring change *within* a bed or meadow at metre to 500 m scale, monitoring of fixed transects is a powerful tool. However, the technique has limited power for comparisons *among* beds, which requires multiple transects. To build a predictive model, a site-specific study examined the relationships among light, water quality, and seagrasses. The link between seagrass and water quality is made through a light attenuation model incorporating both water column and epiphytes. Extensive sampling is required to test the robustness of the model at all scales.

No single scale is appropriate for all approaches, and no approach applies over all scales. If such considerations of scale are not incorporated, errors of measurement, inappropriate techniques for assessment, implementation of wrong solutions, and a lack of understanding of the system under study can result.

Seagrass responses to and recovery (?) from seven years of brown tide

C. P. ONUF

Most harmful algal blooms are relatively short, violent paroxysms to aquatic systems. The Texas brown tide was unique in its 7-year domination of upper Laguna Madre wherein it reduced light penetrating 1 m from 31 to 63% on an annual basis between June 1990 and May 1997. In response, seagrasses declined in biomass in deep areas for two years. Over the next three years, bare areas opened up in the deepest areas of the seagrass meadow and the outer seagrass boundary retreated landward. In the last two years of the brown tide, regression of the dominant species, *Halodule wrightii*, slowed and stopped, and *Halophila engelmanni*, a previously minor species, revegetated some areas. Subsequent to cessation of meadow retreat, water clarity improved to pre-brown tide levels, consistent with the hypothesis that regeneration of nutrients from retreating seagrass meadow may have been the source of the nutrient subsidy required to sustain the brown tide at high concentration. However, after a short interlude of clear water and *Halodule* recovery, a resurgence of the bloom occurred and areas of regrowth succumbed. Although human activities did not seem to be involved in initiation or persistence of the brown tide, nutrients brought in by runoff from agricultural lands may have contributed to the return of bloom conditions.

Effects of depth on manual transplantation of the seagrass *Amphibolis griffithii* (J. M. Black) den Hartog on Success Bank, Western Australia

ERIC I. PALING, MIKE VAN KEULEN, KAREN WHEELER and CATHY WALKER

Transplants were established in February and December 1997 to supplement and provide feedback for a mechanical seagrass transplantation programme. A total of 580, 15 cm diameter plugs of *Amphibolis griffithii* were transplanted to depths of 5, 6, 8 and 10 m with similar energy conditions, and their survival monitored. There was a significant decline in plug survival over the subsequent 14 months. This appears to correlate with the onset of the winter storms in May 1997; the control plugs (seagrass excavated and replanted in the same location) also declined during this period. There was a seasonal decline in stem density in all plugs, with some recovery in the following spring and summer. The decline of plug survival corresponded to large-scale fluctuations in sediment levels across Success Bank. This suggests that, provided the transplants survive hydrodynamic disturbances resulting in sediment level fluctuations, the light climate (up to 10 m depth) does not prevent the survival and growth of seagrass transplants.

Issues for seagrass conservation management in Queensland

W. J. LEE LONG, R. G. COLES and L. J. MCKENZIE

Coastal, reef-associated and deepwater (>15 m) seagrass habitats form a large and ecologically important community on the Queensland continental shelf. Broad-scale resource inventories of coastal seagrasses were completed in the 1980s and were used in marine park and fisheries zoning to protect some seagrasses. At least eleven of the fifteen known species in the region reach their latitudinal limits of distribution in Queensland and at least two *Halophila* species may be endemic to Queensland or northeastern Australia. The importance of seagrasses to Dugongs *Dugong dugon*, Green Turtles *Chelonia mydas* and commercially valuable prawn fisheries, will continue to strongly influence directions in seagrass research and conservation management in Queensland. Widespread loss of seagrasses following natural cyclone and flood events in some locations has had serious consequences to regional populations of Dugong. However, the impacts to Queensland fisheries are little studied. Agricultural land use practices may exacerbate the effects of natural catastrophic events, but the long-term impacts of nutrients, pesticides and sediment loads on Queensland seagrasses are also unknown. Most areas studied are nutrient limited and human impacts on seagrasses in Queensland are low to moderate, and could include increases in habitat since modern settlement. Most impacts are in southern, populated localities where shelter and water conditions ideal for productive seagrass habitat are often targets for port development, and are at the downstream end of heavily modified catchments. For Queensland to avoid losses experienced by other states, incremental increases in impacts associated with population and development pressure must be managed. Seagrass areas receive priority consideration in oil spill management within the Great Barrier Reef and coastal ports. Present fisheries legislation for marine plant protection, marine parks and area closures to trawl fishing help protect inshore seagrass prawn nursery and Dugong feeding habitat, but seagrasses in deep water do not yet receive any special zoning protection. Efficacy of the various Local, State and Commonwealth Acts and planning programmes for seagrass conservation is limited by the expanse and remoteness of Queensland's northern coast, but is improving through broad-based education programmes. Institutional support is sought to enable community groups to augment limited research and monitoring programmes with local "habitat watch" programmes. Research is helping to describe the responses of seagrass to natural and human impacts and to determine acceptable levels of changes in seagrass meadows and water quality conditions that may cause those changes. The management of loss and regeneration of seagrass is benefiting from new information collected on life histories and mechanisms of natural recovery in Queensland species. Maintenance of Queensland's seagrasses systems will depend on improved community awareness, regional and long-term planning and active changes in coastal land use to contain overall downstream impacts and stresses.

Seagrass conservation: lessons from ethnobotany

S. WYLLIE-ECHEVERRIA, P. ARZEL and P. A. COX

Current measures to protect and conserve seagrasses are nested in the legislative or judicial process. While this legal/judicial model may arrest activity in the short term, we contend that it may not deliver a long-term solution. We propose an alternative model, using insights derived from historical archives and participant observation interviews. People tend to conserve what they cherish and use. With the seagrass biome disappearing around the globe, we suggest one strategy for seagrass conservation lies in historical and ethnobotanical records of seagrass use.

Seasonal variation in abundance and sex ratio of Grey Nurse (Sand Tiger) Sharks *Carcharias taurus* in northern New South Wales, Australia: a survey based on observations of recreational scuba divers

PAMELA PARKER and DANIEL J. BUCHER

The Grey Nurse or Sand Tiger Shark *Carcharias taurus* is a protected species in Australian waters. In order to gain an insight into this shark's migratory habits and relative abundance at popular recreational diving sites, a survey was conducted using the observations of recreational divers' in northern New South Wales coastal waters over 15 months from August 1996 to October 1997. The bulk of shark sightings were reported during seasons of low diver activity and when sea surface temperatures were around 20–21°C. The number of reported sightings in each month was adjusted for variations in diver activity (i.e., sampling effort) to give an index of shark abundance. More southerly sites experienced peak shark abundance from August to November 1996, whereas sharks were most common at more northerly sites from April to June 1997, suggesting either that the sharks were migrating northwards, or that seasonal movement into

shallower waters was occurring later at the northern sites. The sex ratio of the population shifted from a majority of females in spring to a majority of males in autumn/winter at the northern sites, indicating that the movements of the sexes may differ. Management strategies for this species, such as providing adequate protection of habitat at critical localities and times, require more detailed knowledge of this shark's migratory pattern, and the timing of reproductive events.

Predation at Sooty Shearwater *Puffinus griseus* colonies on the New Zealand mainland: is there safety in numbers?

P. O'B. LYVER, H. MOLLER and C. J. R. ROBERTSON

Burrow occupancy, survivorship, and breeding success were assessed at eight Sooty Shearwater *Puffinus griseus* colonies along the southeastern coast of New Zealand during the 1994/95 and 1995/96 breeding seasons. An average 46% and 47% of burrows contained breeding birds, but only three colonies had chicks survive to fledge. Most breeding failures were at the egg and early-chick phase. A large proportion of adults were killed at some places, causing the extinction of two of our study colonies. Predation by Stoats *Mustela erminea* was the main cause of breeding failure and adult loss at most mainland colonies, but Norway Rats *Rattus norvegicus* were the principal predator at one colony. Protection of adults, eggs and young chicks from predators is crucial if mainland colonies are to persist. A conceptual model predicts that predation becomes part of the extinction vortex as the size of a colony dwindles because the depredations of a few rogue predators have catastrophic impacts on the few remaining birds.

Pacific Conservation Biology

**Order Form and Subscription information appears at the end of this document —
please complete and return it to Surrey Beatty & Sons**

Volume 6 Number 1

Forum Essays

Why publication matters in conservation biology

M. C. CALVER and D. R. KING

Artificially enhanced tolerance to fluoroacetate and its implications for wildlife conservation

LAURIE E. TWIGG and DENNIS R. KING

Research Papers

Application of a PCR-based approach to identify sex in Hawaiian honeycreepers (Drepanidinae)

SUSAN I. JARVI and PAUL C. BANKO

The application of molecular techniques to conservation genetics issues can provide important guidance criteria for management of endangered species. The results from this study establish that PCR-based approaches for sex determination developed in other bird species (Griffiths and Tiwari 1995; Griffiths et al. 1996, 1998; Ellegren 1996) can be applied with a high degree of confidence to at least four species of Hawaiian honeycreepers. This provides a rapid, reliable method with which population managers can optimize sex ratios within populations of endangered species that are subject to artificial manipulation through captive breeding programmes or geographic translocation.

Effects of variable-intensity logging and the influence of habitat variables on the distribution of the Greater Glider *Petauroides volans* in montane forest, southeastern New South Wales

RODNEY P. KAVANAGH

Populations of arboreal marsupials were assessed in forests before and after logging at different levels of logging intensity to determine the sensitivity of these species to habitat disturbance. The logging treatments imposed were unlogged controls and two intensities of integrated logging for sawlogs and woodchips. The mean basal area of trees retained in logged blocks ranged from 83% to 35% of pre-logging levels. The objective of the study was to develop better methods for managing arboreal marsupials within the wood production forests of southeastern New South Wales.

Seven species of arboreal marsupials were recorded during the study, but the Greater Glider *Petauroides volans* was the only species recorded in sufficient numbers for analysis (86% of all records). No significant differences were observed between the treatments in counts of the Greater Glider before and after logging. However, given the observed trend and an *a priori* expectation of a decline in numbers of this species following intensive logging, a one-tailed statistical test was applied which resulted in a significant difference at $P = 0.08$ for the contrast between the unlogged controls and the most intensively logged treatment. The existence of a threshold in logging intensity within the range of 21% to 39% retention of tree basal area, below which numbers of the Greater Glider suffer a marked decline, was inferred on the basis of comparisons with the results of other studies.

Factors other than logging were important in determining the distribution of the Greater Glider. Elevation, in particular, was a significant environmental variable, with Greater Gliders more likely to occur in forests above 845 m a.s.l. The presence and absence of particular tree species also influenced the distribution of the Greater Glider. Forests containing Manna Gum *E. viminalis* and Mountain Gum *E. dalrympleana* were highly preferred compared to forests with a high proportion of *E. obliqua*. The presence of *E. cypellocarpa* appeared to improve the quality of habitat for the Greater Glider in forests dominated by *E. obliqua*.

This study has shown that Greater Glider populations can be maintained at or near pre-logging levels when at least 40% of the original tree basal area is retained throughout logged areas and when the usual practice of retaining unlogged forest in riparian strips is applied.

In defence of small habitat islands: Termites (Isoptera) in the Western Australian central wheatbelt, and the importance of dispersal power in species occurrence

MAX ABENSPERG-TRAUN

Ecological theory has long undervalued the contribution of small remnants of native vegetation to nature conservation. This study provides data on colony persistence of remnant-dependent wood-eating termites in 28 remnants of mature wandoo (*Eucalyptus capillosa*) trees in paddock situations in the agricultural south-west of Western Australia. Remnants ranged in size from 2 to 30 trees, and in spatial isolation from 50 to 650 m. All remnants have been exposed to livestock-related disturbance for >40 years.

This study found that: (1) Small remnants of eucalypt trees on farms retain important functional representatives, i.e., wood-eating termites for nutrient-cycling, and high species numbers. (2) Seventeen species have the capacity to

establish and maintain colonies in remnants ≤ 5 trees. (3) Spatial isolation has no significant influence on the total number of termite species. (4) The number of trees ($r = 0.60$) and quantity of dead wood in the remnant ($r = 0.86$) were significant indicators of total termite species number. Larger remnants with low quantities of wood supported few termites, however. (5) Rare as well as common species persisted in small remnants. (6) Alate wing-size was a significant indicator of the occurrence of the six most common termite species in remnants ($r = 0.84$).

The implication of isolation effects for rare species with limited powers of dispersal is self-evident, as is the need for the creation of habitat linkages to reduce the effects of spatial isolation on the native fauna.

Inadvertent translocation of amphibians in the shipment of agricultural produce into New South Wales: its extent and conservation implications

TERENCE W. O'DWYER, WILLIAM A. BUTTEMER and DAVID M. PRIDDEL

The recent global decline of amphibians has been as pronounced in Australia as anywhere else on earth. Although the exact causes of this decline are uncertain, the translocation of individuals between populations is likely to exacerbate the problem. Translocation has the potential to adversely affect recipient populations through increased competition, predation, the introduction of diseases and parasites, and by disruption to the integrity of local gene pools through hybridization. One avenue for human-assisted translocation of amphibians is through their inadvertent transportation in shipments of agricultural produce.

It was found that at least 7 130 frogs per annum are translocated into New South Wales in shipments of bananas. Of these, no fewer than 5 044 are subsequently liberated at the point of destination, often deliberately into natural environments where local frog populations already exist. This broad-scale and widespread liberation of translocated frogs has the potential to adversely affect frog populations in New South Wales. We propose several strategies for reducing the conservation problems associated with the inadvertent translocation of wildlife in shipment of agricultural produce.

The avifauna of severely fragmented, Buloke *Allocasuarina luehmanni* woodland in western Victoria, Australia

DAVID M. WATSON, RALPH Mac NALLY and ANDREW F. BENNETT

Buloke *Allocasuarina luehmanni* woodland is an endangered habitat type that was once widespread in southern Australia but now is restricted to a series of remnants, many of which are located in the Wimmera region of western Victoria. The bird communities inhabiting 27 remnants were sampled on transects of 1.0 ha at 6-week intervals over one year. Ninety-five species of birds were observed in Buloke woodlands, of which 66 species were recorded during transect counts. The total species richness, the richness of groups of birds based on their habitat use, and the composition of assemblages on transects, were examined in a series of analyses with respect to habitat type (which probably reflects "quality"), remnant area, shape, isolation and geographic location. There was little evidence for attributes of remnants significantly influencing species richness per transect, but the composition of avifaunal assemblages varied in relation to habitat type, size and geographic location. The Buloke woodlands supported a diverse assemblage, including numerous species believed to be experiencing a regional decline in southern Australia. The composition of the Buloke assemblage has similarities to those of dry eucalypt woodlands across the plains of central Victoria, but elements contributing to a distinctive avifauna include species associated with semi-arid and mallee environments, and a high frequency of occurrence of a group of small insectivores (thornbills, robins) that favour dry She-oak and *Callitris* woodlands. A likely reason for the rich representation of small insectivores in woodland stands, even in small degraded remnants grazed by stock, was the scarcity of the Noisy Miner *Manorina melanocephala* that are often common in eucalypt remnants and known to aggressively exclude other species. The results of this study add weight to the recommendation that protection and restoration of Buloke woodlands is a priority for conservation in the Wimmera bioregion of Victoria.

Thinking honeyeater: nectar maps for the Northern Territory, Australia

JOHN C. Z. WOINARSKI, GREG CONNORS and DON C. FRANKLIN

We create monthly maps of nectar availability for the $1.4 \times 10^6 \text{ km}^2$ jurisdiction of the Northern Territory, Australia. These are based on a combination of vegetation mapping and a series of indices of plant species specific nectar scoring. The maps reveal complex spatial and temporal variation in nectar availability, but most notably a greater nectar resource in the monsoon-influenced north than in the arid south, and a peak in nectar availability in the dry season. The latter is associated with the extensive tropical eucalypt forests (especially those co-dominated by *Eucalyptus miniata* and *E. tetradonta*). In contrast, wet season nectar availability in these forests is limited, but riparian and swampland forests, typically dominated by *Melaleuca* species, provide rich but spatially restricted nectar resources. The extensive and rich nectar resources available in eucalypt forests in the dry season supplement the diets of many species which are not primarily nectarivorous. This resource helps shape the singularity of northern Australian eucalypt forests relative to other extensive forests elsewhere in the world. Nectarivores remain in the system through a combination of movements across a number of scales, habitat shifting, and diet shifting. The latter is aided by the peaking of invertebrate and fruit resources at the times of minimum nectar production; a shuffling in resource availability brought about by the extreme climatic seasonality.

Research Note

Effects of the coastal brown ant *Pheidole megacephala* (Fabricius), on the ant fauna of the Perth metropolitan region, Western Australia

J. E. MAY and B. E. HETERICK

This paper reports on the apparent displacement of native and exotic ants from gardens in the Perth Metropolitan region by the coastal brown ant (*Pheidole megacephala* (Fabricius)). Twelve gardens were sampled, four with *P. megacephala* present, and eight (the controls) where the ant was judged to be absent. Eight out of the 26 ant species recorded (including the coastal brown ant) were introduced. Ninety-two per cent of pitfall trap contents comprised the four most abundant species: *P. megacephala*, *Iridomyrmex chasei* (Forel), *Tetramorium simillimum* (F. Smith) and *Paratrechina ?obscura* (Mayr). Three of the four *P. megacephala*-dominated gardens were depauperate of almost all other ant species. The fourth *P. megacephala*-infested garden had a relatively small number of coastal brown ants (104), and the highest number of ant species was found in that garden. The removal of this outlier garden left an average range of one to three species for the other three *P. megacephala*-infested gardens. Control gardens had between five and 12 ant species. Total ant abundance ranged from an average of 1 027 per *P. megacephala*-infested garden (increasing to 1 171 if the outlier garden is removed) to 146 at control gardens. There was a significant difference both in ant richness and ant abundance between the controls and *P. megacephala*-infested gardens ($P < 0.05$). This remained the case when figures for coastal brown ants were excluded from calculations.

Volume 6 Number 2

Forum Essay

Ecotourism and biodiversity conservation — two way track

PENNY VAN OOSTERZEE

While not denying that tourism has environmental impacts, tourism's potential to aid biodiversity conservation worldwide is great and needs to be harnessed. However, unless precisely explained, the notion of ecotourism clouds the role of tourism in nature conservation. Therefore I define ecotourism as all visits that focus on nature appreciation and the associated infrastructure (park facilities, tours, accommodation, airlines that bring tourists to the area etc.) that supports these visits. This definition, which is used throughout this paper, helps eliminate the false distinction being made between tourism and ecotourism.

Tourism, at the international and national political level, has an influential role as a force for biodiversity conservation by being a rationale for placing extra land in conservation reserves, or otherwise by sustainably managing natural areas for their natural values. Using World Heritage Areas (WHA) as an example — perhaps even as an indicator of tourism and its impacts on natural areas — the little information available suggests that tourism is not often a threat, but that warfare, clearing for agriculture, and poaching are. Regions with an intact tourism industry are also those more likely to have an intact ecosystem.

National parks do act as a catalyst for tourism growth. The question is whether tourism can deliver the financial means to undertake management to neutralize the impacts of tourism on biodiversity, or, perhaps more importantly, to fund more extensive works for biodiversity conservation? Few rigorous economic studies have been carried out to provide

answers to this question; to define the link between biodiversity conservation and tourism, and to explore ways of making tourism maintain and expand the resource on which its profits are based, thus making the industry world-wide a major force for conservation.

Research Papers

Testing methods for mitigation of tree dieback in Tasmanian dry eucalypt forests and woodlands

J. B. KIRKPATRICK, A. ZACHAREK and K. CHAPPELL

Dieback of eucalypts is a widespread phenomenon in subhumid eastern Australian vegetation remnants. It has been shown to have a multifactorial etiology, including drought, vertebrate and invertebrate predation and stock impacts. At three dieback sites in subhumid Tasmania experimental plots were established in the period 1996–1998 to test the single and interactive effects of possum exclusion, watering and stock exclusion on the health of trees, and to determine the influence of fencing on soil bulk density and eucalypt regeneration. At two sites the exclusion of possums mitigated dieback over the two year measurement period, although at one site the trees continued to deteriorate. At the third site there was no impact of any of the treatments, and changes in health over the experimental period related to tree size, indicating a self-thinning process. Soil penetration resistance decreased in the fenced treatment at all sites, and eucalypt regeneration was encouraged by fencing at two sites. Although the results of the experiment are not consistent with moisture deficiencies as a causal factor in dieback, this may relate either to a lack of severe drought during the measurement period, which followed a decade of such drought, or to the magnitude and/or application method of the watering. The results of the experiment indicate that, at some sites, the exclusion of possums will improve tree health, and that the exclusion of stock can improve tree regeneration and soil conditions.

Terrestrial arthropods in a fragmented landscape: a review of ecological research in the Western Australian central wheatbelt

MAX ABENSPERG-TRAUN, GRAEME T. SMITH and BARBARA YORK MAIN

In 1985, CSIRO's Wildlife and Ecology established "The Kellerberrin Project on Fragmented Landscapes", a study to investigate the role of remnant vegetation in sustaining the native biota in Western Australia's central wheatbelt. This paper reviews findings, and other relevant research within the wheatbelt region, with regard to the terrestrial arthropod fauna. We examine critical issues for faunal persistence with regard to disturbance effects on the biota (habitat fragmentation effects of remnant size and spatial isolation (connectivity), livestock and associated exotic weed invasion, altered fire regimes, changes in hydrology, and recolonization of restored habitat), indicators of arthropod species richness at the individual remnant scale, and endemism and taxonomic richness. We provide management recommendations for the conservation of terrestrial arthropods in the Western Australian central wheatbelt and suggest priority research.

Classifying endangered vegetation communities: a case study of Cumberland Plain Woodlands

K. FRENCH, B. CALLAGHAN and S. HILL

Remnants of an endangered community, Cumberland Plain Woodlands on shale, were studied in order to 1) investigate the conflict between the needs of legislation to define parameters of protected communities in a precise manner and the spatial variation in communities, and 2) to define floristic groupings in the Cumberland Plain Woodlands based on all plant species. Sites previously classified as Grey Box Woodland, Grey Box Ironbark Woodland and Spotted Gum Woodland map units were surveyed and compared to the same classification applied by one of the authors. Differences were evident, but both classifications showed statistically significant differences between map units, suggesting that although each classification is valid, the differences between these map units cannot be consistently applied. Canopy species were not useful descriptors of the community as they grouped differently to both the full species list and the understorey species. A significantly different community occurring at the transition between shale and sandstone in Holsworthy Military Area was identified, suggesting the importance of this area to the conservation of variability in communities in this area.

The use of multivariate techniques to describe levels of variation in communities is discussed and a potential method for using a standard level of similarity to classify vegetation communities is introduced as a mechanism for defining communities using some consistent technique.

The use by wildlife of paddock trees in farmland

BRADLEY S. LAW, MARK CHIDEL and GRAHAM TURNER

Morning and dusk watches at live and dead trees were used to systematically investigate which species of vertebrates use paddock trees within farmland proposed for the establishment of *Eucalyptus* plantations in northern New South Wales. Tree-watches at 108 trees were stratified on farmland as isolated, in small patches, remnant vegetation and riparian strips plus in adjacent forest. Arboreal marsupials and bats emerged from hollows in 11% and 8% of trees, respectively. Only one colonial bat roost was observed, although the marsupials *Trichosurus vulpecula* and *Petaurus breviceps* were widespread in the landscape. Two threatened species of marsupials (*Petaurus norfolcensis* and *Phascogale tapoatafa*) were observed using paddock trees on flats or slopes outside of riparian strips. Among owls, only the Southern Boobook *Ninox novaeseelandiae* and Barn Owl *Tyto alba* were observed using tree hollows on farmland. For all hollow-dependent nocturnal fauna (marsupials, bats and owls), very large tree diameter best predicted occupation of a tree-hollow (especially if <800 m from the nearest forest). In addition to providing hollows, paddock trees were used for foraging. Morning surveys revealed 35 diurnal bird species on isolated trees, although most were generalists (e.g., Eastern Rosella *Platycercus eximius*, Noisy Miner *Manorina melanocephala*) that were also regular visitors to non-isolated trees in remnant vegetation. More forest-dependent and forest-associated bird species were recorded in forests and riparian strips than other tree categories, reinforcing the high conservation value of riparian strips in farmland. After dark, ultrasonic detectors recorded 21 species of bat (seven threatened species) flying in close proximity to paddock trees. Relatively high levels of activity were recorded at one study location for species rarely recorded in forests (e.g., *Scoteanax rueppellii*). Remnant *Eucalyptus tereticornis* and *E. amplifolia* were a significant source of blossom for nectarivores and they were also associated with high bat activity, possibly because they grow on fertile soil. Recommendations on tree retention guidelines are discussed.

The ant (Hymenoptera: Formicidae) fauna of coastal heath in south-west Victoria: effects of dominance by *Acacia sophorae* and management actions to control it

R. E. CLAY and K. E. SCHNEIDER

There has been increasing emphasis on the use of ant communities as indicators of recovery during and after minesite rehabilitation. This study also focuses on ants as indicators of recovery but, in this case, assesses the success of active management of coastal heath vegetation.

Remnants of coastal heath near Portland in south-west Victoria are very diverse communities of considerable conservation significance. However, many remnants are suffering a serious loss of plant diversity as they become dominated by the native Coast Wattle *Acacia sophorae*. In an attempt to reverse these declines, heath dominated by Coast Wattle is being actively managed to encourage natural regeneration of diverse heaths. Monitoring of ant communities has documented this regeneration of the vegetation and has attempted to assess the effectiveness of two different management methods, burning and cutting.

Results of pitfall trapping over two years have shown considerable difference in the ant communities of two different intact heath types (the similarity index was a low 0.34). Also clearly illustrated is the detrimental effect that dominance by Coast Wattle has on ant community diversity. The diversity index of intact heath was 0.93 compared to 0.61 and 0.50 for two sites dominated by Coast Wattle. Trapping has also shown improvement in the ant communities following burning or cutting of Coast Wattle. However, our results suggest that complete recovery will require a considerable time and that it is too early to determine the relative effectiveness of different management techniques.

Using biological survey data when selecting Marine Protected Areas: an operational framework and associated risks

M. A. VANDERKLIFT and T. J. WARD

Marine Protected Areas (MPAs) are one of the main tools for protecting marine biodiversity, but they are often selected on the basis of little or no ecological data. As a result, there is a risk that MPAs will not successfully protect marine biodiversity. We propose an operational framework to help prioritize the need for information, and to direct the subsequent collection of appropriate biological data. The framework consists of 7 steps: (1) formulating clearly-defined objectives, (2) a broad-scale classification based on easily accessible surrogates, (3) identifying biological variables for detailed survey, (4) assessing the utility of surrogates, (5) designing and implementing the biological survey, (6) modelling and using inferential statistics to optimize the use of existing knowledge, and (7) validating candidate areas. Each step in the framework involves identifying areas of uncertainty, and the risks that a MPA will fail to achieve its intended objectives. The aim of our operational framework is to make the risks and uncertainties clear, and to force decisions to be made to minimise their potential impact on the outcome of the MPA selection process. We identify four key ecological uncertainties in MPA identification: (1) the reliability of surrogates, (2) spatial uncertainty in survey data, (3) temporal uncertainty in the patterns of the biodiversity in the MPA, and (4) uncertainty in the degree to which important ecological processes will be maintained. We conclude that the key to success in a MPA selection process is the use of clearly specified objectives for the MPA and an explicit assessment of uncertainties involved. We contend that without a competent ecological basis, new MPAs may be little more than the political exercises to appease lobby groups, and are unlikely to be effective tools in protecting marine biodiversity from continuing decay.

RESUMÉ

Les régions marines protégées (MPAs) constituent l'un des principaux outils pour conserver la biodiversité marine, mais elles sont souvent sélectionnées avec trop peu voire aucune donnée écologique. Il y a donc un risque que de telles régions n'atteignent pas leurs objectifs. Nous proposons une méthode opérationnelle pour aider à prioriser les informations nécessaires, et orienter la collection de données biologiques. Cette méthode consiste en sept étapes qui sont les suivantes: (1) formuler clairement les objectifs à atteindre, (2) définir une classification à grande échelle reposant sur des substituts facile à étudier, (3) identifier des variables biologiques spécifiques, (4) évaluer l'utilité des substituts, (5) concevoir et implémenter l'étude biologique, (6) modéliser et utiliser des statistiques afin d'optimiser l'usage des connaissances existantes, et (7) valider les régions candidates. Chaque étape implique pour chaque région l'identification de domaines d'incertitude et les possibilités d'échecs. Le but de cette méthode est de rendre les risques et les incertitudes explicites et de suggérer les décisions qui doivent être prises afin de minimiser leur potentiel à affecter le résultat de la sélection des MPAs. On dénombre quatre domaines d'incertitude biologique: (1) la fiabilité des substituts, (2) l'incertitude spatiale quant aux données collectées, (3) l'incertitude temporelle quant aux modèles de la biodiversité des MPAs, et (4) l'incertitude quant au degré avec lequel les importants processus écologiques seront maintenus. On conclut que les deux clés pour réussir le processus de la sélection des MPAs est l'utilisation d'objectifs clairement définis, et l'évaluation des incertitudes impliquées. On soutiendra que sans une base écologique de qualité, le choix de nouvelles MPAs ne peut être bien plus qu'un exercice politique dont le but est d'apaiser les groupes de pression, et il est improbable que de telles régions deviennent des outils effectifs de protection de la biodiversité marine contre leur continuelle détérioration.

Hector's Dolphin *Cephalorhynchus hectori* calf mortalities may indicate new risks from boat traffic and habituation

GREGORY S. STONE and AUSTEN YOSHINAGA

Two Hector's Dolphin calves *Cephalorhynchus hectori* were killed by probable boat collision in 1999, indicating that boat strikes may pose more of a threat to the species than previously thought. When discovered, one dead calf was still tended by its mother. After recovery, both animals were necropsied with trauma from boat strikes as the most likely cause of death. These deaths are discussed in the context of increasing human contact with Hector's Dolphins in Akaroa Harbour, and risks to the dolphins caused by this habituation.

Science Note

Arthropods on street trees: a food resource for wildlife

SIMRATH BHULLAR and JONATHAN MAJER

Volume 6 Number 3

Review Paper

The effects of non-consumptive wildlife tourism on free-ranging wildlife: a review

RONDA J. GREEN and KAREN HIGGINBOTTOM

Tourism based on free-ranging animals is economically important, but there are no comprehensive studies on the overall balance of its negative and positive effects on wildlife. However, there is a growing body of information on which we can draw for minimizing negative effects and enhancing positive ones. Major categories of negative effects include: direct injury and death; disruption of activities or increase in stress levels; and loss or modification of habitat. About half the published research literature on negative effects involves relatively conspicuous avian species, and there is a need for further research on other taxa. Major categories of positive effects include financial and practical contributions by tourists and tourism operators, economic incentives for wildlife conservation (acting through local communities, the tourism industry and governments) and environmental education. There is far less information on positive than on negative effects, and research is required to examine this quantitatively. However, the evidence suggests there is considerable unrealized potential for wildlife tourism to provide substantial conservation benefits.

Research Papers

Ground vertebrate fauna of Perth's vegetation remnants: impact of 170 years of urbanization

R. A. HOW and J. DELL

Ground vertebrates were surveyed on 34 vegetation remnants on the Swan Coastal Plain within the Perth metropolitan area. The remnants ranged from one hectare to nearly 340 ha and were sampled for at least 50 days during the year using pitfall traps. Six remnants were sampled in two or more successive years. Seven native, non-volant mammal, six introduced mammal, 11 amphibian and 43 reptile species were recorded. Native mammals are the most disadvantaged vertebrates in urban remnants with few species surviving the effects of long-term fragmentation. The herpetofauna is less affected, although snakes are generally rare. Marked annual variation occurred in lizard assemblages recorded on remnants sampled over consecutive years. On average, these remnants had a similarity in species composition of only 77% between years. Small remnants are important for conservation of reptile assemblages and there is a strong correlation between remnant area and species number for all reptile groups, except skinks. Remnants as small as one hectare retain viable populations of many reptiles, but need active management to exclude fire and predation. Regional biogeographic patterns are apparent in reptiles. Subregional patterns on the Swan Coastal Plain are associated with different soil types and the Swan River also creates a barrier across landforms. The diversity of reptile assemblages and variation in species trophic patterns indicate that many elements of the original food chain continue to operate in these urban environments.

Hollow formation in eucalypts from temperate forests in southeastern Australia

P. GIBBONS, D. B. LINDENMAYER, S. C. BARRY and M. T. TANTON

We examined factors associated with the occurrence of tree hollows in four eucalypt species from temperate forest in southeastern New South Wales and East Gippsland. A total of 1 256 standing trees and 328 felled trees was examined. The proportion of trees containing hollows with small entrances (2–5 cm) was significantly negatively associated with dbh, while the proportion of trees containing hollows with medium (5–10 cm) and large (>10 cm) entrances was positively associated with dbh. There was a significant, but weak, relationship between hollow depth and minimum entrance width that was improved with the addition to the model of the variables branch diameter and branch health. Trees of all sizes and ages contained hollows, although larger and older trees had a higher probability of doing so. For two tree species (Brown Barrel or Cuttail *Eucalyptus fastigata* and Messmate *E. obliqua*), the probability of live trees containing hollows remained below 0.5 for stems less than 180 years of age. Unlogged forest supported, on average, 22.0 hollow-bearing trees per ha — 18.5% of which were dead trees. For all values of dbh, trees were more likely to contain hollows if either dead or in poor physiological condition, indicating the potential for hollow development to be accelerated in eucalypts by killing or injuring suitably-sized trees.

Home range and diet of feral cats in Hawaii forests

TY D. SMUCKER, GERALD D. LINDSEY and STEPHEN M. MOSHER

Feral cat *Felis catus* home range in a Hawaiian montane wet forest and their diet in three habitats — montane wet forest, subalpine dry forest, and lowland dry forest — were determined to provide baseline ecological data and to assess potential impacts to native terrestrial fauna. Seven cats (three males and four females) were captured in 624 trap nights. Mean weight of adult cats was 2.85 ± 0.27 (SE) kg for males and 1.87 ± 0.03 kg for females. Mean diurnal home range using the adaptive kernel method was 5.74 ± 2.73 km² for three males and 2.23 ± 0.44 km² for two females. Daytime locations were always within the montane wet forest with the borders on one or more sides of the home ranges of all cats defined by open grassland pastures. Rodents comprised the majority of the cat diets in all three habitats, with the frequencies of occurrence between 0.88 and 0.91. Bird remains were a regular component of the diet of cats, with montane wet forest having the highest frequency of occurrence (0.68), followed by subalpine dry forest (0.53), and lowland dry forest (0.21).

The effective management of threatened flora: lessons from the case of *Zieria 'prostrata' ms*

PATRICIA M. HOGBIN and ROD PEAKALL

The endangered plant *Zieria 'prostrata' ms* is known from only four headlands along three kilometres of the north coast of New South Wales, Australia. Given its restricted range and small population sizes, *Zieria 'prostrata'* has been the subject of extensive management and research for almost a decade. In this paper, we review the history of management and research actions undertaken on *Z. prostrata* and evaluate their practical outcomes. By revisiting past management and research actions, and assessing their outcomes, we can learn much about the effective management and recovery of threatened flora. This review highlights five valuable lessons. First, effective survey is a priority for many rare plants. Second, accurate information and documentation are essential for effective conservation. Third, critical evaluation of the need for ex-situ conservation is necessary. Fourth, critical evaluation of the need for population enhancement and the most effective methods by which this can be achieved is a high priority. Fifth, adequate guidance of all those involved in recovery implementation is vital.

Is the removal of domestic stock sufficient to restore semi-arid conservation areas?

MANDA J. PAGE and R. J. S. BEETON

Increasingly, conservation areas are proclaimed in non-pristine environments that have biodiversity values and the issue of how to change the management regime to restore such landscapes arises. Before gazettal in 1992, Currawinya National Park (28°52'S, 144°30'E) in south-west Queensland's mulga lands was grazed by domestic stock for over 130 years. Following gazettal, the area was destocked and a monitoring programme initiated to determine the response by the vegetation. This paper describes the grass dynamics in three vegetation communities on Currawinya National Park with three different grazing regimes. Data are presented for an on-park site (native and feral herbivores present), an off-park site (domestic, native and feral herbivores were present), and an enclosure (no mammalian herbivores present). The results show that removal of domestic livestock alone is not sufficient to promote rapid recovery of grass populations, and suggest that conservation area managers must reduce native herbivore numbers as well if the desired outcome is a return to the supposed "natural" condition.

Clearing and grazing impacts on vegetation patch structures and fauna counts in eucalypt woodland, Central Queensland

JOHN A. LUDWIG, ROBERT W. EAGER, ADAM C. LIEDLOFF, JULIANA C. McCOSKER,
DAVID HANNAH, NICOLE Y. THURGATE, JOHN C. Z. WOINARSKI and CARLA P.
CATTERALL

There is national and international concern that tree clearing and cattle grazing reduce habitat for native fauna. In this paper we quantify how the degree of clearing and the level of grazing change the patch structure and composition of vegetation in eucalypt woodlands, and how these habitat changes affect counts for 10 species including birds, reptiles and small mammals. These species were selected because they were abundant, hence providing the data needed for ordinations and regressions. We studied 37 sites occurring in two regions of central Queensland: Blackwater/Emerald and Alpha/Jericho. On each site, indices for the degree of tree clearing and the level of livestock grazing were assessed, the cover and size of tree groves, shrub thickets, log hummocks, termite mounds and perennial grass clumps were measured, and abundances of 10 common vertebrate species were estimated. As expected, the cover and size of tree groves declined and the cover of grass clumps increased as the degree of clearing increased. Native grass composition changed to introduced Buffel Grass as the level of grazing increased. Clearing affected fauna counts more than grazing did. The Grey Butcherbird *Cracticus torquatus*, Yellow-throated Miner *Manorina flavigula*, Striated Pardalote *Pardalotus striatus* and Pale-headed Rosella *Platycercus eximius* had significantly lower counts on cleared sites, but the Red-backed Fairy-wren *Malurus melanocephalus* had higher counts. The introduced House Mouse *Mus musculus* also had higher counts on cleared sites, but Carnaby's Skink *Cryptoblephrus carnabyi* had lower counts. Counts of the Weebill *Smicromis brevirostris*, Bynoe's Gecko *Heteronotia binoei* and the Delicate Mouse *Pseudomys delicatulus* did not significantly change with clearing. Counts for the Pale-headed Rosella increased as the level of grazing increased, but counts for the other fauna species did not significantly change with our grazing index. Except for Bynoe's Gecko, fauna counts significantly changed with various vegetation patch attributes, particularly those strongly affected by clearing. From these results, we know which of the 10 fauna species are likely to decline or increase with clearing and grazing, and this knowledge can be used by land managers.

Volume 6 Number 4

Special Section

The BioRap Biodiversity Assessment and Planning Study for Papua New Guinea

DANIEL P. FAITH, H. A. NIX, C. R. MARGULES, M F. HUTCHINSON, P. A. WALKER, J. WEST,
J. L. STEIN, J. L. KESTEVEN, A. ALLISON and G. NATERA

Practical application of biodiversity surrogates and percentage targets for conservation in Papua New Guinea

DANIEL P. FAITH, C. R. MARGULES, P. A. WALKER, J. STEIN and G. NATERA

A conservation planning study in Papua New Guinea (PNG) addresses the role of biodiversity surrogates and biodiversity targets, in the context of the trade-offs required for planning given real-world costs and constraints. In a

trade-offs framework, surrogates must be judged in terms of their success in predicting general biodiversity complementarity values — the amount of additional biodiversity an area can contribute to a protected set. Wrong predictions of low complementarity (and consequent allocation of non-protective land uses) may be more worrisome than wrong predictions of high complementarity (and consequent allocation of protection, perhaps unnecessarily forgoing other land uses benefiting society). Trade-offs and targets work well when predictions of complementarity are based on surrogate information that is expressed as a continuum of variation. The PNG study used hierarchical variation for environmental domains and vegetation types, and a nominated target then dictated the level within those hierarchies that was used. Internationally-promoted targets provide a potential basis for comparative evaluation of biodiversity protection levels among countries or regions. However, conventional application of percentage targets, in focusing on proportions of total area or on proportions of habitat types, does not serve the goal of biodiversity protection or sustainability well because targets can be miss-used to restrict the amount of biodiversity protected. At the same time, recent complaints about percentage targets are equally misguided in claiming, based on species-area curves, that 10% targets imply 50% extinctions. We apply a new approach to percentage targets in PNG, in which the maximum diversity that could be protected by an unconstrained 10% of the total area of the country becomes the working biodiversity target. Reaching that same biodiversity target may then require more than 10% of the area, because of constraints (e.g., existing reserves) and costs. In the baseline analysis for PNG, we found that hierarchical variation at the level of 564 vegetation types, combined with the 608 environmental domains, could be protected in an unconstrained 10% of the country. This process of determining a biodiversity target also revealed some “must-have” areas for any future conservation plan. Such must-have areas were also identified for a 15%-based target. The satisfaction of the 10%-based target in practice required 16.8% of PNG (Faith *et al.* 2001a). This low-cost proposed protected set corresponded to greater net benefits relative to our application of two conventional targets approaches.

A biodiversity conservation plan for Papua New Guinea based on biodiversity trade-offs analysis

DANIEL P. FAITH, C. R. MARGULES and P. A. WALKER

A rapid biodiversity assessment (“BioRap”) project identified candidate areas for biodiversity protection in Papua New Guinea (PNG) and provides an ongoing evaluation framework for balancing biodiversity conservation and other land use needs. Achieving a biodiversity protection target with minimum opportunity cost was an important outcome given that biodiversity values overlap with forestry production values, and high forgone forestry opportunities would mean significant losses to land owners and the government. Allocation of 16.8% of PNG’s land area to some form of biodiversity protection was required, in order to achieve the level of biodiversity representation/persistence that would have been possible using only 10% of the land area if there were no constraints on land allocation and no land use history. This result minimizes potential conflict with forestry production opportunities while also taking account of land use history, human population density and previous conservation assessments. The analysis provides more than a single set of proposed priority areas. It is a frame work for progressively moving towards a country-wide conservation goal, while at the same time providing opportunities to alter the priority area set in light of new knowledge, changes in land use, and/or changes in economic and social conditions.

Some future prospects for systematic biodiversity planning in Papua New Guinea — and for biodiversity planning in general

DANIEL P. FAITH, P. A. WALKER and C. R. MARGULES

We describe three challenges for biodiversity planning, which arise from a study in Papua New Guinea, but apply equally to biodiversity planning in general. These are 1) the best use of available data for providing biodiversity surrogate information, 2) the integration of representativeness and persistence goals into the area prioritization process, and 3) implications for the implementation of a conservation plan over time. Each of these problems is linked to the effective use of complementarity. Further, we find that a probabilistic framework for calculating persistence-based complementarity values over time can contribute to resolving each challenge. Probabilities allow for the exploration of a range of possible complementarity values over different planning scenarios, and provide a way to evaluate biodiversity surrogates.

The integration of representativeness and persistence goals, via estimated probabilities of persistence, facilitates the crediting of partial protection provided by sympathetic management. For the selection of priority areas and land use allocation, partial protection may be a “given” or implied by an allocated land use. Such an integration also allows the incorporation of vulnerability/threat information at the level of attributes or areas, incorporating persistence values that may depend on reserve design. As an example of the use of persistence probabilities, we derive an alternative proposed

priority area set for PNG. This is based on 1) a goal of 0.99 probability of persistence of all biodiversity surrogate attributes used in the study, 2) an assumption of a 0.10 probability of persistence in the absence of any form of formal protection, and 3) a 0.90 probability of persistence for surrogate attributes in proposed priority areas, assuming formal protection is afforded to them.

The calculus of persistence also leads to a proposed system of environmental levies based on biodiversity complementarity values. The assigned levy for an area may change to reflect its changing complementarity value in light of changes to protection status of other areas. We also propose a number of complementarity-based options for a carbon credits framework. These address required principles of additionality and collateral benefits from biodiversity protection. A related biodiversity credits scheme, also based on complementarity, encourages investments in those areas that make greatest ongoing contributions to regional biodiversity representation and persistence. All these new methods point to a new “systematic conservation planning” that is not focused only on selecting sets of areas but utilizes complementarity values and changes in probabilities of persistence for a range of decision making processes. The cornerstone of biodiversity planning, complementarity, no longer reflects only relative amounts of biodiversity but also relative probabilities of persistence.

Research Paper

Pollination and breeding system of a population of Tall Coconut Palm *Cocos nucifera* L. (Areaceae) on the Gazelle Peninsula of Papua New Guinea

G. R. ASHBURNER, M. G. FAURE, E. A. JAMES, W. K. THOMPSON and G. M. HALLORAN

Tall Coconut Palms *Cocos nucifera* L. on the Gazelle Peninsula of Papua New Guinea are almost exclusively (96.3%) insect pollinated. Pollination is most likely to occur in the late afternoon when the number of insect visitors to pistillate flowers increases. Two species of halictid bees, *Homalictus cassiaefloris* and *H. dampieri*, are most likely responsible for most of the pollination. On Gazelle Peninsular Coconut Palms, the pistillate receptive phase partially overlaps with the staminate phase in the subsequently produced inflorescence, and on average 27.8% of fruits are a result of self-fertilization, indicating a mixed breeding system. The self-fertilization rate varies between individuals and with time of the year, and is related to the degree of fertile staminate and pistillate phase overlap between inflorescences. The flexibility in the breeding system appears to confer potential adaptive flexibility on Coconut Palms because they are able to self-pollinate if individuals become established in areas devoid of other Coconut Palms.

Pacific Conservation Biology

**Order Form and Subscription information appears at the end of this document —
please complete and return it to Surrey Beatty & Sons**

Volume 7 Number 1

Research Papers

A direct comparison of trapping and spotlight searches for capturing Brown Tree Snakes on Guam

R. M. ENGEMAN and D. S. VICE

Brown Tree Snake populations on Guam are controlled in the vicinities of cargo staging and transport areas to prevent their dispersal from Guam, and their populations are controlled in areas where endangered species are to be reintroduced. Trapping and night-time spotlight searches of fences are the two primary Brown Tree Snake population reduction methods used on Guam. We conducted a three month study comparing Brown Tree Snake captures by spotlighting fences to captures by trapping. Traps were placed either on the edge of the forest paralleling the fences, or

they were hung on the fences. Applications of each capture method followed the standard practices used within the operational programme charged with deterring the spread of Brown Tree Snakes from Guam. We found captures by trapping to exceed those by spotlighting each month, but the captures by trapping decreased substantially over time, while those by spotlighting did not. We detected no differences statistically between numbers of captures taken by traps hung on the forest edge versus those hung on the fences. We found no differences in sizes of Brown Tree Snakes captured by spotlighting and trapping, based on average snout-vent length (SVL) or the distribution of SVLs. We feel that the two capture methods complement each other in an integrated pest management programme.

Seasonal and landscape differences in the foraging behaviour of the Rufous Treecreeper *Climacteris rufa*

GARY LUCK, ANNE CHARMANTIER and PAULINE EZANNO

The insectivorous Rufous Treecreeper *Climacteris rufa* has declined in abundance in the agricultural regions of southwestern Australia. Examining its foraging behaviour is fundamental to identifying important foraging resources and how landscape change (e.g., fragmentation and disturbance) may affect foraging effectiveness. We studied seasonal and landscape differences in the foraging behaviour of the treecreeper in the wheatbelt of Western Australia. Foraging data were collected in autumn and winter in a large, unfragmented landscape and in a highly modified agricultural landscape (winter only) with grazed and ungrazed woodland patches.

The ground layer was the most common foraging location used by the species, although there were seasonal differences in foraging behaviour in the unfragmented landscape. In autumn, treecreepers foraged primarily on trees (56% of observations) with a shift to mostly ground foraging in winter (72–74%). The species also preferentially foraged on larger trees. Foraging behaviour differed between the two landscapes within the same season. Treecreepers foraged less on the ground in the agricultural landscape (52%), but this difference is attributed mainly to the low percentage of ground foraging in ungrazed (43%) compared to grazed (60%) patches.

In winter and early spring, the ground layer is an important foraging substrate for the Rufous Treecreeper and other woodland birds. Changes to the ground layer and associated invertebrate communities through habitat disturbance (e.g., weed invasion) may be detrimental to the foraging effectiveness of ground-foraging insectivores. This is a potential contributing factor to the decline of these species in the agricultural regions of southern Australia.

Conservation of wetlands in the Paroo and Warrego River catchments in arid Australia

RICHARD T. KINGSFORD, RACHAEL F. THOMAS and ALISON L. CURTIN

Irrigation proposals to divert water from the Paroo and Warrego Rivers in arid Australia will affect their aquatic ecosystems. These two are the last of 26 major rivers in the Murray-Darling Basin without large dams and diversions. Knowledge of the extent of their biodiversity value is critical to assessing likely impacts. During the 1990 flood, 1.73 million ha of wetlands, or 12.5% of the land surface of the Paroo and Warrego River catchments, were flooded. Flooded wetland area in the respective catchments was 781 330 ha and 890 534 ha. Most of the wetland area (97%) was floodplain, with 37 freshwater lakes (>50 ha) occupying 2.5% of the wetland area and 177 salt lakes covering 0.8%. A high diversity and abundance of biota depend on these wetlands. Only 7% of the wetland area, all in the Paroo catchment, is in conservation reserves. New South Wales has a high proportion of the wetland area on the Paroo (60%) and a substantial proportion of the wetland area on the Warrego River (23%). Queensland, the upstream state, will influence the ecology of the entire catchment areas of both river systems through its proposed water management plan. Any resulting extraction practices will have detrimental ecological consequences within a decade. Conservation of wetlands is usually site-focused and reflects a paradigm of conservation based on reservation of parcels of land. However, wetlands are dependent on water that is seldom adequately protected. Intergovernment co-operation should protect the entire catchment of the Paroo River from major diversions and stop further development on the Warrego River. This would do more for the conservation of wetlands than the formal reservation of small parts of their catchments.

Community characteristics, species diversity and management of middle-mountain moist evergreen broad-leaved forest in the Ailao Mountains, Southwestern China

WEN YAO LIU, JOHN E. D. FOX and ZAI FU XU

Middle-mountain, moist, evergreen broad-leaved forest is an important forest type of Yunnan Province, SW China. Species composition, vegetation structure, physiognomy, diversity and phenology of this forest in Ailao Mountain were surveyed. The forest has characteristics common to subtropical, evergreen broad-leaved forest elsewhere in China. It also has local features associated with the middle-mountain location at lower latitude and higher altitude, including relatively high humidity and mild temperatures all year. The forest is dominated by species unique to Yunnan. There is a well-developed bamboo layer, fewer megaphanerophytes, more microphylls, more lianas and more epiphytes than in other subtropical evergreen broad-leaved forests. Floristically, elements of tropical, temperate and endemic flora comprise 54, 43 and 3% of the genera, while tropical, temperate and endemics account for 22, 38 and 40% of the species in the forest. Two-thirds of the trees and shrubs have leaves with drip tips in varying degree. The phenological rhythm of the forest is similar to that of a tropical forest, with plants flowering and bearing fruits almost throughout the year. Species diversity is richer than that of other evergreen broad-leaved forests in central Yunnan. Some management strategies and priorities for this forest are suggested.

The influence of recent changes in public sector management on biodiversity conservation

DR JO ANN BECKWITH and DR SUSAN A. MOORE

Over the last 15 years increasing emphasis has been placed worldwide on biodiversity conservation. During the same period, the public sector which carries much of the responsibility for biodiversity conservation has experienced, in OECD countries, a revolution in management practices. *Managerialism* has emerged, modeled on private sector philosophies including economic efficiency and accountability. Managerialism and an increased emphasis on biodiversity conservation have occurred over the same period, however, the links have not been investigated. This paper explores the influences of managerialism on biodiversity conservation in three Western Australian state public sector agencies: the Department of Conservation and Land Management; Water and Rivers Commission; and Water Corporation.

Each of the agencies has embraced managerialism in a different way, modifying elements to match organizational mandates. All have become conscious of managing political risk. Other managerialist influences include increased emphases on contracting, strategic planning and performance reporting. Understanding managerialism helps managers and researchers manage the socio-political environment to achieve desired outcomes, in this case biodiversity conservation. Managerial skills such as diplomacy, administration, decision making and leadership are essential if managers and researchers are to influence decision making and progress through agencies, given that technical expertise is no longer sufficient.

The reproductive biology and diet of sea snake bycatch of prawn trawling in northern Australia: characteristics important for assessing the impacts on populations

G. C. FRY, D. A. MILTON and T. J. WASSENBERG

Trawlers catch up to 17 species of sea snake as bycatch in the Northern Prawn Fishery (NPF) in northern Australia. We examined the biological characteristics of 660 sea snakes caught by research, scientific observer and commercial vessels between 1986 and 1998 as part of a project to assess their vulnerability. Three species accounted for more than 75% of the total sea snakes caught. *Hydrophis* species were more common in unstructured habitats close to prawn trawling grounds, while *Aipysurus* species were the dominant species in areas having reef structure. Sea snakes were caught more frequently at night on commercial trawlers and even more were caught during the day by research trawling. Female sea snakes were caught more often than males for 10 out of 13 species examined. The proportion of mature sea snakes in trawl catches was high (67% males, 89% females). Juvenile sea snakes of most species are not caught suggesting there is little impact of trawling on recruits. We found all species breed annually, producing a few large young after a gestation period of 6–7 months. Litter size varied between 1 to 20 and young of most species were born during the NPF closed season (Nov-Mar). Except for *Aipysurus duboizii*, *Disteira major* and *Hydrophis ornatus*, pregnant females of most species were not more catchable by prawn trawls than non-pregnant females. The relative clutch mass had little effect on the catchability of pregnant females. Most sea snake species had a specialized diet, feeding on one to four benthic fish species and did not appear to be attracted into trawl grounds by the increased availability of discarded bycatch. Their reproductive characteristics mean that populations of many species caught by trawlers in northern Australia are potentially vulnerable.

Volume 7 Number 2

Research Papers

Community survey of the distribution of Lumholtz's Tree-kangaroo on the Atherton Tablelands, north-east Queensland

J. KANOWSKI, L. FELDERHOF, G. NEWELL, T. PARKER, C. SCHMIDT, B. STIRN,
R. WILSON and J. W. WINTER

Lumholtz's Tree-kangaroo *Dendrolagus lumholtzi* is endemic to the rainforests of north Queensland, Australia. Most records of *D. lumholtzi* are from upland forests on the Atherton Tablelands, an area extensively cleared for agriculture. In 1997, residents of the Tablelands formed the Tree Kangaroo and Mammal Group Inc. (TKMG) with the aim of promoting the conservation of the species. The first project of TKMG was an intensive community-based survey of the distribution of *D. lumholtzi*. Residents of all postal districts encompassing areas of upland rainforest within the range of *D. lumholtzi* were sent a written questionnaire seeking details of tree-kangaroo sightings. The Malanda postal district was surveyed in 1998 while all other postal districts were surveyed in 1999. In total, 10 122 questionnaires were distributed in the survey. "Nearly 800 responses were received to the survey, providing 2 368 sighting records of *D. lumholtzi*. Of these, 367 records were of dead tree-kangaroos, mostly road-kills." The survey has provided a much more comprehensive account of the distribution of the species than was previously available. Most records of *D. lumholtzi* obtained in the survey were from upland forests between Atherton and Ravenshoe, particularly remnant forests in the central and western Tablelands. Although the survey methodology is biased towards areas frequented by humans, these patterns are consistent with independent surveys. The conservation of *D. lumholtzi* on the Tablelands would benefit from the protection of remnant forests, the restoration of habitat and a reduction in the incidence of road-kills and dog attacks on tree-kangaroos.

Testing for food limitation in reintroduced Hihi populations: contrasting results for two islands

DOUG P. ARMSTRONG and JOHN G. EWEN

The Hihi *Notiomystis cincta*, a New Zealand honeyeater (Aves: Meliphagidae), became extinct everywhere except one offshore island following European colonization. Attempts to establish Hihi on additional islands in the 1980s had poor success, and this was attributed to food limitation. These islands had all been modified by human use, and had a lower diversity of natural carbohydrate (fruit and nectar) sources than the source island, particularly in winter. When Hihi were released on two additional islands, Mokoia and Tiritiri Matangi, we used supplementation experiments to test whether condition and survival of birds were limited by availability of carbohydrate food. Sugar water was provided on an on-off basis from autumn through spring in the year after the release. Birds were weighed at the beginning and end of fed periods, and survival for fed and unfed periods was estimated using mark-recapture analysis on sighting data. Armstrong and Perrott (2000) reported that supplementary feeding had no effect on condition or survival on Mokoia, and annual survival was about 40%, both in the year of the experiment and in subsequent years when food was supplied continuously. This paper reports contrasting results for Tiritiri Matangi. Supplementary feeding on Tiritiri Matangi increased both condition and survival, and overall survival was substantially higher than on Mokoia — 66% in the year of the experiment and 76% the following year when food was supplied continuously. It therefore appears that supplementary feeding can be used to improve survival of Hihi on Tiritiri Matangi, whereas survival is constrained to a low level by other factors on Mokoia. These results emphasize the value of habitat manipulation experiments for developing appropriate management strategies for reintroduced populations.

Case history studies of the effects of vegetation succession and fire on the moth *Fraus simulans* (Lepidoptera, Hepialidae) and its food plant, the sedge *Ecdeiocolea monostachya* (Ecdeiocoleaceae) in the Western Australian Wheatbelt: implications for retention of biodiversity

A. R. MAIN

Field observations of the effects of succession of vegetation, grazing by the moth *Fraus simulans* on the sedge *Ecdeiocolea monostachya* in a long unburnt area, the post-fire survival and regeneration of established tussocks and the survival of seedlings germinating in the first winter following burning are presented. There was considerable post-fire mortality of the established tussocks and in only one of the three areas burnt did any of the seedlings survive successive summer droughts. Surviving seedlings did not replace the tussocks killed by the burning. The possible effects of fire, drought and insect grazing on the biotic composition of small reserves are discussed. It is suggested that the

information presented provides a basis for a formal decision process for risk assessment when managing reserves for retention of biodiversity and fire hazard reduction.

Biodiversity of canopy arthropods in Jarrah forest of south-west Western Australia: review of ecological theory and conservation management

IAN ABBOTT and ALLAN WILLS

A theory proposed in 1996 by Recher, Majer and Ganesh linking biodiversity of forest canopy arthropods to site productivity is analysed. Available evidence from Jarrah *Eucalyptus marginata* forest is inconsistent with this model. We instead propose that increased habitat variety and temperature and rainfall clines are the major environmental factors that determine canopy arthropod species richness. Biodiversity gradients for mammal, landbird and reptile species across south-west Western Australia appear to provide an appropriate model for forest insect faunas. These gradients predict that the most diverse canopy fauna should occur in the eastern Jarrah and Wandoo forests.

Precautionary forest management policies and procedures currently in place to conserve the poorly collected and inadequately known arthropod fauna of tree crowns in Jarrah forest are summarized and discussed. In essence, these maximize habitat diversity at landscape scales. Major conservation threats are considered to be factors that reduce leaf area at large spatial (*Phytophthora* infection) and temporal scales (summer wildfire and defoliating insect outbreaks). Logging is not considered significant because it is constrained to small spatial scales (10 ha for the most extreme treatment) and long return times (2–3 decades).

***Prostanthera junonis* Conn (LAMIACEAE); is recovery possible?**

D. A. TIERNEY and C. L. GROSS

Prostanthera junonis is an endangered plant from the Somersby plateau west of Gosford, New South Wales. Most populations occur in sites modified by clearing or adjacent to developments. This paper examines the current status and recovery efforts for this species in the light of research to date.

Studies undertaken indicate that the species has the reproductive ecology expected of a colonising species. Autogamy, a low pollen/ovule ratio, higher seed set in open sites compared with densely vegetated sites, clonal growth, a long flowering period and flowering by young plants were recorded for the species. It is predicted that these reproductive traits should help the population recover from clearing.

Comments on recovery planning are made.

Ecological attributes and conservation of dasyurid marsupials in New South Wales, Australia

CHRISTOPHER R. DICKMAN, DANIEL LUNNEY and ALISON MATTHEWS

This paper outlines the status of dasyurid marsupials in New South Wales, Australia, and then compares the ecological attributes of threatened and non-threatened species. Of the 21 species recorded in the state since European settlement, eight are protected but not threatened, 10 are listed or proposed for listing as vulnerable or endangered, and three are presumed extinct. Status was not related to diet, habit or habitat. However, species weighing <35 g are less likely to be threatened than heavier species, while species occupying a single region are more likely to be threatened than species occurring in two or more regions. All vulnerable and endangered species occur at least partly in reserves and other areas of protected land, but are likely to be affected by one or more threatening processes. These processes differ regionally, with larger species (≥ 175 g) being affected by a greater range of threats than very small species (<15 g). We propose a programme of survey, research, management and education to promote and sustain recoveries.

Abundance and management of Mariana Fruit Bats and feral ungulates on Anatahan, Mariana Islands

DAVID J. WORTHINGTON, ANN P. MARSHALL, GARY J. WILES and CURT C. KESSLER

A survey of Mariana Fruit Bats *Pteropus mariannus* and feral ungulates was conducted on Anatahan, Mariana Islands, in July 1995. We estimated that a population of 1 902–2 136 bats persists on the island, based on a combination of direct colony counts, departure counts, and station counts of non-colonial animals. Our data suggest that bat numbers have declined since the last surveys were made in 1983 and 1984. We located seven colonies, which held approximately 85–92% of the total population. Most colonies and foraging animals were associated with native forest or isolated native trees in other habitats. Bats fed on five species of plants, with the fruit of *Pandanus tectorius* eaten most frequently. Anatahan supports a very large Feral Goat *Capra hircus* population estimated at roughly 5 000–6 000 animals. Feral Pigs *Sus scrofa* are less common. Both species cause severe damage to plant communities of the island. We recommend that a legal hunting programme for fruit bats be deferred until 1) population censuses on neighbouring islands are completed and it is determined that bat populations can sustain harvesting, 2) habitat degradation is reversed through the control of feral animals, and 3) illegal hunting is curtailed.

Research Note

Field evaluation of a visual barrier to discourage gull nesting

P. A. POCHOP, J. L. CUMMINGS and R. M. ENGEMAN

Expanding gull populations along the Columbia River have been implicated in depredations to threatened and endangered migrating salmon smolt. We tested a visual barrier made of woven black polypropylene fabric to discourage gull nesting. The barrier was installed on Upper Nelson Island, Benton County, Washington, in parallel rows spaced 5 m apart. Gulls used 87% of the 7.9 ha island as nesting habitat and we estimated >21 000 gull nests, 80% Ring-billed Gull *Larus delawarensis* and 20% California Gull *L. californicus* nests. The zone with fencing had 84% fewer nests than the control zone. Silt fencing showed potential as a nonlethal bird management technique.

Volume 7 Number 3

Viewpoint

The conflict between animal welfare and conservation

GRAHAM R. FULTON and HUGH A. FORD

Research Papers

The Pied Currawong's role in avian nest predation: a predator removal experiment

GRAHAM R. FULTON and HUGH A. FORD

Pied Currawongs *Strepera graculina* have been implicated as a major threat to the persistence of small passerines in urban and rural landscapes through their intense nest predation while raising their young. Pied Currawongs have recently increased in abundance and colonized new areas, due to the planting of exotic berry-bearing trees and shrubs. In association with habitat fragmentation, this may have intensified their predatory impact. We measured the rate of predation on 416 artificial nests, using quail and plasticine eggs, in a 240 ha remnant of eucalypt woodland. Nests were placed in one grid from which Pied Currawongs were removed and in one control grid. The level of predation was monitored before and after Pied Currawong removal. Overall, nest predation was extremely high with 91% of all nests

preyed upon in seven days. Moreover, nest predation decreased significantly following Pied Currawong removal, thus identifying them as significant nest predators. However, imprint evidence from plasticine eggs and the remains of real eggs indicate that other animals, particularly other birds, are also important predators. If this high level of nest predation is reflected in real nests and occurs over a number of years, it may lead to low recruitment of open-nesting birds at this site. If it occurs regionally, it could contribute to long term declines of these species. Our findings suggest that even quite large woodland fragments may be too small to sustain many declining bird species.

Culture, commerce, and international co-operation in the global recovery of Polar Bears

MILTON M. R. FREEMAN

About thirty years ago, Polar Bears were considered to be severely depleted over most of their international range. In 1973, the five range states signed an international treaty that allowed continued hunting and sale of skins by some customary users whose subsistence had historically involved commercial trade in the products of the hunt. There have been multiple benefits associated with this continued consumptive use, including Polar Bear population recovery throughout the species extensive range, enhanced international research and management co-operation, progressive involvement of the user communities in management initiatives, and excellent regulatory compliance. This successful regional and international conservation programme provides a model for managing other highly migratory (and difficult to monitor), culturally and commercially valuable species.

Impacts of agricultural land use on the floristics, diversity and life-form composition of a temperate grassy woodland

S. D. HAMILTON

This opportunistic study examines the impacts of cropping and grazing management on a eucalypt grassy woodland in northern Victoria. The woodland is an area of uniformity in abiotic attributes, and with significant anecdotal similarity in pre-European floristic composition and abundance. Permanent vegetation quadrats were established within the now named Dookie Bushland Reserve, a 270 ha remnant of White and Grey Box grassy woodland located at Dookie College in northern Victoria. Density and cover for all species, as well as life form type, were evaluated within quadrats in 1992, when agricultural land uses ceased and conservation management was instigated.

Results indicate that agricultural impact over a 27 year period had contributed to significant declines in the number and cover of indigenous species, and had resulted in the significant increase in the number and cover of introduced species. The loss of shrub species, juvenile eucalypts, and the dominance of tussock-forming indigenous grasses with increased agricultural impact was observed. Individual species responded differently to increased agricultural impacts. Some species, particularly non-tussock forming indigenous grasses and introduced annuals, were promoted in establishment and cover by increased impact, while others, most notably Orchidaceae and Liliaceae, were intolerant of any impact. Certain groups of indigenous species, particularly the Asteraceae and tussock forming indigenous grasses, were reduced significantly in cover by increasing impact. Grazing increased proportions of therophytic (annuals) and/or hemicryptophytic (rosette-forming) forbs, while lesser impacted sites contained a greater diversity of forbs, greater evenness across life form types, and greater proportions of perennial phanerophytes, chamaephytes and cryptophytes, and with fewer therophytes.

Cattle, mining or fire? The historical causes of recent contractions of open forest in the wet tropics of Queensland through invasion by rainforest

ROSEMARY HILL, DERMOT SMYTH, HARRY SHIPTON and PETER FISCHER

Changes to Aboriginal fire regimes since European occupation are thought to have affected the range and demographic structure of many vegetation communities. This study shows a contraction by 49% of the area of fire-prone open forest through rainforest invasion between 1945 and 1991–94 in the northern wet tropics of Queensland, Australia. Relative Growth Rates (RGR) for open forest areas varied from -0.112 to -0.005. Collaborative historical research with the Aboriginal traditional owners, the Kuku-Yalanji people, investigated possible linkages with alterations to their fire practices. A multiplicity of human impacts is associated with the measured vegetation change, including clearing for agriculture and mining, logging for timber and firewood, and the introduction of cattle and horses. Some rainforest expansion since 1945 represents a recovery following clearing from earlier mining operations.

Contraction of open forest through rainforest invasion was most rapid (RGR = -0.124) where there was a continuation of Aboriginal fire management with cattle grazing. The contraction of open forest was nine times slower in an ungrazed area (RGR = -0.005) than in a nearby area grazed by horses (RGR = -0.045). Aboriginal fire regimes may act synergistically with cattle or horse grazing to accelerate the invasion of rainforest into open forest. Management prescriptions currently focus on active fire management to prevent further open forest contraction. However, fire management may have unexpected outcomes when rainforest-open forest dynamics are complicated by recent historical factors such as cattle grazing, logging, and tin mining, and possible synergies between these factors and fire regimes. Managers need to understand the histories of particular sites when formulating plans, and monitor the consequences of their actions to enable an adaptive approach.

Abundance and decline of isolated trees in the agricultural landscapes of central New South Wales, Australia

AMANDA OZOLINS, CRIS BRACK and DAVID FREUDENBERGER

Prior to this study, isolated trees were largely isolated from research. This study has provided a methodology, rigorous assessment of isolated tree density and distribution, and identified the potential ecological, social and economic importance of isolated trees, in a relatively small, but probably typical area of the wheat-sheep zone of eastern Australia. The abundance and decline of isolated native trees was measured by line-intersect sampling in the highly fragmented agricultural landscapes of the mid-Lachlan Valley of central New South Wales, Australia. A total of 7 000 trees were sampled along 5 678 km of transect on 441 aerial photographs. An isolated tree was defined as having no neighbouring tree within 25 m. The density of trees outside of remnant patches is low (0.3/ha) and has generally declined by 20% since the 1960s. The 1990s density of isolated trees equates to 275 000 trees across 830 000 ha of agricultural land not occupied by remnant vegetation patches larger than about 10 ha. The density of isolated trees was found to vary with land use with consistently fewer trees in cultivated areas compared to areas with no traces of cultivation. The isolated trees that remain within the agricultural landscape are not uniformly scattered. They exist as widely spaced clusters of isolated trees with 50% of trees having a nearest neighbouring tree within 25–49 m and less than 10% of trees had a nearest neighbour within a distance class greater than 100 m. Compared to the 1960s, isolated trees are now more isolated — the nearest neighbour distance has increased. The mean diameter of isolated tree crowns has significantly increased from 15 m in the 1960s to 18 m in the 1990s. The total canopy cover of isolated trees from the 1990s samples was 0.8% of the total study area below 400 m asl. A reversal in isolated tree decline will only occur if trees are replanted, or existing trees fenced to promote regeneration. Otherwise, isolated trees are dying relicts of 150 years of clearing and intensive agriculture. This is of concern considering that we do not fully understand their value. We speculate on some of the ecological, economic and social values of these trees.

Conservation of relict potato *Solanum tuberosum* cultivars within Maori communities in New Zealand

GRAHAM HARRIS

It is generally accepted by scholars that potatoes were first introduced to New Zealand in the late 18th century by Captain James Cook and the French explorer, Marion du Fresne. Further introductions of potatoes from a variety of sources including possible direct introductions from South America, followed into the 19th century. Maori were quick to recognize the advantages that these new introductions had over their traditional food crops including kumara (sweet potato) *Ipomoea batatas* and Taro *Colocasia esculentum* both of which they introduced from east Polynesia some 800–100 years previously. Potatoes soon became a staple item in the Maori diet and an important trade commodity and by the mid-19th century they were growing thousands of hectares of potatoes for that purpose. The various cultivars that were introduced were given Maori names and many of these early types are still grown by Maori, having been passed down through families for many generations. With their deep set eyes, often knobby irregular shape, “open” leaves and colourful tubers these “Maori Potatoes” are quite distinctive in appearance from modern potatoes and some retain many of the features of *Solanum tuberosum* subsp. *andigena* types. This paper discusses the adoption of the potato by Maori, the effects it had on Maori society and the perpetuation of the early cultivars within Maori families and communities.

This examination of an introduced crop plant and its intersection with an indigenous people is essentially an ethnobotanical study which in addition to its botanical and anthropological foci includes elements of *Matauranga Maori* (traditional Maori knowledge) history, geography and horticulture. The preservation of these old potato cultivars by generations of Maori people has made a valuable contribution to conservation of biological diversity.

Volume 7 Number 4

Forum Essay

Are economic instruments the saviour for biodiversity on private land?

P. GIBBONS, S. V. BRIGGS and J. M. SHIELDS

Research Papers

The canopy, bark, soil and litter invertebrate fauna of the Darling Plateau and adjacent woodland near Perth, Western Australia, with reference to the diversity of forest and woodland invertebrates

J. D. MAJER, H. F. RECHER, B. E. HETERICK and A. C. POSTLE

This paper tables and reports on pooled taxonomic data from three separate research projects involving aspects of eucalypt invertebrate ecology: canopy invertebrates in jarrah and marri forest; bark invertebrates on four eucalypt species in forest and woodland; and soil and litter fauna in jarrah and marri forest. The data support the concept of a high invertebrate biodiversity on and under southwestern eucalypts, with 1 234 adult morphospecies of invertebrates being collected from the bark alone. Despite different trapping methods used in each of the three studies, we were able to find a high degree of overlap at the family level between bark and canopy fauna (126 families were found on both bark and in the canopy representing 79.2% of 159 canopy families). Eighty identified genera were also found on both bark and canopy, which represents 46.2% of the 173 identified canopy genera. The soil and litter fauna data are not complete (a taxonomic inventory of Acarina and Formicidae is not available) but appears to be more distinctive, sharing only 24 families (= 60% of the 40 identified soil-litter families) with bark, and 17 families (= 42.5% of the soil-litter families) with the canopy. At the generic level, only seven identified genera (= 8.6% of 22 soil-litter genera) were shared between soil-litter and bark, and five genera (= 6.2% of soil-litter genera) were shared between soil-litter and the canopy.

An examination of the trophic guilds reveals that fungivores-decomposers were very diverse in soil and litter (accounting for approximately 50% of the biodiversity in these substrates). This guild was much less diverse on the canopy (21.6% of the canopy diversity) and the bark (16.9% of bark diversity). Sap-sucking organisms were more diverse in soil (13.9%) and litter (12.8%) than on the canopy (5.3%) or on bark (5.9%). The canopy result is surprising, and suggests that not many invertebrate species are able to feed on the sap of southwestern eucalypts, the sap of which may contain a high proportion of toxic compounds. Predators were more diverse on the canopy and on bark (\approx 19–23% of total taxa) than in soil and litter (\approx 9–9.5%), as were parasitoids (18.7% and 22.5% compared with 10.5% and 14.8%). Epiphyte grazers and phytophages were not very diverse (\leq 11%) on any of the substrates, and representatives of other guilds or organisms whose diet was unknown accounted for less than 2.5% of the total diversity. Tourist species were not recognised among the soil and litter fauna, though they were found in the canopy and on bark, and ants were not quantified for soil and litter.

Conservation of vertebrate fauna using hollows in forests of south-west Western Australia: strategic risk assessment in relation to ecology, policy, planning, and operations management

IAN ABBOTT and KIM WHITFORD

Forty-two vertebrate species use hollows in live standing trees in the forests of south-west Western Australia. We determined the reliance of each of these species on hollows in standing trees, assessed the relative frequency of occurrence of suitable hollows (based on the size of hollow and hollow entry), and further categorized species by the size of their home range and their current dependence on publicly-owned forest. No species was identified as being at high or immediate risk of decline. Eight species (6 bird, 2 mammal) were identified as excellent candidates for monitoring, with one species (*Trichosurus vulpecula*) most likely to provide the earliest indication of any critical reduction in the long-term supply of large hollows at small spatial scales.

Past impacts of Aborigines and Europeans on populations of the larger species are likely to have been substantial, as these were hunted for food and trapped for fur. Hollow-using species are considered at present to be adequately safeguarded by: extensive areas of forest reserved from logging; science-based prescriptions mandating the retention of trees in Jarrah *Eucalyptus marginata* forest available for timber harvesting; a forest-wide baiting program to reduce predation by the introduced Red fox *Vulpes vulpes*; and a 70 year tradition of adaptive forest management. The recovery of populations of medium-sized mammal species following control of foxes will provide an opportunity to re-assess the adequacy of current hollow-management strategies. Future research should include modelling of stand structure, determining the home range of priority species, and assessing the extent of overlap of home ranges. Monitoring of indicator hollow-using species should take place at landscape scales.

Understanding the impacts of recreation in Australian protected areas: Quantifying damage caused by horse riding in D'Entrecasteaux National Park, Western Australia

N. PHILLIPS and D. NEWSOME

There is presently very little published quantitative information on the environmental impacts of recreational horse riding. Particularly in Western Australia the lack of "hard evidence" concerning the environmental impacts of horse riding hinders objective judgement of damage caused by horse riding in national parks. This paper presents data on horse riding impacts in a Western Australian (D'Entrecasteaux) national park. The research measured vegetation and soil impacts caused by horse use in un-tracked areas with the specific aim of relating the amount of horse use to degree of environmental impact. Horse riding altered plant species composition, increased the area of bare ground and decreased height and cover of vegetation. Significant impacts occurred after only low levels of horse use. The findings indicate the need for a database on horse riding impact in Australia so that, where horse riding is allowed, impacts can be properly assessed and effectively managed.

How grassland plants are distributed over five human-created habitats typical of eucalypt woodlands in a variegated landscape

S. McINTYRE, K. M. HEARD and T. G. MARTIN

A sample of 212 quadrats in grassland vegetation was collected in eucalypt woodlands in sub-tropical Queensland. These included roadside (53 sites), native pasture (109), riparian zone (20), sown pasture (16) and crop (14) habitats. A total of 350 species and subspecies was recorded of which 89 species were identified as being locally rare (native species of <3% frequency, not specialists of other habitats). Forty-three species were collected in addition to the quadrat records. Multivariate analysis indicated the major difference in floristic composition was between roadsides and native pastures, versus the other three habitats. The second axis separated roadside from native pasture vegetation, and the third axis separated riparian sites from all the rest. Crop and sown pasture habitats were the most similar in composition. The grazing practices in this region have enabled the persistence of grasslands that are of national significance in conservation terms. The variegated nature of the landscape is demonstrated by the occurrence of native grassland species across all the human-created habitats, including native species that were unique to intensive land uses. However, our results also show that intensive land uses (cropping, sown pastures) are more of a threat to the conservation status of grasslands than is cattle grazing, even at commercial levels of stocking. Species at most immediate risk are those that are sensitive to commercial cattle grazing and to intensive land uses such as crops and sown pastures.

Research Note

Bryophytes and the morphospecies concept: a comparison of novice and expert sorting

EMMA J. PHARO

Pacific Conservation Biology

Order Form and Subscription information appears at the end of this document —
please complete and return it to Surrey Beatty & Sons

Volume 8 Number 1

Special Section

Veterinary Conservation Biology: Wildlife Health and Management in Australasia

Roles for veterinarians in wildlife conservation

ANNE MARTIN

The past, future and present of biodiversity conservation in Australia

HARRY F. RECHER

Australia has a poor record for biodiversity conservation. Government and community priorities promote growth and resource exploitation over conservation and ecologically sustainable land and water use. Programmes to protect biodiversity are inadequate, poorly funded, and inappropriate. Consequently, Australia has a large extinction debt and the 21st Century will see massive losses of continental biodiversity. Because birds are well known, these trends are already evident among Australia's avifauna and illustrate the magnitude of the problems facing biodiversity conservation in 21st Century Australia. Only by ending land clearing, limiting population growth, and adopting scientifically based land and water management and conservation practices can these trends be reversed. This is unlikely, as Australia's largely urban population is ill-informed, while the scientific community is marginalized and the agenda of green groups perpetuates the *status quo*.

Conservation and sustainable use of wildlife — an evolving concept

GRAHAM J. W. WEBB

The proposition that wildlife conservation can sometimes be enhanced through allowing and even promoting the harvesting of wildlife is a sensitive issue. For the last 30 years, conservation has tended to focus on protecting rather than using wildlife. Yet conservation through sustainable use (CSU) is now a mainstream conservation strategy, and research on sustaining rather than stopping uses is commonplace. This paper discusses some of the fundamental and confusing elements of the CSU concept. Two case histories are discussed: Saltwater Crocodiles *Crocodylus porosus* in the Northern Territory of Australia, and Hawksbill Turtles *Eretmochelys imbricata* in Cuba. That wildlife populations are themselves highly dynamic entities, capable of adapting to harvest reductions, is well established, but often not appreciated. To advance conservation, research at the dynamic population level of resolution needs to take precedence over research on individual population dynamics.

Recovery of wildlife and restoration of habitats in New Zealand

I. A. E. ATKINSON

Although New Zealand's native fauna shares a Gondwana origin with that of Australia, there are major differences between our countries. The near-absence of land mammals and the restricted biodiversity and habitat range of New Zealand, contrast with the species-rich fauna and habitat variety of Australia. Both countries share an unenviable extinction record, particularly birds in New Zealand and mammals in Australia. Introduced mammals, often interacting with habitat destruction, have frequently been responsible for these losses in New Zealand. In some places, entire vertebrate foraging guilds have disappeared. On the mainland, control of introduced mammals has had limited success but a steadily increasing number of islands have been cleared of alien mammals. This has created new opportunities for translocating threatened species of native vertebrates and invertebrates to pest-free islands. It has also created options for substituting an ecologically similar species for one that is extinct, thus potentially achieving a more comprehensive restoration. Recent progress with island restoration has stimulated a "mainland island" strategy involving simultaneous intensive control of several pest mammals within a limited area that is then used to re-establish viable populations of threatened species. Examples are given to illustrate these conservation actions.

Tackling conservation/welfare conflicts in the management of wild animals

JAMES K. KIRKWOOD

During the last century there were two distinct and profound changes in attitudes to animals. First, it became widely understood that human activities and anthropogenic changes to the environment present a serious threat to biological diversity. In response to this many programmes to protect habitat and to conserve species have been launched. Second, advances in various fields of science led to a strengthening belief in many societies that a wide range of animals may have the capacity for consciousness and thus suffering. This has led to growing concern for the welfare of animals — the quality of their lives — and to the development of extensive bodies of welfare legislation in many countries. Concerns for species conservation and concerns for individual animal welfare do not always pull in the same direction. Around the world, conflicts are becoming commonplace between those who believe it can be justifiable to compromise the interests of individual animals in order to prevent species extinctions and those who do not. Such conflicts may be addressed and hopefully avoided or minimized through use of an ethical review process in which conservation benefits and welfare costs are carefully identified, considered and weighed in a cost/benefit analysis. A second function of this review process is to ensure that, where the decision is taken to proceed with a conservation programme that may adversely affect the welfare of some individuals, all necessary steps are taken to minimize these threats and their possible impacts.

Research Papers

Swallowing the bait: is recreational fishing in Australia ecologically sustainable?

D. P. McPHEE, D. LEADBITTER and G. A. SKILLETER

Recreational fishing is a growing component of the total fishery harvest in many countries, but the impacts of this sector on aquatic resources are often ignored in the management of aquatic systems. Recreational fishing is open-access, and in many inshore regions, the recreational harvest exceeds the commercial harvest. The environmental impacts from recreational angling can be both ecologically significant and broad in scope and include: the removal of a considerable biomass of a wide variety of species; discarded by-catch; possible trophic cascades through the removal of higher order carnivores; impacts on habitat through bait harvesting; impacts of introduced and translocated species to support angling fisheries; direct impacts on sea-birds, marine mammals and reptiles; and angler generated pollution. Management, for several reasons, has largely ignored these environmental impacts from recreational fishing. Recreational fishing impacts are cumulative, whereas there is a tendency for consideration of impacts in isolation. Recreational fishing lobbyists have generally been successful in focusing public and political attention on other impacts such as commercial fishing, and recreational fishing has tended not to come under close scrutiny from conservation and environmental groups. Without changes to the monitoring and management of recreational fisheries that incorporate the broad ecological impacts from the activity, it may not be ecologically sustainable in the long term and Australia will not meet its international obligations of protecting aquatic biodiversity. The definition of property rights and appropriate measures to prevent or manage large scale marine restocking are two emerging issues that also need to be addressed.

A test of monitoring methodology for the conservation management of birds

D. A. TIERNEY and A. K. MORRIS

We report on a programme to integrate monitoring for birds into conservation management and planning by local government. Bird surveys were used to develop a monitoring protocol for birds in woodlands/forests of north Wyong. Regional vegetation units have distinct bird assemblages when surveyed with adequate temporal and spatial replication. Multivariate analyses revealed a different bird assemblage structure in some locations, suggesting that assemblage decline could be monitored through time. Attributes necessary to successfully monitor bird conservation are discussed. We conclude that the success of a conservation management plan in conserving birds within the north Wyong area can be determined with appropriate monitoring.

Status of crocodiles in the U Minh Thuong Nature Reserve, southern Vietnam

BRYAN L. STUART, BENJAMIN HAYES, BUI HUU MANH and STEVEN G. PLATT

Both species of native crocodile, Siamese Crocodile *Crocodylus siamensis* and Estuarine Crocodile *C. porosus*, are seriously threatened in the wild in Vietnam. The swamp forest of the U Minh region in southern Vietnam was recently suggested to harbor the last remaining wild Estuarine Crocodiles in the country. We investigated the status of crocodiles in the U Minh Thuong Nature Reserve by conducting field surveys and interviewing local people. Field surveys found no signs of living wild crocodiles, and interview results strongly suggested that wild crocodiles have not occurred at U Minh Thuong Nature Reserve for perhaps as long as 30 years.

Volume 8 Number 2

An Opinion Piece

Animal Welfare v Wildlife Research?

CHRISTOPHER R. TIDEMANN and MICHAEL J. VARDON

In this paper we review difficulties with two recent research proposals to a university animal experimentation ethics committee and two court injunctions, initiated by community groups, purportedly for animal welfare and/or conservation benefits. The common thread in the ethics cases and the court cases is that individuals delayed or prevented actions that were subsequently shown to be in the best interests of animal welfare and/or conservation. We conclude that community groups or individuals, claiming to represent animal welfare and/or conservation, should be accountable for their actions and should be able to demonstrate the factual basis for their decisions, as are scientists and other professionals. Lay individuals seeking appointment to ethics committees, or other committees concerned with animal welfare or scientific experimentation, should have their suitability and credentials to undertake these roles formally reviewed. Ethics committees need to be able to make majority decisions to prevent abuse of process by unscrupulous individuals. We recommend an urgent review of the operation of ethics committees and cognate non-government organizations to resolve the destructive case of Animal Welfare v Wildlife Research.

Research Papers

Effects of alien rodent control on demography of the O'ahu 'Elepaio, an endangered Hawaiian forest bird

ERIC A. VANDERWERF and DAVID G. SMITH

The O'ahu 'Elepaio *Chasiempis sandwichensis ibidis* is an endangered monarch flycatcher endemic to the Hawaiian island of O'ahu. Nest predation by alien Black Rats *Rattus rattus* is one of the main causes of the decline of this forest bird. From 1996 to 2000 we monitored demography of the largest remaining O'ahu 'Elepaio population and we controlled rats with snap traps and poison bait stations in an attempt to begin recovery of the species. Nest predation by Black Rats influenced many aspects of 'Elepaio demography. Rat control resulted in a 112% increase in 'Elepaio reproduction, a 66% increase in survival of female 'Elepaio, and restored mate fidelity, site fidelity, female age

structure, and female recruitment age to more natural conditions. The 'Elepaio population growth rate (λ) was 0.76 without rat control and 1.00 with rat control, indicating rat control stabilized 'Elepaio populations, but was not sufficient to cause population increase due to the added threat of alien mosquito-borne diseases. Rat control may facilitate evolution of disease resistance by providing birds that have greater natural immunity an increased chance of reproducing, thereby increasing the proportion of resistant birds in each subsequent generation more quickly.

Bird assemblages in wildlife habitat strips in a Tasmanian plantation matrix

MICHAEL A. MacDONALD, ROBERT J. TAYLOR and STEVEN G. CANDY

In Tasmania, a system of 100 m wide strips of native forest, referred to as wildlife habitat strips, is retained within production forest, including plantations. Thirty-nine points in 18 wildlife habitat strips within both eucalypt and pine plantations (which were not differentiated for the purposes of the present study) were paired with points in nearby extensive native forest and surveyed for birds. At non-riparian sites (upper slopes and ridges), bird species richness and total abundance were both significantly lower in habitat strips than in controls. This difference is quantitative rather than qualitative, as ordination did not distinguish strip sites and controls, and no species were obviously absent from habitat strips. Riparian zones showed no significant difference in species richness and total abundance between habitat strips and controls. Species richness and total abundance relative to controls increased as wildlife habitat strip length increased over the measured range (0.4–2.1 km). It is thought that this may be because birds perceive strips as linear forest patches rather than corridors, so that there may be a habitat area effect. Other strip characteristics such as width and plantation age were not significant in riparian areas, but may be important on upper slopes and ridges, and the former will affect strip area. Wildlife habitat strips appear to be a valuable component of a conservation programme for birds in production forests in Tasmania.

The ecological consequences of Buffel Grass *Cenchrus ciliaris* establishment within remnant vegetation of Queensland

ANDREW J. FRANKS

The effects of Buffel Grass *Cenchrus ciliaris* presence and dominance in 78 Poplar Box *Eucalyptus populnea* woodland remnants of south central Queensland are documented. Buffel Grass was recorded from the majority of sites sampled. As the relative cover of Buffel Grass increased at both the quadrat and site level, the number of native ground cover species declined significantly. Most commonly recorded ground cover species displayed significant changes in frequency as Buffel Grass cover increased. Only two species increased with increased Buffel Grass cover: Desert Goosefoot *Chenopodium desertorum* subsp. *anidiophyllum* and Galvanised Burr *Sclerolaena birchii*.

The average cover of Buffel Grass decreased significantly from the edge of remnants towards the core areas. The foliage projected cover of the sub-canopy layers appeared to be an important factor affecting the relative cover of Buffel Grass at any one site indicating that shading and competition with the woody layers are important determinants in the structure and composition of the ground cover layer. A number of sub-canopy species were found to produce leachates that were capable of significantly reducing the germination or growth of Buffel Grass seeds, alluding that allelopathy may play a minor role in determining ground cover species assemblages. However, this result can only be interpreted conservatively in relation to its ecological relevance with effects related to competition with overstorey woody species being of greater importance.

This study quantifies the long observed effect that the exotic perennial Buffel Grass excludes other ground cover species, which may have detrimental ramifications on the functioning of remnant native vegetation over much of the state. With the recent introduction of regulations controlling broad scale tree clearing on both freehold and leasehold lands in Queensland, it is now important to identify a range of issues pertaining to the effective on ground management of remnant vegetation located outside the existing nature refuge network.

Landscape surrogates of forest fragmentation: Synthesis of Australian Montreal Process case studies

C. A. McALPINE, D. B. LINDENMAYER, T. J. EYRE and S. R. PHINN

Habitat loss and fragmentation are key biodiversity indicators of the Montreal Protocol for monitoring progress towards ecologically sustainable forest management. Over the last 15 years, an array of landscape metrics have been developed as spatial measures of habitat loss and fragmentation. However, most metrics require rigorous empirical testing if they are to provide scientifically credible information to managers and policy makers.

We present a synthesis of three Australian case studies for developing Montreal Indicator 1.1e, fragmentation of forest type, each representing different levels of landscape modification: St Mary State Forest, south-east Queensland; Tumut, southern New South Wales; and the Central Highlands, Victoria. Collectively, the studies found that no single landscape metric captured the response of the target species and fauna assemblages, or served as a reliable ecological surrogate for the conservation of a large set of species. Rather, species demonstrated a diversity of responses to habitat loss and fragmentation. Fragmentation effects were more important for the Tumut study, but not important for the Central Highlands study. Stand-scale habitat variables and area of suitable habitat were dominant explanatory variables for the St Mary study. Differences in observed response are partly explained by: (i) differences in landscape structure, particularly the proportion of preferred forest habitat remaining; (ii) differences in the ecology of target species; and (iii) the insensitivity of the landscape measures. Based on the outcomes of the three case studies, we propose principles for developing landscape surrogates for conserving biodiversity in Australia's eucalypt forest landscapes.

The ecological roles of logs in Australian forests and the potential impacts of harvesting intensification on log-using biota

D. B. LINDENMAYER, A. W. CLARIDGE, A. M. GILMORE,
D. MICHAEL and B. D. LINDENMAYER

A review is presented of the ecological values of logs in Australian eucalypt forests. Logs are a key component of stand structural complexity and have critical functional roles for forest biodiversity including:- (1) providing nesting and sheltering sites for biota, (2) providing foraging substrates for predators like snakes and predatory invertebrates such as velvet worms, (3) providing basking and hibernation sites for reptiles, (4) facilitating animal movement, (5) providing places for key social behaviours, (6) acting as plant germination sites, (7) providing substrates to promote the growth of fungi, (8) providing mesic refugia for organisms during drought and/or fire, and (9) contributing to heterogeneity in the litter layer and patterns of ground cover. Logs also play significant roles in nutrient cycling in forests.

The role of logs is often ignored in forestry operations, including those where harvesting intensification will occur through the removal of dead and/or "defective" standing trees and logs under the guise of removing so-called waste or logging "residues". Recently proposed intensive large-scale forestry operations in the Australian native forest estate (e.g., biomass burning power plants and charcoal plants) have the potential to reduce stand structural complexity, alter forest ecosystem function and negatively impact upon log-dependent species in those part of the landscape where harvesting takes place. The risks of such impacts have not been adequately measured in Australia, but they need to be addressed urgently. Prescriptions for the retention and future recruitment of logs must be developed to avert possible losses of biodiversity.

Volume 8 Number 3

Research Papers

Community preferences for tree species for household wood products in Vanuatu: A summary of four surveys

S. SIWATIBAU and D. J. BOLAND

Four surveys which gathered information from rural communities on useful tree species in Vanuatu have been reviewed and summarized. The surveys were undertaken from 1990 to 1993 and concentrated on species used for fuelwood and local construction. One survey also reported tree species useful for other purposes, such as fruit and nuts, edible foliage and customary uses. There were regional differences in species choices that could be related to the Northern, Central and Southern regions of the country. Popular fuelwood species included *Macaranga* spp., *Hibiscus tiliaceus*, *Kleinhovia hospita*, *Dysoxylon* spp. and the introduced *Leucaena leucocephala*. In general, people did not perceive any shortage of fuelwood. There were differences in preferences for fuelwood, depending on whether wood was required for open-fire pot cooking, open-fire roasting, or laplap (a kind of earth oven). Popular species for ground poles included *Hibiscus tiliaceus*, *Flueggia flexuosa*, *Macaranga* spp., *Pterocarpus indicus*, *Bischofia javanica* and *Intsia bijuga*, with some variations in preference between regions. Preferred species for aerial timbers for house construction included *Macaranga* spp., *Flueggia flexuosa*, *Ficus* spp., *Kleinhovia hospita* and *Alphitonia zizyphoides*. Species

providing commercial timbers, such as *Endospermum medullosum*, *Santalum austro-caledonicum* and *Intsia bijuga*, are valued and are being planted, or wildlings cared for, on-farm. Important fruit and nut trees included *Barringtonia edulis*, *Canarium* spp., *Syzygium malaccense*, *Pometia pinnata*, *Inocarpus fagifer*, *Burckella obovata* and *Dracontomelon vitiense*. Tree species having multiple importance in customary use, such as *Hibiscus tiliaceus*, *Macaranga* spp., *Intsia bijuga*, *Casuarina equisetifolia*, *Flueggia flexuosa*, *Kleinhovia hospita*, *Leucaena leucocephala*, *Barringtonia edulis* and *Acacia* spp., are ranked highly.

The dynamics and conservation of a spatially subdivided avian population in a fragmented landscape

GARY W. LUCK

Many bird species have declined in abundance in the agricultural regions of southern Australia. The mechanisms underlying these declines and the viability of the remaining populations are largely unknown. A number of species exist as spatially subdivided populations in heavily fragmented landscapes. Metapopulation and source-sink theory have influenced thinking on the dynamics of subdivided populations, but the general applicability of these theories is uncertain.

I examined the dynamics of a subdivided population of the Rufous Treecreeper *Climacteris rufa*, a declining woodland passerine, occupying a fragmented, agricultural landscape in southwestern Australia. I determined if local populations could replace themselves without immigration and estimated population growth rates for the periods 1998–1999 and 1999–2000. I also examined the influence of movement between local populations on the viability of the entire subdivided population. Out of four geographically defined local populations, only one was above replacement, and only in one year of the study. Fledgling productivity and recruitment in the remainder were not sufficient to compensate for breeding female mortality. Long-term population growth estimates were <1 for all local populations, but variability in demographic rates suggested that the status of these populations may fluctuate over time. Also, there appeared to be sufficient movement between local populations, and into the study area from nearby habitat remnants, to slow or halt any decline in local population size. Within- and between-local-population processes appeared to be important to the viability of the treecreeper population during the two years of the study, and this is consistent with the general principles of metapopulation theory.

I compared the dynamics of the treecreeper population occupying the fragmented landscape with one occupying a continuously wooded landscape and found that the latter had population growth rates >1 , suggesting it may be an important population source and vital to the regional viability of the species.

Causes of mortality of Black-fronted Terns *Sterna albobriata* on the Ohau River, South Island, New Zealand

RACHEL J. KEEDWELL, MARK D. SANDERS, MAURICE ALLEY
and CAROLINE TWENTYMAN

We examined the carcasses of 148 Black-fronted Terns *Sterna albobriata* found during the 1998–2000 breeding seasons on the Ohau River, South Island, New Zealand. Predation was the primary cause of mortality of adults, juveniles and chicks, resulting in 47% of all deaths. Video footage showed Feral Cats *Felis catus* were responsible for 6% of all predator-caused deaths, and physical evidence at carcass remains linked cats to another 19% of predations. Further evidence suggested Norway Rats *Rattus norvegicus* and Stoats *Mustela erminea* were responsible for 51% and 6% of predator-caused deaths, respectively. The prey remains left by the different predator species are described. Other causes of mortality included starvation (4%), power lines (1%), road traffic (1%) and various natural causes of mortality (5%). Causes of mortality could not be assigned to 41% of Black-fronted Terns, but most of these were young chicks that died at the nest soon after hatching. We suggest that predators are potentially the main cause of population decline in black-fronted terns and that predator control targeting cats and Norway Rats during the breeding season should be trialled.

Impacts of logging, fire and grazing regimes on bird species assemblages of the Pilliga woodlands of New South Wales

E. M. DATE, H. A. FORD and H. F. RECHER

We investigated the composition and distribution of bird assemblages in the continuous Pilliga woodlands of north-west New South Wales in relation to floristic assemblages and disturbance (logging, fire and grazing) patterns. Box-ironbark woodlands contained high densities of White Cypress Pine *Callitris glaucophylla* and Narrow-leaved Ironbark *Eucalyptus crebra*, had a sparse, depauperate understorey, and were associated with frequent, intense logging and infrequent fires (due to fire exclusion and the use of grazing for fuel reduction). Box-ironbark woodlands were characterized by high frequencies of 12 bird species that occurred throughout the Pilliga and low frequencies of many other species. Blakely's Red Gum *E. blakelyi* woodlands typical of creeks and Broad-leaved Ironbark *E. fibrosa* woodlands typical of poor soils contained lower densities or smaller trees of *C. glaucophylla* and *E. crebra*, had a moderately dense, diverse understorey, and were associated with infrequent low-intensity logging and moderately frequent wildfire. Bird species assemblages of Broad-leaved Ironbark woodlands were similar to those of box-ironbark woodlands. Blakely's Red Gum woodlands were characterized by 36 bird species that were virtually absent from box-ironbark and Broad-leaved Ironbark woodlands, including 10 threatened and declining species. The 10 are among 48 woodland species that are known or thought to be declining and that are dependent on woodlands with mature trees and grassy or patchy grass/shrub understorey. We conclude that these species have declined in the Pilliga and will continue to decline under existing disturbance regimes, particularly in box-ironbark woodlands. We suggest adaptive management strategies for maintaining and rehabilitating their habitats.

Distribution of the native earthworm fauna of the Perth metropolitan sector of the Swan Coastal Plain

IAN ABBOTT and ALLAN WILLS

Assessment of areas suitable for inclusion in a comprehensive, adequate and representative (CAR) reserve system has been based primarily on distribution of original native vegetation and occurrence of vertebrates, particularly birds and mammals. However, reliable predictors of vertebrate and floristic diversity are not necessarily adequate predictors of invertebrate diversity. We sampled the earthworm fauna of the Perth metropolitan Swan Coastal Plain (SCP) to examine whether vegetation-based criteria are sufficient for identifying a conservation estate for native earthworms.

Twenty-one native species were collected from 136 sample localities. All five previously described native species from the region and three native species previously collected but not formally described were again collected, while 13 previously uncollected species were found. Species abundances of native earthworms were uneven, in common with species-abundance relationships for many other invertebrate assemblages, with 10 singleton occurrences of species and few common species. Species diversity increased away from the coast across the sandy geomorphic units Quindalup, Spearwood and Bassendean. Our study did not resolve whether differences in earthworm faunas reflect the gradient in soil qualities across these units, gradients in species-area effects, habitat diversity effects or a combination of these.

Blocks of remnant vegetation identified in the Western Australian Government's *Bush Forever* plan as containing natural areas of regional conservation value are also likely to support at least one native earthworm species. However, many of the blocks of remnant vegetation so identified are not within the formal conservation estate. Two species identified in this survey fortuitously persist only in remnant vegetation patches not considered regionally significant. Actual regional diversity was estimated to be 38 native species, indicating many uncollected relatively rare species. Although earthworms are a low diversity group compared with other invertebrates, the localized distributions of most species indicate that the formal conservation estate does not provide adequate protection. Ongoing degradation of unprotected remnant vegetation will result in extinctions of localized invertebrate species.

A Response

Can altitudinal diversity gradients be explained by a reduction in area with altitude?

C. KINGSTON

Species richness at higher altitudes of a region typically decreases with altitude, the usual explanation being that environmental conditions become harsher as altitude increases. On conical or ridge shaped mountains the surface area available within equally spaced altitude bands declines as altitude increases. It has been suggested (Ogden 1995) that this may be responsible for the decrease in species richness. The phenomenon of decreasing species richness with altitude has been further interpreted by Ogden as lending support to the equilibrium theory of island biogeography

(MacArthur and Wilson 1967) which predicts that larger areas will contain more species. The hypothesis that a decrease in area is responsible for the decline in diversity with altitude is here considered critically, and the evidence presented in support of it is found to be lacking.

A Reply

Altitudinal diversity gradients and the theory of island biogeography — an explanation

J. OGDEN

As part of a wider discussion of forest diversity in New Zealand, Ogden (1995) pointed out that the area available between any pair of contours on a conical mountain decreased with altitude in parallel with the decrease in species richness. This correlation is confounded with other environmental variables, such as temperature, which have been widely considered to be causal in the diversity decline. However, generalization has been elusive, and the supposed causal mechanisms are often couched in vague terms such as “harshness”. Ogden chose to emphasize area, and invoked the theory of island biogeography of MacArthur and Wilson (1967) by drawing parallels between islands and successively superimposed areas on mountains. Kingston (this issue) objected, mainly on the grounds that the theory of island biogeography refers to “isolated” areas and deals with the equilibrium between immigration and extinction, on which Ogden presented no evidence. In the light of these criticisms the data presented in Ogden (1995) is re-assessed here. I conclude that the “area hypothesis” is at least as good as any other for “explaining” (correlating with) elevational diversity trends. Area is itself correlated with environmental heterogeneity, which is presumably more important as a causal agent. However, Kingston’s insistence on the need for evidence on immigration and extinction to support the application of island biogeography theory is acknowledged.

Volume 8 Number 4

Research Papers

Translocation of the socially complex Black-eared Miner *Manorina melanotis*: a trial using hard and soft release techniques

ROHAN H. CLARKE, REBECCA L. BOULTON and MICHAEL F. CLARKE

We translocated five colonies of the highly social and co-operatively breeding Black-eared Miner *Manorina melanotis*, an endangered Australian honeyeater. Two colonies were released immediately (hard release) and two colonies were housed in aviaries for up to a week on-site and then supplied with food for a further week following release (soft release). A fifth colony was released using a combination of methods. All four hard and soft released colonies contained dependent fledglings at the time of release. This appears to be the first translocation of a co-operative species where intact colonies containing multiple breeding females, each with a suite of helpers have been translocated successfully. Both hard and soft release treatments appeared equally successful during an initial monitoring period of up to two months. All four colonies maintained social cohesion, and displayed high levels of survival and site fidelity. Both hard release and one soft release colony attempted to breed within 600 m of their release site within eight weeks of release. The other soft release colony bred 12 months later. We believe the inclusion of dependent young in each translocated colony provided a focus for translocated colonies that promoted site faithfulness and colony cohesion. Results of long-term monitoring remain inconclusive and it is recommended that monitoring be repeated during several future breeding events. Given our findings, we recommend that when translocating highly social species every effort is made to translocate the entire group, hard release techniques be applied and stimuli that enhance group cohesion and site faithfulness (the presence of dependent young) be exploited.

Developing landscape frameworks for regional conservation planning; an approach integrating fauna spatial distributions and ecological principles

DAVID SCOTTS and MICHAEL DRIELSMA

Habitat loss, degradation and fragmentation are heavily implicated in the decline of biodiversity throughout the world. Numerous conservation programmes have emerged in the attempt to deal with these primary threats but they are often isolated and disparate, foregoing opportunities for integrated, cumulative approaches and benefits.

This paper describes an approach that, through the integration of species' modelled distributions, and the application of landscape ecology principles, systematically considers the spatial requirements of priority forest fauna as surrogates for biodiversity across the landscape. With the aid of innovative Geographic Information System analysis tools, key habitats and corridors for priority faunal assemblages are delineated across north-east New South Wales.

The mapped outputs from this study provide spatially complete, data-driven, systematically derived conservation frameworks for the region. The frameworks provide an explicit basis for regional protected area networks and a landscape context for regional conservation planning. As predicted high conservation value habitats, the mapped key habitats and corridors are also focus areas for the protection, enhancement and restoration of native vegetation.

The Geographic Information System-referenced key habitats and corridors conservation frameworks have been adopted for conservation planning in north-east New South Wales, including "off-reserve" planning (e.g., government and community-based programmes at regional, catchment and local levels), and "on-reserve" planning (e.g., national park and nature reserve management planning).

The approach is applicable to other regions, wherever Geographic Information System-based spatial mapping, describing habitat quality for fauna species, can be collated.

Australian bat research: the limitations of *The Action Plan for Australian Bats* in determining the direction of research

DANIEL LUNNEY, ALISON MATTHEWS, JESSE ADAMS STEIN and H. W. M. LUNNEY

The Action Plan for Australian Bats is a Commonwealth initiative (Duncan *et al.* 1999a) which sets out the species considered to be in need of conservation and recommends Commonwealth funding to be applied. The argument of the present paper is that the *Action Plan* does not provide an adequate basis for bat research in Australia because it concentrates almost exclusively on a small number of threatened species and omits general bat research. This argument is supported by recent surveys of the opinions of bat researchers. The threatened species determinations of the various States also suffer from the same deficiency, i.e., threatened species have become the focus of attention at the expense of the conservation of all bat species. This increasing emphasis on threatened species, particularly those now on the national list, diminishes the possibility of carrying out basic bat research or research on species threatened at State level (at least in New South Wales) but not listed on a federal level under current national criteria. We contend that a better approach would be to focus on the threatening processes that affect all bat species (including non-threatened species) across the country in order to simultaneously determine strategies for protecting those that are threatened, as well as instituting measures that will prevent others from declining.

Woodland fragmentation is causing the decline of species and functional groups of birds in southeastern Australia

JAMES WATSON, ALEXANDER WATSON, DAVID PAULL and DAVID FREUDENBERGER

The clearance of woodlands and the simultaneous creation of alien environments have been identified as the primary reasons for the decline of many woodland birds in southeastern Australia. This study measured how the size of woodland remnants and habitat structural complexity affected bird composition and distribution in the northern Australian Capital Territory and bordering areas of New South Wales. Within this region only 8% of the original woodlands remain, embedded as patches in a matrix of pasture and suburbia.

Woodland birds were surveyed in 72 woodland remnants of different size and vegetation structural complexity. Avifaunal species richness was found to increase with remnant area and habitat complexity ($p < 0.01$). Of the 31

resident woodland bird species detected, 22 were significantly affected by woodland patch size reduction and 20 species were significantly affected by habitat complexity loss ($p < 0.05$). Of the species affected, 19 were affected by both reductions in patch size and vegetation complexity. Seven species (Weebill, Brown Thornbill, Buff-rumped Thornbill, Spotted Pardalote, Grey Shrike-thrush, Scarlet Robin and White-winged Chough) not previously identified as threatened by habitat fragmentation occurred significantly less often in small remnants with low habitat complexity. Assessment of avifaunal guilds based on body size and foraging behaviour showed that all large species ($n = 4$) and 85% ($n = 17$) of insectivorous species that foraged above the ground were statistically affected by patch size and/or loss of habitat complexity. The occurrence of three species (50%) of granivores was also significantly affected ($p < 0.05$) by patch size and/or habitat complexity reduction. These results show that the distribution of many bird species, including some considered “common” and “widespread”, is affected by patch size and habitat complexity. There are few, large complex woodland remnants within the study area, which continue to reduce in size and complexity. It is therefore predicted that the decline of woodland bird species will continue unless appropriate habitat conservation strategies are applied.

The spatial dynamics of White-browed Babbler groups in a fragmented agricultural landscape

PETER G. CALE

White-browed Babbler *Pomatostomus superciliosus* groups occupying linear strips of vegetation had breeding territories that were smaller in area and had longer linear dimensions than those occupying patches. A group's non-breeding home range was larger than its breeding territory. Groups occupying linear/patch home ranges expanded the linear extent and area of their home ranges more than those within other home range configurations.

Some groups moved during the non-breeding season and this was more likely to occur if the group occupied a remnant with a low abundance of invertebrates during summer. Some groups that moved returned prior to the next breeding season, but the majority were never seen again. New groups moved into the study sites and established in vacant home ranges. This suggests that those groups that left the study sites may have established new home ranges elsewhere. Breeding site fidelity was lower in groups that had failed in previous breeding attempts. Therefore, group movements were influenced by the feeding and breeding quality of the habitat. However, the configuration of the local population also influenced group movements with those groups on the edge of a local population being more likely to move than those in the interior.

New groups were formed by two processes; group dispersal, where groups generally filled a vacant home range, and group budding, which involved the splitting of a large group. Group dispersal maintained group densities while group budding increased the density of groups in a local population. These two processes were common, producing localized fluctuations in the density of groups. Since babbler groups contain only one breeding pair, changes in group density represent changes in effective population size. Therefore, group dynamics may be important to the persistence of local populations of White-browed Babblers, especially in landscapes that have suffered from habitat loss and fragmentation.

The extent of Mission grasses and Gamba Grass in the Darwin region of Australia's Northern Territory

LOUISE KEAN and OWEN PRICE

Mission grasses *Pennisetum polystachion* (L.) Schult. and *P. pedicellatum* (Trin) and Gamba Grass *Andropogon gayanus* (Kunth) are three weed species that are thought to be spreading rapidly in the vicinity of Darwin and may pose a major threat to ecosystems in northern Australia. The distribution of the species was assessed from a vehicle along 913 km of roads near Darwin. The study provided data on the potential source of further spread and an analysis of the potential habitat of the weeds.

For analysis, roadsides were divided up into 200 m cells and the distributions of the grasses were compared against land tenure and broad land unit maps. Mission grasses were present in approximately 52% of cells, and were particularly common around the rural residential/horticultural area of Humpty Doo. They occurred equally commonly in all broad land units, but differed among tenures, being particularly common on freehold land. Gamba Grass occurred in 15% of cells, with hot spots in a number of areas. It was most common on freehold land, and was rare on conservation reserves. It also showed an association with broad land units reflecting wetter areas.

Mission grasses are so widespread in the Darwin region that control can only be contemplated in very small areas requiring frequent treatment of re-invading plants. It may be possible to control Gamba Grass in conservation reserves

and Crown land if prompt action is taken. For all three species, preventing their spread to new areas should be a high priority.

Pacific Conservation Biology

**Order Form and Subscription information appears at the end of this document —
please complete and return it to Surrey Beatty & Sons**

Volume 9 Number 1

Forum Essay

The need for a vision

HARRY F. RECHER

Research Papers

The wheatbelt of Western Australia

RICHARD J. HOBBS

Perspectives on sustainability: the nutrient cycle

A. R. MAIN

Farming as if we belong

E. C. LEFROY

Balancing economics and sustainability in building an integrated agricultural system

DAVID J. PANNELL

Guiding principles for sustainability

RICHARD J. HOBBS

Eden Valley Farm: an integrated approach to a sustainable future

TERRI LLOYD and JAMES BUTTERWORTH

“Jangarri”: economics, environment, society

GARRY ENGLISH

Dangemanning Farm: a holistic development

M. R. and S. M. McFARLANE

“Koobabbie”: ecological and economic sustainability

ALISON DOLEY

“Paradise” and “Cloverdowns”: following natural systems

DEAN MELVIN

Toolibin Lake: working together

K. J. WALLACE

Integrated land management in the Kalannie-Goodlands district

V. READ and D. STANLEY

“Payneham Vale”: integrated whole farm planning

R. and S. WATKINS

Farming for the future: designing agricultural landscapes for conservation and production

ROBERT LAMBECK

Volume 9 Number 2

Forum Essay

The value of Animal Ethics Committees for wildlife research in conservation biology — an Australian perspective

SUSAN E. DYSON and MICHAEL C. CALVER

Research Papers

Relationships between bird species and characteristics of woodland remnants in central New South Wales

J. A. SEDDON, S. V. BRIGGS and S. J. DOYLE

This study investigated relationships between birds and characteristics of woodland remnants in the central wheat/sheep belt of New South Wales, in order to provide information for conservation management of woodland birds and their habitats in this region. Birds were surveyed in standard area plots in 36 woodland remnants, which ranged from 1 to 1376 hectares in size, in the central Lachlan catchment in the wheat/sheep belt of New South Wales. Habitat (e.g., shrub cover) and landscape (measures of isolation) characteristics of the remnants were recorded also. Presence/absence occurrences of 20 or more bird species, mostly woodland birds, were positively related to remnant area, shrub cover, number of shrub species, pine cover, fallen logs and branches, and number of remnants within two

and five kilometres of the survey remnant. Species of birds that are habitat generalists showed negative or no relationships with these habitat and landscape variables. Richness of all bird species was positively related to remnant area and shrub cover. Number of woodland bird species was positively related to remnant area, shrub cover and tree hollows. Lower species diversities in smaller remnants were most likely caused by lower chances of survival or of successful breeding in small remnants, effects of isolation on the ability of birds to recolonize smaller remnants, small remnants being of insufficient area for some species to form territories, and generally poor habitat quality in small remnants. Retention, management and enhancement of woodland remnants 10 to 20 hectares or larger in size with good understorey cover are necessary for the future viability of woodland birds in the wheat/sheep belt of New South Wales.

Diversity and abundance of pit-trapped reptiles in Australian arid and mesic habitats: Biodiversity for Environmental Impact Assessments

GRAHAM G. THOMPSON, SCOTT A. THOMPSON, PHILIP C. WITHERS and ERIC R. PIANKA

Based on pit-trapping data for reptile assemblages from mesic, semi-arid and arid Australian sites, we examined species richness, diversity and evenness for general patterns. Reptile assemblages in Australian arid and semi-arid areas are generally species rich, have a high diversity, and have a high proportion of species that are rarely caught. Skinks are generally the most abundant taxa, followed by geckos and agamids. Varanids, elapid and blind snakes are less frequently caught, and pygopods are seldom caught in pit-trapping programmes. However, there was considerable variability in the pattern of reptile assemblages across the Australian arid and semi-arid landscape, and even among closely located sites within the same soil and vegetation zones. A high proportion of arid and semi-arid reptile species are rarely caught in pit-traps. Western Australian Environmental Protection Authority's current requirements for assessing the effects of a potential disturbance, which are based on desktop study and small-scale field survey, are inadequate to describe biodiversity at the genetic, species and ecosystem levels, and also in terms of ecosystem function. If the Environmental Protection Authority considers rare species are an important component of the biodiversity of an area, then a greater level of trapping is required for the preparation of an environmental impact assessment than is generally occurring at present.

A review of the diet of Rusa Deer *Cervus timorensis russa* in New Caledonia: Are the endemic plants defenceless against this introduced, eruptive ruminant?

MICHEL DE GARINE-WICHATITSKY, PATRICK DUNCAN, ALICE LABBÉ,
BERNARD SUPRIN, PHILIPPE CHARDONNET and DANIEL MAILLARD

Rusa Deer *Cervus timorensis russa* was introduced to New Caledonia in 1870 from Java, and has colonized the main island of Grande Terre, where it is found in virtually all the terrestrial biotopes. Despite its abundance and its socio-economic importance for New Caledonians, little is known about the diets of the wild deer populations living in contact with native vegetation which has a high degree of endemism and which, until recently, evolved without ruminant herbivores. We collected information on the diet of Rusa Deer in New Caledonia from published and unpublished reports, a questionnaire addressed to experts and preliminary data from browse-surveys. All sources of information suggested that wild Rusa Deer in New Caledonia is a mixed-feeder, and the list of plants consumed included 25 grasses, 15 forbs, 26 trees/shrubs and 12 vines and ferns. Nearly half (49%) of the plants identified as principal and preferred foods were introduced species. Physical defences (spines and thorns) did not seem to deter deer. It is remarkable that many of the avoided plants were native species (56% of the avoided species). Further research is required to confirm these results, but they are relevant to the evolution of plant/herbivore interactions and to the management of deer populations for conservation perspectives in island ecosystems.

Carnivore persistence in fragmented habitats in urban southern California

LOURRAINE A. TIGAS, DIRK H. VAN VUREN and RAYMOND M. SAUVAJOT

We investigated the responses of carnivores to habitat fragmentation in urban southern California. We used scat, track, and remote camera surveys to determine presence and residence of carnivores on habitat fragments of various sizes

(4.4–561.0 ha) and degrees of isolation (10–750 m). Fragment area explained a significant portion of the variation in all four measures of species richness (total species present, native species present, total species resident, and native species resident). Isolation was of secondary importance and was significant only for species presence. We suggest that fewer carnivore species at smaller or more isolated fragments resulted from foraging decisions based on lower food reward in smaller fragments and greater movement costs for more distant fragments. Carnivore species responded differentially to fragmentation. Bobcats *Lynx rufus* were fragmentation-sensitive and apparently required large fragments, thus they may be useful as focal species for conservation planning. In contrast, Coyotes *Canis latrans* were more fragmentation-tolerant and, along with smaller species such as Northern Raccoons *Procyon lotor*, Striped Skunks *Mephitis mephitis*, and Virginia Opossums *Didelphis virginiana*, can persist in smaller fragments. Our results suggest that most of the common carnivores can persist in fragmented urban habitat, provided that fragments are sufficiently large and in close proximity.

Science Note

Conservation status of *Lechenaultia aphylla* (Goodeniaceae), a disturbance opportunist from the Great Victoria Desert, Australia

LEIGH W. SAGE

Volume 9 Number 3

Research Papers

Salinization of southwestern Western Australian rivers and the implications for the inland fish fauna – the Blackwood River, a case study

DAVID L. MORGAN, DEAN C. THORBURN and HOWARD S. GILL

Increasing salinities throughout southwestern Western Australia, facilitated by extensive land clearing, have compromised the region's highly endemic freshwater fishes. Salinization of the Blackwood River has resulted in the main channel and upper cleared catchment being dominated by estuarine and halotolerant teleosts. The non-halotolerant species are restricted to the forested non-saline tributaries of the lower catchment. Of the 12 943 fish (13 species) captured in 113 sites, the halotolerant introduced Mosquitofish *Gambusia holbrooki* was widespread and the most abundant, representing almost 52% of fish caught. The estuarine Western Hardyhead *Leptatherina wallacei*, which was also widespread throughout the main channel and upper catchment, was the next most abundant, representing ca. 24% of fish caught. Freshwater endemics represented ca. 23% of captures, with the Western Minnow *Galaxias occidentalis* and Western Pygmy Perch *Edelia vittata* accounting for most (i.e., ca. 20%). There were significant differences in teleost communities among the naturally vegetated, low salinity tributaries of the river compared with the main channel and upper cleared catchment. While the forested tributaries still contain populations of *E. vittata*, Nightfish *Bostockia porosa* and Mud Minnow *Galaxiella munda*, the elevated salinities in the upper reaches of the Blackwood River system appear to have caused a massive decline in, or extinction of, populations of these species. The protection of the region's unique freshwater teleosts relies on the preservation of their remaining habitat in both the uncleared catchments of the region and in the low salinity forested tributaries within largely cleared systems, such as those in the Blackwood River catchment.

The distribution and habitat characteristics of a threatened lucanid beetle *Hoplogonus simsoni* in north-east Tasmania

J. M. MEGGS, S. A. MUNKS and R. CORKREY

The distribution and characteristics of habitat utilized by a threatened species of stag beetle in north-east Tasmania *Hoplogonus simsoni* (Coleoptera: Lucanidae), were examined as first step in the development of conservation management objectives for the species. The beetle was found to have a restricted a distribution of 250 km² and its regional distribution appeared to be related to the occurrence of granitic geology and a moderately high rainfall at low elevations. The species was patchily distributed across its range. High-density populations of the species were restricted to the eastern part of its distribution, but over most of its range it occurred at very low densities. Relative abundances of *H. simsoni* were greatest in wet eucalypt forest, with significantly fewer beetles found in mixed forest and rainforest.

Dry eucalypt forest was found to be unsuitable habitat although the beetle was found to occur in the ecotone between wet and dry eucalypt forest. Potential wet forest habitat for the species is estimated to encompass 18 200 ha or 72% of its range. The species was not found in areas of wet eucalypt forest that had been converted to pine plantation. However, *H. simsoni* was found to occur in wet eucalypt forest regenerating after clearfelling and some of the highest density populations of the species occurred in 70 year old wet eucalypt forest regenerating following a wildfire. The relationship between various habitat variables and the occurrence of the beetle was investigated using Generalized Additive Modelling and robust regression. The presence of wet eucalypt forest below 300 m altitude; slope less than 5°; a deep leaf litter layer; and a forest structure with a well-developed canopy best explained the occurrence of the beetle. These habitat characteristics probably relate to a requirement for a cool, moist, stable microclimate and an absence of wildfire for some time. The potential habitat of *H. simsoni* as identified in this study is poorly reserved across its range and a high percentage has been identified by the forest industry as having potential for conversion to pine plantation. This highlights the importance of having mechanisms for “off-reserve” conservation of threatened species, like *H. simsoni*, which are often poorly represented in or completely absent from formal reserves.

The vertebrate fauna of the Tasmanian Wilderness World Heritage Area

MICHAEL M. DRIESSEN and STEPHEN A. MALLICK

The Tasmanian Wilderness World Heritage Area encompasses an area of 1.38 million hectares, or approximately 20% of the island state of Tasmania. The World Heritage Area plays a significant role in the conservation of Tasmania's fauna and natural biological processes. The area supports 30 species of terrestrial mammal including three endemic species (91% of total Tasmanian species), 120 species of terrestrial bird including 10 endemic species (76% of state total), 14 species of terrestrial reptile including seven endemic species (67% of state total), seven species of frog including three endemic species (64% of state total), 16 species of freshwater fish including four endemic species (64% of state total), and 68 species of marine fish including one endemic species (14% of state total). A number of vertebrate species are entirely restricted to the World Heritage Area (Moss Froglet, Pedra Branca Skink, Mountain Skink, Pedder Galaxias, Swamp Galaxias and Western Paragalaxias, while the migratory Orange-bellied Parrot breeds only within the World Heritage Area. A number of other species have the majority of their Tasmanian range within the World Heritage Area (Broad-toothed Rat, Ground Parrot, Southern Emu-wren, Tasmanian Tree Frog, Northern Snow Skink, Southern Snow Skink, Bathurst Harbour Skate and the Clarence Galaxias). The World Heritage Area also supports a range of threatened mammal, bird, reptile and fish species. Of the 44 species of introduced vertebrates which have established feral populations in Tasmania, only seven species (16% of state total) have a significant presence within the World Heritage Area and pose a potential threat to the area's integrity. The diversity and endemism of the vertebrate fauna of the World Heritage Area reflects the Gondwanan origins of much of the fauna of western Tasmania, the repeated glaciation of the area during the Pleistocene, and subsequent pulses of speciation among certain taxa.

Distribution and population structure of the vulnerable riparian palm *Livistona lanuginosa* A. N. Rodd (Arecaceae) in the Burdekin River catchment, north Queensland

N. E. PETTIT and J. L. DOWE

This study investigated the distribution and population structure of *Livistona lanuginosa*, a vulnerable palm that is mainly restricted to riparian areas in the Burdekin River catchment. The known population, though dispersed, is composed of small and isolated sub-populations which are located entirely on pastoral leases. Mapping of the occurrence of *L. lanuginosa* indicates that distribution is primarily linear in the riparian zone along first and second order streams, as well as associated flood zones. A total of 510 adult plants, recorded at the eight sites surveyed, suggests that the overall population size is limited. The population structures at four sites indicate a stable population at those sites, whilst the population structures at the other four sites indicate unstable and senescent populations. The greatest proportion of individuals is in the seedling stage, thus indicating that sufficient viable seed is being produced and that conditions for germination and the development of seedlings are favourable. However, prominent gaps in life stage classes at some sites suggest that recruitment is limited or is not taking place at those sites, and this situation is reflected in high numbers of intermediate life stage classes and adult palms compared to seedlings and lower life stage classes. *Livistona lanuginosa* remains largely unprotected from livestock and fire, and other exogenous disturbances throughout its limited range, and the small total population size makes it vulnerable to rapid decline given unfavourable natural conditions.

Low abundances and diversities of benthic faunas of shallow, coastal sediments in the Solomon Islands and their implications for assessing environmental impacts of logging

D. J. MORRISEY, R. G. COLE, J. BELL, I. LANE and G. B. READ

The diversity and abundance of benthic organisms were examined in relation to logging impacts in Western Province, Solomon Islands. Organisms occupying sediments offshore from the mouths of logged and unlogged streams in two areas were sampled at three depths during a single survey. Overall abundances of organisms were low, and patterns varied between areas. At Kolombangara, ANOVA showed that numbers of molluscs and crustaceans were higher at mouths of rivers with unlogged catchments than with logged catchments, but numbers of individuals, taxa, and polychaetes differed among river mouths within treatments. At Vangunu, numbers of taxa varied inconsistently among depths in the different logging treatments, whereas numbers of individuals were greater at river mouths of unlogged than logged catchments. Multivariate analyses (MDS, ANOSIM) showed differences among river mouths within treatments but not among treatments. In general, there were indications of logging impacts but the effects were not consistent across taxa. Because of this inconsistency, the low abundance and diversity of animals, and the relatively high cost of processing samples, benthic macrofaunal variables were not considered to be cost-effective measurement variables for longer term monitoring of the effects of run-off from logging operations on inshore marine habitats at these study sites.

Southern Right Whale *Eubalaena australis* sightings on the Australian coast and the increasing potential for entanglement

SIMON ALLEN and LARS BEJDER

Southern Right Whales *Eubalaena australis* are an endangered species that have been recovering from unsustainable whaling practices and, despite being reported along the east and west coasts of Australia, they have not been duly accounted for in recent risk assessments for marine development. This review of the last decade of sightings highlights northerly movements into temperate and sub-tropical waters, indicates that fatal entanglement has occurred and points toward an increasing likelihood of interactions between migrating whales and inshore marine development. Given that entanglements and vessel strike are preventing the recovery of North Atlantic Right Whales *Eubalaena glacialis*, we recommend a precautionary approach to risk assessment around Australia and the formation of a national animal entanglement committee with both a pre-emptive role in assessing coastal development applications and a reactive role in the event of entanglement.

Volume 9 Number 4

News and Views

Society of Conservation Biology — Australasia

KAREN FIRESTONE

Research Papers

Population structure, growth and longevity of *Placostylus hongii* (Pulmonata: Bulimulidae) on Tawhiti Rahi Island, Poor Knights Islands, New Zealand

I. A. N. STRINGER, G. R. PARRISH and G. H. SHERLEY

Placostylus hongii, a threatened snail species, was studied on Tawhiti Rahi Island in the Poor Knights Islands group off the east coast of northern New Zealand between 1998 and 2000. Most live snails and empty shells were adults (83% and 85% respectively) and the low proportion of empty adult shells (36%) compared with live adult snails found in an area last burnt in the late 1950s suggests that the population there is still recovering. Growth was measured using snails recaptured with the aid of harmonic radar transponders attached to their shells. Increase in shell length varied from 6 to 25 mm per year in juveniles with shells >38 mm long, but it slowed when juveniles approached maturity (adult shell length 55–89 mm). The juvenile period is greater than three years and growth in shell length virtually stops when a thick aperture lip develops. This lip continues to thicken at 0.1–0.4 mm per year and can reach a maximum thickness of 15.5 mm, indicating that adults may live 10 years and possibly more than 30 years. A comparison of our data with two previous studies on the same population and on Aorangi Island, in the Poor Knights Islands group, confirms that these snails are slow developing, have low recruitment of adults, and that populations are probably maintained by a pool of long-lived adults. Our results indicate that following predator control on the mainland, the recovery of a snail population is likely to be slow. Once a population has recovered it could be maintained by intensively controlling rodents for periods of greater than three years (to allow recruitment of adults into the population) alternating with longer periods without control.

Spatial modelling of “alternative” future landscapes under climate change and fire suppression, Mont Do, New Caledonia

GEORGE L. W. PERRY and N. J. ENRIGHT

The vegetation dynamics and disturbance regimes of the south-west Pacific have been significantly altered following human settlement. Previously forested landscapes are now dominated by a matrix of flammable early successional vegetation within which patches of mesic, fire-sensitive forest are embedded. Future environmental change, and in particular climate change, will further affect disturbance regimes in these ecosystems. If ignition frequency and fire extent increase, then the persistence of these landscapes in their current composition and structure is uncertain. Using a spatially explicit landscape ecological model, we explored the implications of climatically altered fire regimes for landscape composition and structure in a mountain-top reserve in New Caledonia. The outcomes of the modeling suggest that increased ignition probability and vegetation flammability would lead to a maquis (heathland)-dominated landscape structurally simpler than that seen today. The feasibility of fire suppression as a means of managing altered fire regimes was explored using a series of model experiments. Fire suppression has been problematic in some systems, especially those where fire hazard increases over time. However, in this ecosystem, and others in the south-west Pacific, it may be a viable alternative for managing fire because fire hazard, in terms of flammability, peaks early in the succession and then decreases over successional time.

An experimental investigation of the effects of human intrusion into breeding colonies of Bridled Terns *Sterna anaethetus* in the Great Barrier Reef

EMMA GYURIS

Many studies have demonstrated that recreational visitors impede the breeding success of nesting seabirds, although recently some authors challenged the view that human visitation is always detrimental to the breeding birds. This emerging lack of consensus, as well as the fact that almost all disturbance studies to date were conducted in habitats and on species of high latitudes, presents a challenge to managers of Australia's Great Barrier Reef World Heritage Area.

The present study used an experimental approach to examine the impact of recreational visitors on aspects of the reproductive biology of a tropical tern, the Bridled Tern, *Sterna anaethetus*, at Rocky Islets in the Far Northern Section of the Great Barrier Reef World Heritage Area. Two levels of human disturbance schedules were implemented over five experimental sites and over three breeding seasons. The dependent variables were hatching success, body mass and bill length of chicks at both 12–13 and 21–22 days of age. Chicks at 12–13 days of age were significantly heavier and hatching success was higher at sites exposed to higher level disturbance than at sites exposed to lower level disturbance. The results suggest that the early development of Bridled Tern chicks may be adversely affected by non-lethal human disturbance and that such adverse effects may be ameliorated by habituation to human intrusion into nesting areas.

A male-biased sex-ratio in non-breeding Hooded Plovers on a salt-lake in Western Australia

M. A. WESTON, F. J. L. KRAAIJEVELD-SMIT, R. McINTOSH,
G. SOFRONIDIS and M. A. ELGAR

The Hooded Plover *Thinornis rubricollis* is a threatened, sexually monomorphic wading bird that occurs in two allopatric populations in eastern and western Australia. We used a PCR-based molecular sexing technique to sex captured birds from both populations. We found 69% of adults captured at a salt-lake in Western Australia were male. We tested for a sex-bias in our trapping technique by examining the sex-ratio of eastern birds captured under circumstances analogous to the western capture operation. No sex-bias in the trapping technique was apparent although the sample size was low. This suggests that the male-bias at the lake was real. Any spatial or habitat-related segregation of the sexes must be investigated before we can conclude that the bias is a trait of the western population. If the bias occurs in the population as a whole, then the effective size of the breeding population will be less than that indicated by counts. If the sexes segregate to different sites or habitats, then spatially constrained threatening processes may lead to a skewed sex-ratio.

Kahikatea *Dacrycarpus dacrydioides* and Totara-Matai *Podocarpus totara-Prumnopitys taxifolia* forest patches in the agricultural landscape, Westland, New Zealand: representatives of a past and future condition

C. J. MILLER, D. A. NORTON and T. K. MILLER

Due to extensive clearance, podocarp forests on alluvial floodplains are under-represented, relative to their original extent, in the New Zealand agricultural landscape, and remnants are a priority for protection. This study uses a stand dynamics approach to 1) determine whether Kahikatea *Dacrycarpus dacrydioides* and Totara-Matai *Podocarpus totara-Prumnopitys taxifolia* forest patches in Westland, New Zealand, are remnants of pre-European forest, and 2) predict whether podocarp species will remain dominant in these patches. The majority of patches were initiated following European land clearance, with few being remnants of the original forest. Recruitment of podocarp seedlings and saplings into the canopy is no longer occurring in these stands, and over time they are likely to become dominated by angiosperm species. Within patch management may be an option to maintain podocarp dominance, while providing an economic return for landholders. While the forest types are representative of the original forest, the forest communities are not, with a lower β diversity than in intact Kahikatea forest in the region. Planning for and managing patches as a shifting mosaic in the landscape is likely to be the most successful approach for maintaining their conservation value in the region.

Birds of remnant vegetation on the Mornington Peninsula, Victoria, Australia: the role of interiors, edges and roadsides

MARK J. ANTOS and JOHN G. WHITE

Habitat loss and fragmentation on the Mornington Peninsula, Victoria, Australia, has resulted in a mosaic of forest patches, forest edges abutted by agricultural land and linear habitat strips amidst a human-modified land matrix. To examine the use of forest elements by the avifauna in this landscape, bird populations were sampled along fixed transects established within forest interiors, on forest edges and along forested roadsides. A total of 60 species was recorded during this study, five of which were introduced. Species richness and diversity did not differ significantly between the three habitat elements, but avifaunal composition varied considerably. The species assemblages of all habitat elements differed significantly, with forest interiors and roadsides showing the greatest difference and forest interiors and forest edges showing the least degree of difference. Forest-dependent bird species used both interiors and edges. Interiors differed from edges and roadsides in having lower abundances of open country species, predatory species and introduced species. A clear gradient of change in bird communities from forest interiors to roadside vegetation was observed. This study suggests that the interiors of medium-sized (<1 000 ha) patches may play an important role in conserving bird biodiversity on a local level as they provide refuge for forest-dependent native species in extensively cleared landscapes.

The impact of livestock grazing on the persistence of a perennial forb in a temperate Australian grassland

JOSH DORROUGH and JULIAN ASH

The presence of perennial plant species in grazed habitats may be an imperfect predictor of their long-term ability to persist under grazing by livestock. This is particularly the case in landscapes where grazing by livestock is a relatively recent occurrence or where management practices are leading to intensification of grazing. This paper investigates the impacts of grazing on the native perennial inter-tussock forb *Leptorhynchos elongatus* (Asteraceae) in grasslands on the Monaro Tablelands of New South Wales. Although the species persists in grazed habitats, exclosures indicate that current grazing management can lead to severe depletion of seed, largely due to selective removal of flowers and seed heads by livestock. A population model suggests that under current grazing management, population growth rates may be negative. Removal of livestock during flowering and seed set may assist long-term persistence of this species in grazed habitats. Despite almost 200 years of livestock grazing on the Monaro Tablelands, recent intensification of grazing management could result in the future loss of some plant species in grazed habitats.

Pacific Conservation Biology

**Order Form and Subscription information appears at the end of this document —
please complete and return it to Surrey Beatty & Sons**

Volume 10 Number 1

News and Views

News from the Australasian Section

ROB DAVIS and KAREN FIRESTONE

An Opinion Piece

Musings on Biodiversity by a Retired Park Manager

ROBERT E. FOX

Research Papers

Soil seedbanks in natural and restored box-ironbark forests at Stawell Gold Mine, Victoria

E. COMINO, B. P. MILLER and N. J. ENRIGHT

Natural communities have the capacity to regenerate themselves, and this functional ecosystem attribute must be regarded as a key indicator of success for revegetation programmes. The accumulation of species (and individuals) as dormant propagules in a soil seedbank, representing potential future states for the vegetation, is one possible index of revegetation success. Here, we investigate the soil seedbanks for five natural vegetation (Box-Ironbark forest) remnants, a topsoil stockpile and three revegetated mine-site areas associated with gold mining at Stawell (Victoria, Australia). The revegetation efforts largely date from 1987 and, in terms of their composition and structure, are relatively similar to natural vegetation remnants. Soil samples were treated with heat or smoke (plus control) and were monitored for seedling emergence, species composition and density in the glasshouse for 150 days. Seedling densities in treated seedbank samples were high (2 200 to 17 500 seedlings m⁻²) while species richness was low, ranging from 10

to 20 species per sample. Exotic species made up 22–61% of emergents and 33–50% of species observed. Correlation of seedbank composition and density with chemical attributes of soils, and with above ground (extant) vegetation at sites showed few significant relationships. Total species richness and the proportion of exotic species varied significantly between natural bushland remnants and revegetation areas. Richness was highest, and the proportion of exotic species was lowest in natural bushland samples. Total emergent numbers and the density of exotic emergents did not vary significantly between remnant bushland and revegetation areas. Declining vigour of some woody species in revegetation sites that are well represented in the seedbank, including *Acacia pycnantha* and *A. genistifolia*, indicates that the re-introduction of fire might be an appropriate management practice to facilitate long-term recovery of a functional community on these revegetated surfaces, but the potential for the establishment of weed species from the seed-bank following fire may pose a challenge to management.

Pounce site characteristics of the Western Yellow Robin *Eopsaltria griseogularis*: the importance of assessing foraging microhabitat

JARRAD A. COUSIN

The ground ecosystem represents an important foraging substrate for a large number of Australian birds, including the ground-pouncing Western Yellow Robin *Eopsaltria griseogularis*. The present study examined the foraging locations of *E. griseogularis* at the “extreme” microhabitat scale, by measuring ground substrate composition in a 300 mm by 300 mm area surrounding pounce sites, as well as habitat features surrounding pounce sites. Ground substrate composition of pounce sites remained relatively unchanged between seasons, and was characterized by a higher mean percentage of leaf litter and logs when compared to random points. The importance of logs was further emphasized by the closer proximity of logs to pounce sites than to random points. Selection of pounce sites in close proximity to logs and with abundant leaf litter reflects the higher abundance of invertebrate prey associated with these microhabitat attributes, although it may also represent a pounce in close proximity to a log utilized as a perch. During the warmer months of autumn, logs and their associated accumulations of leaf litter, provide sufficient moisture to maintain invertebrate prey, a resource diminished in the surrounding desiccated leaf litter. The conservation implications of these findings are discussed, as is the importance of examining foraging microhabitat in ground-foraging birds.

Australian rainfall patterns and the southern oscillation. 1. A continental perspective

R. G. VINES, J. C. NOBLE and S. G. MARSDEN

Various Australian rainfall records have been subjected to filter-analysis. The results represent an extension of the findings of Currie and Vines (1996) in their analyses of more than 300 annual rainfall-series gathered from weather stations widely spaced across the continent. Further evidence is presented for the existence of “cyclic” variations in precipitation with periods of 16–20 years and 10–11 years. Links are suggested with the luni-solar cycle of 18.6 years and the sunspot cycle of nominal period 10–12 years. A shorter “cycle” of 6–7 years is also postulated. Similar analyses of yearly data for the Southern Oscillation yield further suggestions of “cycles” that correspond closely with those obtained from the rainfall records. Explanations are proposed which appear to account for a substantial proportion of the inter-annual variability of rainfall, particularly in eastern Australia — with connections being made between El Niño/Southern Oscillation events and the incidence of drought in various parts of the continent. A major implication is that a variety of climatic effects in different parts of the world can be largely ascribed to the influence of the (18.6 year) luni-solar cycle.

Invasion of native vegetation by Coolatai Grass *Hyparrhenia hirta*: impacts on native vegetation and management implications

S. L. McARDLE, C. NADOLNY and B. M. SINDEL

Coolatai Grass *Hyparrhenia hirta* is an exotic perennial grass and environmental weed that is spreading rapidly in parts of southeastern Australia. This study examined the effects of Coolatai Grass invasion on the composition of ground strata vegetation within Kwiambal National Park in northern New South Wales. Plots that were heavily infested with Coolatai Grass together with matching control plots were surveyed. Coolatai Grass infestation reduced the richness of native ground strata plants and their projected groundcover, but did not affect the number of exotic species in plots. The control plots varied markedly in floristic composition, but infested sites were more homogenous, with Coolatai Grass clearly dominating the ground strata vegetation. Coolatai Grass appears to increase in abundance following fire; it persists under heavy grazing and is resistant to many herbicides. Spot spraying small swards and isolated tussocks with

glyphosate or flupropanate provides prospects of control on a small scale, but there are no suitable methods for large-scale control. Changes to roadside management practices could help to reduce the spread of Coolatai Grass, but research into seedbank dynamics and appropriate control techniques is required, as well as increased awareness of the threat to native vegetation posed by the species.

Implications of phylogeography and population genetics for subspecies taxonomy of Grey (Pacific Black) Duck *Anas superciliosa* and its conservation in New Zealand

JUDITH M. RHYMER, MURRAY J. WILLIAMS and RICHARD T. KINGSFORD

Subspecies delineations may not reflect actual intraspecific diversity; an issue that becomes important when conservation of populations and/or subspecies that face severe declines is involved. The Grey Duck in New Zealand is considered a separate subspecies *Anas superciliosa superciliosa* from the Pacific Black Duck *A. s. rogersi* of Australia, even though poorly differentiated morphologically. Because the New Zealand and Australian populations of *A. superciliosa* are considered taxonomically distinct, the decline of New Zealand's Grey Duck and its hybridization with the introduced Mallard *A. platyrhynchos* has led to assignment of "endangered" conservation status. Taxonomic distinction and absence of periodic gene flow between the Australian and New Zealand populations are crucial for acceptance of this status. We used phylogeographic analysis of mitochondrial DNA control region sequences to determine whether haplotypes representing current subspecies are unique or are more consistent with populations in the two countries being considered the same subspecies. Two highly divergent genetic lineages of Grey Duck occur in New Zealand. One lineage (Group I) is found only in New Zealand primarily on North Island, while the other (Group II), occurs in populations throughout New Zealand and Australia. The split between Group I and II lineages is on the order of that found between some avian species. Even though subspecific designations of *A. s. superciliosa* and *A. s. rogersi* do not hold up based on molecular data, we identify a need for Grey Duck in New Zealand to be conserved to maintain the historical diversity within the species.

Research Note

The demise of mass migration of the Brown Awl *Badamia exclamationis* (Fabricius 1775) (Lepidoptera: Hesperiiidae): a consequence of land clearing in Queensland?

PETER S. VALENTINE

Volume 10 Number 2

News and Views

Australasian Section of the Society for Conservation Biology

K. FIRESTONE

Research Papers

The biodiversity values of farming systems and agricultural landscapes

E. C. LEFROY and F. P. SMITH

The current effort in Australia to increase the proportion of perennial vegetation in agricultural landscapes to manage dryland salinity presents opportunities to improve the viability of remnant vegetation and its dependant biota. At this intersection of ecology and agriculture, many questions arise concerning interpretations of biodiversity from the perspectives of landowners and conservationists, the conservation priorities in agricultural landscapes, and the role of ecological science in understanding the functional contribution of emerging perennial-plant based farming systems to the viability of the native biota. This paper provides the background for the four papers that follow, presented originally at a workshop at Rutherglen in Victoria in October 2003 to discuss the issue of biodiversity values in agricultural landscapes. It then puts forward an approach to research into the biodiversity value of perennial land use systems based on three principles; understanding regional conservation priorities, appreciating farm scale priorities and constraints

from the perspective of the landholder, and identifying response functions to establish the role of revegetation in maintaining the viability of the native biota.

Heathens in the chapel? Economics and the conservation of native biodiversity

DAVID J. PANNELL

Biodiversity conservation is a human endeavour and economic drivers play a key role in shaping human behaviour. This is particularly true of human behaviour in management of businesses (such as farms) and in relation to the resources that underpin businesses (such as land and water). For this reason, the theories and models of economics have a lot to offer people concerned with biodiversity conservation. The paper outlines a number of theories and insights from economics that are relevant to biodiversity, particularly from the point of view of governments wishing to make efficient and cost-effective decisions about investment priorities for biodiversity. There is a need for better definition of biodiversity objectives, and for improved information about cause and effect relationships between interventions and outcomes. The importance of paying adequate attention to the farm-level economics of proposed changes in land management is emphasized. This is an important influence on farmers' responses, particularly if large-scale changes are sought. Non-market valuation studies to place monetary values on biodiversity outcomes have a potential role to play in evaluating policy options, although a measured approach to the use of these techniques seems warranted. There is a discussion about the limited role that economics can play in determining who should pay for biodiversity interventions. The selection of policy approaches and policy instruments for biodiversity needs to be sophisticated, based on science, and sensitive to different biodiversity-related problems and opportunities.

Identifying priority areas for conservation action in agricultural landscapes

ANDREW F. BENNETT and RALPH Mac NALLY

Farming for food, fibre and other products for human consumption is a dominant land-use throughout the world. Rural landscapes are also critical to the conservation of flora and fauna, and the maintenance of ecological processes on which all of life depends. In Australia, excessive clearing of native vegetation in the most productive agricultural landscapes has had profound environmental and social consequences. Restoration of these landscapes is an enormous challenge that offers the opportunity to shape the future of Australia, environmentally, socially and economically. In this paper we address the issue of identifying priority areas for conservation in agricultural landscapes. The spatial location of conservation actions in rural landscapes is important because it affects the degree of representation of the biota, the level of protection for rare and threatened species, the adequacy of habitats for species and communities and their future viability, the maintenance of ecological processes, and the integrity of habitats. However, because most land in agricultural regions is privately owned, effective implementation of restoration goals in preferred locations requires understanding of social processes, recognition of pragmatic issues in land management and financial commitment by the wider Australian society. We briefly review the strengths and limitations of some current approaches to determining priority locations for conservation action, including the use of general principles, species-based approaches, quantitative approaches for assessing representativeness, and "bottom-up" approaches based on landholder action. There is no single "best" solution: the most effective approach or combination of approaches depends on the objectives for restoration and the circumstances in the area where restoration will occur. An important consideration is the quality of the data available for the area, particularly detailed vegetation maps and knowledge of the status and habitat requirements of species that occur there. We summarize five stages that form a logical sequence in restoration programmes and highlight some of the issues at each stage. As the outcomes of the present continent-wide experiment in restoration cannot be fully evaluated for many decades, it is prudent that a range of alternatives are trialed and monitored for their effectiveness and success.

Biodiversity and agricultural landscapes: Can the wicked policy problems be solved?

ANDREW BRENNAN

Conservation issues for agricultural landscapes are typical examples of "wicked" public policy problems: that is, ones in which questions are not clearly defined, and there is apparent conflict between different sets of values, all of which are legitimate. The paper argues that how to protect intrinsic value in nature is itself a wicked policy problem, complicated by the fact that at least three different senses of "intrinsic value" are easily confused. The challenge for policy in Australian agriculture is how to protect remaining natural values by processes that are fair to stakeholders,

governed by scientific credibility and sensitive to the plurality of values held by groups within the community. The paper argues that scientists themselves can play an important role not just in problem definition, but also in helping set the agenda for action that will be effective in preserving natural diversity.

Volume 10 Number 3

Research Papers

Metrics for assessing the biodiversity values of farming systems and agricultural landscapes

JANN WILLIAMS

This paper reviews current approaches to assessing biodiversity values in agricultural landscapes in southern and eastern Australia and makes recommendations about their applicability to revegetation for commercial and non-commercial purposes. A typology based on the quantitative measurement of structural, functional and compositional attributes of biodiversity at multiple scales is used as the framework for the review. Metrics currently used to assess biodiversity primarily focus on conservation outcomes for natural systems rather than other cultural, social and economic values. They cover a range of scales (from local to global), landscape contexts (from intact to relic) and levels of organization (from genes to ecosystems). Surrogate measures are commonly used to assess biodiversity, particularly vegetation type and condition. Recently developed metrics are beginning to attach weightings to different habitat attributes and incorporate “natural” benchmarks. While expert panels play an important role in developing and assessing biodiversity metrics, a number of untested assumptions underpin current approaches. Rigorous testing and validation is therefore required if the current set of metrics is to serve as a reliable indicator of biodiversity across agricultural landscapes in Australia. While it is encouraging that more explicit and repeatable measures are being developed, as well as metrics that score the biodiversity value of a broad range of land uses, clearer definitions and objectives are required. Metrics also need further development and testing for aquatic species and systems and their interface with terrestrial systems, non-woody terrestrial systems, revegetation and the persistence of species across the landscape. Importantly, there is a need for greater cross-fertilization between ecologists, agricultural, social and other scientists, and private land managers to identify specific and measurable attributes of biodiversity within a farming systems context. This will help ensure that the conservation and utilization of biodiversity becomes an integral part of natural resource management in rural landscapes.

Ecological research on private land: lessons from the farm

DONNA HAZELL

Conservation on private land is a major challenge for ecologists, policy makers and landholders. This paper presents an example of ecological research on private land in southeastern Australia where landholder involvement was central. An ethical approach to ecological research on private land is presented as well as some lessons learnt from landholder involvement. With consideration of these issues ecologists working on private land are likely to be in a better position to make management recommendations for conservation that are meaningful, agriculturally practical and possible for landholders to apply.

Distribution of the amphibian chytrid *Batrachochytrium dendrobatidis* and keratin during tadpole development

GERRY MARANTELLI, LEE BERGER, RICK SPEARE and LEIGH KEEGAN

A large outbreak of chytridiomycosis occurred in captive metamorphs of *Mixophyes fasciolatus* that died between 9 and 25 days post metamorphosis. The mortality rate in infected tubs was 100% and more than 500 frogs died. Examination of the husbandry records suggested that tadpoles had been infected before two weeks of age. However, a sample of tadpoles separated before hatching remained uninfected. We studied the changes in distribution of keratin and sporangia of *Batrachochytrium dendrobatidis* in tadpoles during development, by examination of histology sections stained with Ayoub-Shklar stain. Keratin occurred only on the mouthparts during most of tadpole life, and appeared on the feet shortly before metamorphosis. At metamorphosis the keratinized mouthparts are shed before keratin forms on the skin of the body. *B. dendrobatidis* only occurred on keratinized, stratified epidermis and followed the changes in distribution. There is a rapid redistribution of *B. dendrobatidis* at metamorphosis leading to fatal infection in *M. fasciolatus*. These findings are useful considerations when translocating tadpoles as well as for diagnosis and treatment.

Avian use of farm habitats, including windbreaks, on the New South Wales Tablelands

DR. CILLA KINROSS

Many windbreaks are being planted on the Tablelands of New South Wales, Australia to provide shelter for stock and crops, but little is known of the effect of these linear plantations on the regional bird community. This paper compares the avian diversity, density and species composition in a range of habitats in agricultural landscapes, including farm windbreaks, and draws conclusions as to the benefits of windbreaks to bird conservation.

The data were collected between 1993 and 1997 with 12 visits to each of 84 sites, placed *a priori* into seven habitat types on six grazing properties in the Tablelands of New South Wales, Australia and analysed using ANOVA and canonical variate analysis to identify bird-habitat relationships and patterns.

Species diversity and density were found to be highest in remnant woodland and lowest in grassland, but differences between other habitats were less robust. Windbreaks >19 m wide were closer in diversity and species composition to remnant woodland than windbreaks ≤15 m wide.

Of the 105 bird species observed, 17 were confined to remnant woodland and 67 native species were observed using planted sites. These species were not, as had been predicted, entirely composed of generalist-opportunistic species, but, particularly in the wider planted sites, included several woodland species identified as declining in this region.

Although clearly not as important as remnant woodland, farm windbreaks, shelterbelts and woodlots of suitable size and composition appear to contribute significantly to avian diversity in agricultural areas and their planting should be encouraged and supported by the rural community and government.

The activity of Sand Goannas *Varanus gouldii* and their interaction with reintroduced Greater Stick-nest Rats *Leporillus conditor*

JULIA BOLTON and KATHERINE MOSEBY

The activity pattern of the Sand Goanna *Varanus gouldii* in northern South Australia was estimated by radio telemetry during the summer months. Individuals were located within the Arid Recovery Reserve where introduced European Rabbits *Oryctolagus cuniculus*, Feral Cats *Felis catus* and European Foxes *Vulpes vulpes* were removed. Interaction between the re-introduced Greater Stick-nest Rat *Leporillus conditor* and the Sand Goanna, a potential significant predator in the absence of cats and foxes, was examined.

Mean activity area for Sand Goannas was 5.9 ha (± 1.0 , n = 9), and their summer activity was concentrated on sand dunes rather than the adjacent inter-dunal swales. Tracks of Sand Goannas were found more often around Greater Stick-nest Rat nests than control sites. However, Sand Goanna predation on re-introduced Greater Stick-nest Rats could not be confirmed and most deaths of radio-collared Greater Stick-nest Rats coincided with a period of exceptionally high maximum temperatures and were probably due to heat and dehydration. Sand Goannas scavenged Greater Stick-nest Rat carcasses, and analysis of scats and stomach material revealed that although invertebrates were the most common prey item, mammal material (hair and bones) was present in 20% of scats.

Volume 10 Number 4

News and Views

News from the Australasian Section of the Society for Conservation Biology

TISH SILBERBAUER, ANDY MACK and KAREN FIRESTONE

Research Papers

The influence of Feral Cats *Felis catus* on the distribution and abundance of introduced and endemic Galápagos rodents

NICK DEXTER, ROBERT C. DOWLER, JOSEPH P. FLANAGAN, SHARELLE HART,
MARCIA A. REVELEZ and THOMAS E. LEE Jr.

The impact of feral cats on the distribution and abundance of endemic and introduced rodents in the Galápagos Islands, Ecuador was assessed by sampling the rodent fauna of islands with and without cats. All islands where endemic rodents are known to have previously occurred were sampled. No new species of rodent or species considered extinct were recorded, but all species of endemic rodents believed to be extant were recorded. All islands sampled had rodents, but no endemic rodents were recorded on islands with cats. To examine whether endemic rodents had a potentially higher susceptibility to predation by cats compared to introduced rodents, the aversion of rodents to the scent of cats was tested by placing dried cat faeces on every second trap at each site trapped and the difference in trap success between endemic and introduced rodents compared. Introduced rodents on islands with feral cats were significantly less likely to enter traps with cat faeces compared to endemic and introduced rodents on islands without cats. This suggests that Galápagos endemic rodents may be more susceptible to predation by cats than introduced rodents because of the lack of an innate aversion to cats.

Characteristics of Brown Treesnakes *Boiga irregularis* removed from Guam's transportation network

DANIEL S. VICE AND DIANE L. VICE

The accidental introduction of the Brown Treesnake *Boiga irregularis* to Guam led to catastrophic ecological and economic consequences, including the extirpation of most native forest birds and millions of dollars in damages to the island's power distribution system. Since colonizing the island in the late 1940s, Brown Treesnakes associated with cargo from Guam have arrived at numerous locations throughout the world. Concerns for the potential establishment of other populations have led to intensive control efforts, aimed at the prevention of snake dispersal from the island. Information regarding snakes entering the outbound cargo flow is critical in the development and implementation of both operational control strategies and research necessary to improve available control technologies. Data collected from 31 snakes removed from the outbound cargo network on Guam reveal the typical snake in cargo is smaller in snout-vent length than the average snake captured using traps or hand capture in support of operational control. Potential reasons for small snakes in cargo include the presence of a snake cohort refractory to capture methods, and/or the nomadic behaviour of sub-adults. Additionally, snakes have been found in nearly every location that handles or processes cargo, indicating the need for containment efforts throughout the outbound shipping process. Intensive containment, coupled with the continued development of techniques that effectively capture small snakes, is necessary for successful interdiction efforts.

Critical review of threatened species collections in the New South Wales Seedbank: implications for *ex situ* conservation of biodiversity

C. A. OFFORD, M. L. McKENSY and P. V. CUNEO

This article reviews the germinability and viability of seeds of threatened species collections in the New South Wales (NSW) Seedbank with the manifold aims of: ensuring that existing storage treatments and conditions provide effective *ex situ* storage of threatened species seed; providing baseline viability and seed storage life data on threatened species; and, identifying research gaps in seed germination and storage protocols for threatened species and communities. The germinability and viability of a range of seed accessions, of various ages and stored under different (although mainly identifiable) conditions in the NSW Seedbank, was determined through germination and cut-tests. The results indicated that many of the Fabaceae, Myrtaceae and Proteaceae species tested are orthodox and can be stored at 5 to 10% moisture content at 5°C for up to ten years without significant loss of viability (short- to medium-term storage). The best results were obtained in the lower seed moisture content range (2 to 9%), which appeared to be especially critical for long-term storage of many Proteaceae accessions, reinforcing the need to attain the correct seed moisture content for long-term storage. Around 10% of accessions exhibited some degree of dormancy even after long storage periods. Storage of the widest range of species, for periods greater than ten years for long-term conservation purposes, is generally best conducted by storing at sub-zero temperatures. Freezing at -18°C had little effect on the germinability of a range of seeds tested and is recommended over storage at 5°C. Collection and seedbanking procedures for the NSW

Seedbank will be regularly reviewed and procedures modified in order to identify the best long-term storage conditions for species within this and other seedbanks.

Seed collection strategies to maximize diversity and uses of seedbanks in conservation are discussed.

Rediscovery of an endangered frog *Platymantis vitianus*, on mainland Fiji: implications for conservation and management

C. MORRISON, A. NAIKATINI, N. THOMAS, I. ROUNDS, B. THAMAN, and J. NIUKULA

Many herpetofauna species in the Pacific region have undergone dramatic declines due to invasive species, primarily introduced predators. Fiji has two species of endemic frogs (Family Ranidae, Genus *Platymantis*) one of which, the Fiji Ground Frog, *P. vitianus*, has been extirpated from much of its original range due to the mongoose *Herpestes javanicus*. We conducted a short-term follow up survey to confirm an earlier report (September 2003) of the co-existence between mongoose and the ground frog on mainland Fiji (Vanua Levu). We used systematic nocturnal and diurnal surveys to census the frog fauna of Waisali Reserve and described microhabitat and threatening processes. A series of key management actions are outlined to facilitate the long-term conservation of this frog in the reserve.

Exhaustive sampling in a Southern Hemisphere global biodiversity hotspot: inventorying species richness and assessing endemism of the little known jarrah forest spiders

KARL E. C. BRENNAN, MELINDA L. MOIR and JONATHAN D. MAJER

Spiders from Southern Hemisphere temperate ecosystems may contribute substantially to global biodiversity in terms of species richness and distinctiveness of the biota. To date, few studies have considered their potential contribution in this context and most have restricted focus to a limited number of families. Here richness, endemism and the proportion of described taxa at specific, generic and familial ranks are examined from a global biodiversity hotspot. Spiders were sampled from a region of Jarrah *Eucalyptus marginata* Forest (approx. 20 000 ha) in southwestern Australia (32°16'S, 116°06'E). Two hundred and eighty-seven species (from 138 described genera, and 46 families) were collected. Using the ACE, ICE and Chao2 estimators, the inventory was considered 93 to 95% complete. Continued sampling, however, would be costly as the effort to add one additional species had become high in terms of the number of specimens collected per additional species. Taxonomic knowledge of the fauna was limited for most groups. Only 83 species (29%) could be assigned a name. Of the remaining unnameable species, >95 could not be assigned to described genera. Six could not be assigned to a family. Where possible, analyses showed high levels of endemism at generic and species levels; 64% of described genera were known only from Gondwanan land-masses, 41% were endemic to Australia. Most described species were known only from Australia (77%). Of these, >36% had only been collected within Western Australia (most were known only from the South-West Botanical Province). However, these results are constrained as few countries have as limited knowledge of their spider fauna as Australia.

Use of instream wood habitat by Trout Cod *Maccullochella macquariensis* (Cuvier) in the Murrumbidgee River

IVOR GROWNS, IAN WOODEN and CRAIG SCHILLER

Microhabitat use of instream wood habitat by Trout Cod *Maccullochella macquariensis* (Cuvier), a critically endangered species with a restricted distribution, was examined in the Murrumbidgee River in New South Wales, Australia. Habitat variables were scored or measured at 100 m intervals along the river or wherever Trout Cod were captured using electrofishing. The occurrence of Trout Cod was significantly dependent on the presence of instream woody habitat and 95% of samples where trout cod were caught were associated with the presence of woody habitat. Trout Cod were more likely to be found on simply-structured woody habitats, away from the river-bank and their abundance showed no relationship with water velocity. The low abundance of other fish species at the sampling sites suggests that the relationships demonstrated are not due to inter-species interactions. The results will assist with specific management actions to restore and protect populations of this endangered species.

The role of connectivity in Australian conservation

M. E. SOULÉ, B. G. MACKEY, H. F. RECHER, J. E. WILLIAMS, J. C. Z. WOINARSKI,
DON DRISCOLL, W. C. DENNISON and M. E. JONES

The existing system of nature reserves in Australia is inadequate for the long-term conservation and restoration of native biological diversity because it fails to accommodate, among other elements, large scale and long-term ecological processes and change, including physical and biotic transport in the landscape. This paper is an overview of the connectivity elements that inform a scientific framework for significantly improving the prospects for the long-term conservation of Australia's biodiversity. The framework forms the basis for the WildCountry programme. This programme has identified connectivity at landscape, regional and continental scales as a critical component of an effective conservation system. Seven categories of ecological phenomena are reviewed that require landscape permeability and that must be considered when planning for the maintenance of biological diversity and ecological resilience in Australia: (1) trophic relations at regional scales; (2) animal migration, dispersal, and other large scale movements of individuals and propagules; (3) fire and other forms of disturbance at regional scales; (4) climate variability in space and time and human forced rapid climate change; (5) hydroecological relations and flows at all scales; (6) coastal zone fluxes of organisms, matter, and energy; and, (7) spatially-dependent evolutionary processes at all scales. Finally, we mention eight cross-cutting themes that further illuminate the interactions and implications of the seven connectivity-related phenomena for conservation assessment, planning, research, and management, and we suggest how the results might be applied by analysts, planners, scientists, and community conservationists.

Pacific Conservation Biology

**Order Form and Subscription information appears at the end of this document —
please complete and return it to Surrey Beatty & Sons**

Volume 11 Number 1

Forum Essay

The South East Queensland Forests Agreement: Lessons for Biodiversity Conservation

C. A. McALPINE, A. PETERSON and P. NORMAN

News and Views

News from the Australasian Section of the Society for Conservation Biology

T. SILBERBAUER and K. FIRESTONE

in

Theme: Forests/Forestry

Native species dominate the millipede fauna in a second-rotation *Pinus radiata* plantation in Tasmania, Australia

ROBERT MESIBOV

Soil-dwelling millipedes were methodically hand-sampled in two second-rotation *Pinus radiata* stands in Stoodley Plantation in north-central Tasmania. Eleven of 14 species collected were natives, and native millipedes comprised 83% of the 1 456 identified specimens. The average millipede catch in 40×0.5 m² quadrats was 74 individuals/m². All nine of the native species of Chordeumatida, Polydesmida and Polyzoniida found in the survey had previously been collected in native forest within a 10 km radius of the pine plantation. Historical records indicate that Stoodley Plantation was established on abandoned farmland, and the two sampled areas have carried *P. radiata* for at least 60 years. The survey results support the suggestion that plantation development on cleared farmland can assist in local-scale conservation of native invertebrates.

Hollow-bearing trees in large glider habitat in south-east Queensland, Australia: Abundance, spatial distribution and management

TERESA J. EYRE

This study examined factors influencing the distribution of live and dead trees with large diameter hollows (>10 cm) in a productive coastal lowland forest of south-east Queensland. Forest age and type, historic logging rules and topographic position influenced the distribution of live hollow-bearing trees across the landscape. Also, some tree species (*Eucalyptus acmenoides*, *Corymbia intermedia* and *C. trachyphloia*) contained hollows at smaller diameters than others (*C. citriodora*, *E. siderophloia* and *E. fibrosa*), suggesting variation in rates of hollow formation among species. The average number of live hollow-bearing trees throughout the forest was 3.4 ± 0.4 per ha (mean \pm s.e.), which is lower than the number of hollow-bearing trees to be retained during logging operations as specified by the Queensland Code of Practice for Native Forest Timber Production. The dead hollow-bearing tree resource is therefore important, and made up 42.3% of the total hollow-bearing tree resource. Dead hollow-bearing trees were available predominantly due to intensive silvicultural treatment conducted throughout the forest >50 years ago. However, the abundance of dead hollow-bearing trees appears to be influenced by fire management. If current management practices persist, it is predicted that in 50 years the dead hollow-bearing tree resource will be depleted. If so, the hollow-bearing tree resource for the Yellow-bellied Glider *Petaurus australis* and in particular, the Greater Glider *Petauroides volans*, will be critically limited in the study area.

The status of hollow-bearing trees required for the conservation of arboreal marsupials in the dry sclerophyll forests of south-east Queensland, Australia

KEVIN RAY WORMINGTON, DAVID LAMB, HAMISH IAN McCALLUM
and DAMIEN JOHN MOLONEY

At 38 sites in the dry sclerophyll forests of south-east Queensland, Australia, hollow-bearing trees were studied to determine the effects of past forestry practices on their density, size and spatial distribution. The density of hollow-bearing trees was reduced at sites that had been altered by poisoning and ringbarking of unmerchantable trees. This was especially the case for living hollow-bearing trees that were now at densities too low to support the full range of arboreal marsupials. Although there are presently enough hollow-bearing stags (i.e., dead hollow-bearing trees) to provide additional denning and nesting opportunities, the standing life of these hollow-bearing stags is lower than the living counterparts which means denning and nesting sites may be limited in the near future. The mean diameter at breast height (DBH) of hollow-bearing stags was significantly less than that of living hollow-bearing trees. This indicated that many large hollow-bearing stags may have a shorter standing life than smaller hollow-bearing stags. Hollow-bearing trees appear to be randomly distributed throughout the forest in both silviculturally treated and untreated areas. This finding is at odds with the suggestion by some forest managers that hollow-bearing trees should have a clumped distribution in dry sclerophyll forests of south-east Queensland.

The impact of recent logging and pond isolation on pond colonization by the frog *Crinia signifera*

B. LAUCK

A colonization experiment was used to investigate landscape use of a commercially managed wet forest in southern Tasmania by the ground-dwelling frog, *Crinia signifera*. Replicated artificial ponds were placed at increasing distances (20, 100, 250 and 500 m) from nine permanent breeding sites to investigate the effect of pond isolation on colonization. Four of these permanent breeding sites were surrounded by coupes that had been logged within the previous five years and five permanent breeding sites were surrounded by unlogged forest to investigate the effect of recent logging on colonization. The rate of colonization, the frequency of colonization, male size and female size (inferred from clutch size) were monitored over two breeding seasons. No pond isolation effects were found, indicating that *C. signifera* is randomly distributed throughout the forest landscape for up to 500 m around each permanent breeding site. Such patterns of forest habitat use indicate that management prescriptions should not only take into account the habitat characteristics of breeding sites but should also consider the surrounding terrestrial landscape. Ponds surrounded by unlogged forest were colonized almost two times faster than ponds surrounded by logged forest indicating that landscape modification can significantly alter amphibian mobility. These findings have consequences for total reproductive output especially in landscapes where breeding sites are highly variable and for species that are slow to colonize new breeding sites.

The occurrence of hollows in eucalypts and Ironwood *Erythrophleum chlorostachys* in the Gulf region of the Northern Territory and its implications for timber harvesting

R. J. TAYLOR and R. A. CHISHOLM

The occurrence of hollows in eucalypts and Ironwood *Erythrophleum chlorostachys* was examined in different habitats in Limmen National Park in the Gulf Falls and Uplands bioregion of the Northern Territory. For each tree sampled, the diameter of the trunk at breast height (DBH) and numbers of hollows in three size categories were recorded.

It was found that the riparian zone had the highest density of hollows per unit land area, followed by the rocky hill zone, and then the sandy flat zone. The relationship between hollows per tree and DBH was compared for four species: *Eucalyptus camaldulensis* (the dominant riparian tree), *Eucalyptus leucophloia* (the dominant tree on rocky hills), *Eucalyptus miniata* (the dominant tree on sandy flats), and Ironwood. *E. miniata* and Ironwood were found to have fewer hollows for a given DBH.

It is suggested that the low incidence of hollows in Ironwood is a result of the species' known resistance to termites. The low number of hollows per Ironwood tree, the scarcity of Ironwood in the study area, and the small size of Ironwood trees relative to most of the eucalypts resulted in very few Ironwood hollows overall. This considered, harvesting of Ironwood (a preferred timber species) in this area is unlikely to have an impact on the availability of hollows to fauna. Further research is required to clarify discrepancies with other studies, and assess whether these results apply more broadly, for instance to wetter areas with larger Ironwood trees.

Research Paper

Terrifying tourists and wary wallabies: responses of macropodid species to the presence of humans

NARELLE G. KING, KAREN B. HIGGINBOTTOM and JOHANNES J. BAUER

The responses of four species of macropodid to humans at a wildlife sanctuary were investigated experimentally. Bridled Naitail Wallabies *Onychogalea faenata*, Red-necked Wallabies *Macropus rufogriseus* and Swamp Wallabies *Wallabia bicolor* all spent less time feeding, resting, grooming, interacting and more time looking up or moving in the five minutes after being approached by the researcher. Eastern Grey Kangaroos *M. giganteus*, Red-necked Wallabies and Bridled Naitail Wallabies fled at shorter distances from an approaching researcher in a vehicle than from a researcher on foot. The proportion of macropodids found in grassland compared with forest was not significantly affected by a recent tour.

To minimize negative impacts of tours on macropodids in the sanctuary, it may be necessary to conduct tours in vehicles rather than on foot.

Volume 11 Number 2

News and Views

News from the Australasian Section of the Society for Conservation Biology

NICOLA NELSON

Research Papers

Native vegetation of coastal floodplains — a diagnosis of the major plant communities in New South Wales

DAVID A. KEITH and JUDITH SCOTT

Coastal floodplains are among the most modified landscapes in southeastern Australia. We used available vegetation survey data for coastal alluvium and other unconsolidated Quaternary sediments to construct a diagnosis of the major plant communities and document their flora. We used soil landscape maps and historical portion plans to gain an understanding of the distribution and environmental relationships of the communities. The flora of coastal floodplains includes more than 1 000 native vascular plant taxa and more than 200 introduced taxa. The introduced flora is likely to be considerably larger, given that sampling was biased toward the least disturbed sites. Six major plant communities were diagnosed including a rainforest found north from the Shoalhaven floodplain, a mixed forest of eucalypts and melaleucas found north from Jervis Bay, a casuarina forest (sometimes with melaleuca) found throughout the coast, one open eucalypt forest found principally south from the Hunter region, another open eucalypt forest found north of the Hunter region and a complex of treeless wetland assemblages scattered throughout the coast. The extent and spatial arrangement of these communities varies between floodplains, with landform, rainfall, water regime and soil properties including moisture, fertility and salinity thought to be important factors mediating their distribution patterns. All six assemblages are listed as Endangered Ecological Communities under Threatened Species legislation. The coastal floodplain communities continue to be threatened by land clearing and crop conversion, fragmentation, changes to water flows, flooding and drainage, input of polluted runoff, weed invasion, activation of acid sulphate soils, climate change and degradation through rubbish dumping and other physical disturbances.

Distribution, biology and prey selection of the introduced Norway Rat *Rattus norvegicus* at Kiska Island, Aleutian Islands, Alaska

HEATHER L. MAJOR and IAN L. JONES

At Kiska Island, Alaska, USA we quantified age, sex, size, distribution and predation of Least Auklets *Aethia pusilla* by non-indigenous Norway Rats *Rattus norvegicus*, to evaluate their impact on auklet reproductive success. Rat distribution was assessed by surveying accessible parts of Kiska Island for rat sign and prey hoards. To quantify prey selection and infer diet, the contents of all hoards found were identified. Age, sex and size structure of the rat population was assessed using limited snap trapping on and off the Sirius Point auklet colony. Norway Rat sign was abundant in all areas near breeding seabirds and marine sources of food but rat sign abundance varied among years at Sirius Point. Although we found a larger proportion of juvenile to adult rats (0.54 : 0.46, $p < 0.01$) at Sirius Point, no significant differences were found in the proportion of reproductive to non-reproductive females (0.50 : 0.27, $p > 0.05$) or in overall adult body size (257 g and 37 cm : 236 g and 35 cm, $p > 0.05$) between Sirius Point and Christine Lake where breeding auklets are absent. Surplus killing and food hoarding by rats was noted in all years during the auklet laying period, with adult Least Auklets being the principal prey taken (4–148 individuals per hoard, $n = 16$ hoards). Our observations were consistent with the notion that rats have a negative impact on auklet populations, but for management purposes further information on whether rats are the sole cause of auklet reproductive failure is required.

Decline in the prevalence of chytridiomycosis in frog populations in North Queensland, Australia

K. R. McDONALD, D. MÉNDEZ, R. MÜLLER, A. B. FREEMAN and R. SPEARE

In the early 1990s stream-associated amphibian populations in tropical upland North Queensland experienced severe declines resulting in extinction of three species, local elimination of four species, marked reductions in one species and apparently no declines in other species. Chytridiomycosis, a disease due to the amphibian chytrid fungus, *Batrachochytrium dendrobatidis*, was the likely cause of this epidemic. We conducted a monitoring study for chytridiomycosis in four species of frogs in North Queensland from October 1998 to October 2002 by collecting specimens in the field and using histology of removed digits to diagnose chytridiomycosis. Chytridiomycosis was diagnosed in 112 (7.1%) of the 1 578 specimens and prevalence was significantly associated with season and altitude, with higher prevalences in winter and above 300 metres altitude. A multivariate model adjusting for potential confounding effects arising from the sampling process demonstrated a significant decline in the time trend of prevalence of chytridiomycosis. The study supports the hypothesis that *B. dendrobatidis* becomes endemic after the initial epidemic wave. Since the surviving species of stream-associated frog, *Litoria genimaculata*, has increased to pre-decline numbers, the decline in prevalence of chytridiomycosis is evidence of a changed pathogen-host relationship. The reasons for this change are speculative but could be due to an increase in innate host resistance in response to selection pressure by *B. dendrobatidis* or to lower rainfall associated with an El Niño effect. These findings justify management strategies that assist susceptible amphibian species to survive an initial epidemic wave of chytridiomycosis.

A test of fluctuating asymmetry as a bioindicator of stress in antlered flies

GARY DODSON

Disturbances to the developmental processes of organisms produce phenotypic asymmetries. It has been hypothesized that populations subjected to sustained environmental stress will suffer greater developmental instability and, therefore, exhibit greater morphological asymmetry than healthy populations. Thus, sampling the average asymmetry of populations through time might be a useful indicator of the overall health of their corresponding habitat. This hypothesis was investigated using antler flies (*Phytalmia* spp.) in Papua New Guinea rainforests. The larval substrate of these flies is restricted to a few rainforest tree species found in primary forests. The prediction that fly populations in logging areas would exhibit greater asymmetry was tested by comparing fluctuating asymmetry (FA: small, random deviations from perfect symmetry) of fly populations in primary forest and logging areas, as well as from a single location across time. Only one (*P. biarmata*) of three species had significantly higher FA (according to a composite measure of wing venation) at logged sites than at intact forest sites, and the average FA decreased in a population of *P. alvicornis* over a 20-year period despite continuous logging in the area. Because some sample sizes were unavoidably small, a meta-analysis of combined effect sizes was performed and revealed a significant effect of habitat on FA across the species. Logging practices may impose stress on these flies as alleged, but if so the indication of the stress through FA levels was weak. Thus, reliance on this method as a monitoring tool for this environment should be considered with caution.

Re-establishing the endangered grassland herb *Trioncinia retroflexa* (Asteraceae)

R. J. FENSHAM and R. J. FAIRFAX

The endangered perennial herb *Trioncinia retroflexa* was re-established within suitable grassland habitat in central Queensland. The trial included direct seeding and transplanting nursery-grown seedlings during the wet season. Successful establishment may be contingent on moist surface soils at the time of planting and the maintenance of this moisture by adequate follow-up rain in the month after planting. Five years after planting there were a total of 22 mature plants and eight infertile plants within two small areas of the re-establishment trial. The established plants are now reproducing and several generations of seedlings have become established. Topographic position (ridges or swales) and post-planting fires had no significant effect on the density of the re-established population. There have been substantial fluctuations in the re-established population in concert with seasonal rainfall patterns. A patchy and small re-established population could be expected given the patchiness of the largest natural population and the relatively low rainfall of the introduction site.

Prospects for a restorative fishery enhancement of Lake Kununurra: a high-level tropical impoundment on the Ord River, Western Australia

ROBERT G. DOUPÉ, DAVID L. MORGAN and HOWARD S. GILL

The high-level irrigation water supply dams of the Ord River in tropical Western Australia impede the movement of Barramundi *Lates calcarifer* and other tropical fish species. A recreational Barramundi fishery enhancement of Lake Kununurra using a fishway has been widely promoted as advancing fishery conservation and the reformation of land and water management practices within the greater Ord River region. Of the fishways considered here, none have been found to admit Barramundi in the numbers and size classes necessary to establish or maintain the recreational fishery. Reasons for this include an inadequate understanding of fish behaviour and/or fishway design faults. The seemingly reluctant use of fishways by Barramundi might also be confounded by some observations being made on rivers where Barramundi populations are either comparatively small or non-existent. The alternative to a fishway is hatchery stocking. This option, like a dedicated Barramundi fishway, represents a single-species approach to fishery enhancement and is the least legitimate attempt to restore the ecological integrity of the fish communities of either Lake Kununurra or the Ord River. We argue that progress toward the restoration of the lake should continue, though a fishery enhancement programme that incorporates the broader fish community and not just a single species, would better rebuild the presently degraded Ord River system. Of the available options, we recommend testing an experimental model that incorporates aspects of the vertical-slot and bypass fishway designs, with the objectives being to learn migratory fish behaviour, abundance, and patterns and cues for fish movement. This approach can incorporate Barramundi as the target species to better understand entrance design constraints, minimum slot widths for larger fish, and operation under low flows during peak irrigation water demands, but still accommodate the movement of tropical fishes during these periods.

Volume 11 Number 3

News and Views

News from the Australasian Section of the Society of Conservation Biology

K. FIRESTONE and R. DAVIS

Research Papers

Foraging ecology of the Swift Parrot *Lathamus discolor* in the box-ironbark forests and woodlands of Victoria

SIMON J. KENNEDY and CHRISTOPHER L. TZAROS*

The foraging ecology of the Swift Parrot *Lathamus discolor* in the box-ironbark forests and woodlands of Victoria was investigated over three years. We sought to identify features that characterized Swift Parrot foraging habitats. A total of 159 foraging sites was found, mainly in box-ironbark forests or nearby woodlands, and were located at a disproportionately high frequency on drainage lines, and a correspondingly low frequency on ridges. The species was observed foraging on 12 eucalypt and one *Acacia* species, but more than 90% of observations were of birds using Red Ironbark *Eucalyptus tricarpa*, Mugga Ironbark *E. sideroxylon*, Yellow Gum *E. leucoxylon* or Grey Box *E. microcarpa*. Nectar, lerp and other food from eucalypt foliage were frequent dietary items. Foraging and random sites were broadly similar in tree size-class structure. However, Swift Parrots selected trees in larger size classes for foraging more often than expected given the relative abundance of such trees. Larger trees flowered more reliably across the study area in all years.

The habitat of the Swift Parrot in the study area is extensively fragmented and degraded, and management to increase the density of larger trees is recommended. We found considerable between-year variation in regional distribution and relative use of principal tree species. The five identified regions within the study area all supported a significant percentage of the population in at least one of the three years. As a result, recovery measures will need to target important sites across the geographical extent of the study area.

Estimating population size of the Black-eared Miner, with an assessment of landscape-scale habitat requirements

ROHAN H. CLARKE, REBECCA L. BOULTON and MICHAEL F. CLARKE

The decline of the Black-eared Miner *Manorina melanotis* has been caused primarily by habitat degradation and vegetation clearance. To better direct conservation actions for this species there was a need to assess habitat requirements on a regional-scale and to estimate the population size using quantitative methods. We used vegetation mapping and the current distribution of the Black-eared Miner to determine regional-scale habitat requirements. These findings were combined with the results of distance sampling to provide population estimates. The species is restricted to large tracts of intact mallee in the Murray Mallee of southeastern Australia that have not been burnt for at least 45 years. The density of Black-eared Miners is highest in areas that are dominated by mallee-*Triodia* associations and have not been intensively grazed. The Bookmark Biosphere Reserve supports an estimated 501 (270–927, 95% CI) colonies, containing 3 758 (2 026–6 954) phenotypically pure Black-eared Miners, 2 255 (1 215–4170) hybrids and small numbers of Yellow-throated Miners *Manorina flavigula*. However, the effective population size is considerably smaller (390 Black-eared Miners (210–726) and 234 hybrids (126–433)), due to a skewed adult sex ratio (1 female: 1.81 males) and complex social organization. A smaller population also persists in the Murray Sunset National Park containing 53 (32–85) Black-eared Miner/hybrid colonies. Both populations face a high risk of extinction from large-scale wildfire. The endangered status of the species under IUCN criteria remains warranted.

Distribution, habitat, and conservation status of the Giant Barred Frog *Mixophyes iteratus* in the Bungawalbin catchment, northeastern New South Wales

B. D. LEWIS and D. A. ROHWEDER

A distribution and habitat assessment was used to determine the conservation status of the Giant Barred Frog *Mixophyes iteratus* in the Bungawalbin catchment in northeastern New South Wales. Repeated surveys were used to collect presence absence data at 70 sites between January 1997 and March 1999. Giant Barred Frogs were found at 23 sites (33%) comprising five isolated populations which may have contracted from a single remnant population. Habitat analysis revealed frogs showed a significant preference for sites with pool riffle sequences and the presence of undercuts and overhanging vegetation on the primary stream bank. Principal Components Analysis identified five habitat variables that accounted for 73% of the variability in our bi-variate data. We found the level of disturbance to riparian and instream habitats significantly influenced frog distribution, but this trend was not apparent when adjacent habitats outside the riparian zone were analysed. We propose that sedimentation of waterways may have facilitated this decline due to a reduction in the permanency of surface water flows resulting in reduced recruitment opportunities.

An inventory of the invertebrates of the Tasmanian Wilderness World Heritage Area

STEPHEN A. MALLICK and MICHAEL M. DRIESSEN

This paper summarizes the information contained in an inventory of invertebrates recorded from the Tasmanian Wilderness World Heritage Area (WHA). The WHA covers an area of 1.38 million hectares in the western half of Tasmania. A total of 1397 terrestrial/freshwater species from 293 families in nine phyla are listed as occurring in the WHA. The most diverse phylum is the Uniramia (904 species, 172 families), followed by the Chelicerata (179 species, 56 families), Aschelminthes (Rotifera: 90 species, 22 families), Crustacea (88 species, 21 families), Mollusca (69 species, 14 families), Annelida (57 species, five families), Platyhelminthes (eight species, one family), and the Onychophora and Nemertea (one species each). Sixty-three marine and estuarine species from six phyla are listed for the limited area of marine/estuarine habitat within the WHA. The terrestrial/freshwater WHA invertebrate fauna is characterized by high Tasmanian endemism (46.7% of species are Tasmanian endemics), and a high proportion of species with a predominantly western-Tasmanian distribution and/or a restricted geographical range. The WHA includes the globally unique Bathurst Harbour estuarine system. The marine and estuarine invertebrate fauna of the estuary is largely undescribed, but is likely to show very high levels of Tasmanian and local endemism. The characteristics of the WHA invertebrate fauna reflect the extant habitats of the area, as well as past geological and climatic processes that have led to their development. The WHA contains 16 threatened invertebrate species, while a total of 34 introduced terrestrial and seven introduced marine invertebrate species have been recorded from the WHA. The invertebrate fauna of the WHA contributes substantially to the World Heritage faunal values of the area. Formal

description of currently undescribed material from Bathurst Harbour is likely to substantially add to the World significance of the WHA. The high level of protection afforded the WHA makes the area important for long-term invertebrate fauna conservation in Tasmania. A full inventory of species can be viewed on the Tasmanian Department of Primary Industries, Water and Environment (DPIWE) website (www.dpiwe.tas.gov.au).

The effect of causeway construction on seagrass meadows in the Western Pacific — a lesson from the ancient city of Nan Madol, Madolenihmw, Pohnpei, FSM

ROB COLES, LEN MCKENZIE, STUART CAMPBELL, RUDI YOSHIDA,
AHSER EDWARD and FRED SHORT

Two seagrass meadow sites were chosen at Nan Madol adjacent to the now permeable remnants of an ancient causeway constructed 500 to 700 years ago: one immediately on the shoreward side of the causeway, and one immediately on the seaward side. The shoreward site had greater seagrass cover, canopy height, algal abundance, and epiphyte abundance and lower species diversity (both seagrass and macro-algae), as well as muddier sediments than the seaward site. The abundance of associated fauna did not appear to differ between sites, although the composition of the faunal communities was different. On the seaward site, average epiphyte cover was less than one-tenth the epiphyte cover of that on the shoreward side. *Halimeda* species were the most common algae on the seaward side, while on the shoreward side *Hypnea* species were dominant. *Cymodocea rotundata* was the dominant seagrass species (54% of seagrass cover) on the seaward site, but was absent on the shoreward site, which was dominated by *Thalassia hemprichii* (84%) and *Enhalus acoroides* (16%). There was no difference in salinity between the two sites. Sediments had a higher proportion of fine mud shoreward. The beche-de-mer, *Holothuria atra*, was common on the seaward side of the causeway, but not on the shoreward side. The causeway is open to water flow at all tide heights and does not appear to influence water height in any way. The effects of even this simple permeable barrier on seagrass meadows are evident and include differences in seagrass species, algal species, and fauna. We discuss the management lesson from this historic location for present-day Pacific island causeway developments.

Volume 11 Number 4

News and Views

News from the Australasian Section of the Society of Conservation Biology

NICOLA NELSON and HARRY RECHER

Research Papers

Environmental weed control policy in Australia: current approaches, policy limitations and future directions

T. J. MASON, W. M. LONSDALE and K. FRENCH

Plant invasions of natural systems threaten biodiversity and ecosystem processes across many biomes. Historically most plant invasions have been facilitated by human activities such as industry, transport and landscape modification. Consequently, both causes and management of weed invasion are dependent on human behaviour and management advice provided by ecologists needs to take account of this fact. This paper assesses current environmental weed control policy in Australia and asks: are government, land managers and the scientific community using available social levers to achieve optimal weed management? We do this by comparing aspects of weed policy with a generalized natural resource policy framework. Adequacy of issue characterization and policy framing are discussed with particular reference to public perceptions of the weed problem, policy scaling and defining policy principles and goals. The implementation of policy instruments, including regulation, voluntary incentives, education, information, motivational instruments, property-right instruments and pricing mechanisms are reviewed. Limitations of current instruments and potential options to improve instrument effectiveness are discussed. Funding arrangements for environmental weed

control are also reported: environmental weed invasion generally represents an external cost to economic markets which has resulted in relatively low funding levels for control operations. Finally, review and monitoring procedures in weed programmes and policy are addressed. Rigorous monitoring systems are important in effective, adaptive weed management where control techniques are continually refined to improve ecological outcomes. The utility of maintaining links between project outcomes and policy inputs along with methods of implementing appropriate monitoring are discussed.

Floristics and structure of the mossy cloud forest of Mt Gower summit, Lord Howe Island

REBECCA HARRIS, GERASIMOS CASSIS, TONY AULD and IAN HUTTON

The summit of Mt Gower, Lord Howe Island (31°33'S, 159°05'E), is a small area of 27 ha supporting mossy cloud forest. This study describes patterns in the floristic composition and structure of the vegetation of the summit, in relation to a range of environmental variables. A total of 42 vascular plant species was recorded, 86% of which are endemic to Lord Howe Island, and 17% of which are found only on the summit and upper slopes of Mt Gower and adjacent Mt Lidgbird. A complete species list for Mt Gower is presented, including species from the present survey and all previously recorded species. The composition of the vegetation differed in gullies and on ridges, reflecting differences in substrate rockiness and soil moisture, and was also influenced by the number of bird burrows and aspect. The summit of Mt Gower is of high conservation significance, due to the restricted distribution of the habitat type it represents, its relatively undisturbed state and high levels of endemism. Potential threats to the summit vegetation include the impacts of climate change, seed predation by introduced rats, and the introduction of weed species and exotic pathogens such as *Phytophthora cinnamomi*.

Eradicating Feral Cats to protect Galapagos Land Iguanas: methods and strategies

R. B. PHILLIPS, B. D. COOKE, K. CAMPBELL, V. CARRION,
C. MARQUEZ and H. L. SNELL

A three-year programme to eradicate Feral Cats *Felis catus* from the island of Baltra in the Galapagos archipelago achieved good results by initially poisoning with sodium monofluoroacetate (compound 1080) then trapping or shooting the remaining cats. The poisoning campaign removed 90% of the cats, its success being attributable to pre-baiting with unpoisoned baits to accustom cats to eating baits and placing enough baits to ensure that all cats encountered several baits within their home range. This, together with the use of metaclopramide (Pileran) as an anti-emetic, overcame a problem associated with poor retention of 1080 in thawed fish baits that limited the dose available to 1 mg 1080/bait, a quantity insufficient to kill large cats. Removal of the remaining cats was delayed by a weather-induced irruption of Black Rats *Rattus rattus* and House Mice *Mus musculus* that enabled recruitment of kittens in 2002, but made cats more susceptible to trapping and shooting in 2003 when rodent populations collapsed. Since July 2003 no sign of a cat has been detected on Baltra despite extensive searching and monitoring throughout 2004. As cat abundance has decreased there have been more locally-bred juvenile iguanas (*Conolophus subcristatus*) seen during annual censuses. However, such recruitment may reflect the increasing maturity and higher fecundity of iguanas repatriated from 1991 onwards rather than being a direct result of reduced cat predation alone. More time is necessary to determine the benefits of reduced cat predation on the iguana population.

Mammals or reptiles, as surveyed by pit-traps, as bio-indicators of rehabilitation success for mine sites in the goldfields region of Western Australia?

GRAHAM G. THOMPSON and SCOTT A. THOMPSON

We compare the relative merits of using mammals and reptiles as bio-indicators of rehabilitation success for mine sites in the semi-arid goldfields region of Western Australia (WA). Based on 54 600 pit-trap days of data we found that both mammals and reptiles colonized rehabilitated areas that were between three and nine years old. The complete suite of mammals generally return in the early stages of the rehabilitation programme, whereas the movement of reptiles into a rehabilitated area is spread over a much longer period. More reptile species seem to have specific requirements that are provided in the latter stages of the rehabilitation process. Using criteria of relative abundance, species richness, habitat

preference, activity area and period, diet and foraging strategies, reptiles were assessed as a better bio-indicator than mammals. On other criteria such as population fluctuations, colonizing capacity and sensitivity to environmental changes, differences between reptiles and mammals were not as clear but most favoured reptiles as the preferred bio-indicator. Overall, we judged reptiles to have more merit as bio-indicators of rehabilitation success than mammals in the Ora Banda area.

Threatened plant communities of Western Australia. 2 The seasonal clay-based wetland communities of the South West

N. GIBSON, G. J. KEIGHERY, M. N. LYONS and B. J. KEIGHERY

The communities of seasonal clay-based wetlands of south-west Australia are described. They are amongst the most threatened in Western Australia. It is estimated that >90% of the original extent of these communities has been cleared for agriculture, and the remaining areas, despite largely occurring in conservation reserves, are threatened by weed invasion and rising saline groundwater. Thirty-six taxa are identified as claypan specialists occurring in six floristic communities. Composition was strongly correlated with rainfall and edaphic factors. The most consistent attribute shared between the seasonal clay-based wetlands of south-west Australia, and the analogous vernal pools systems of California, Chile, and South Africa was the widespread conversion of these wetlands to agricultural systems. The south-west Australia wetlands had a richer flora, different lifeform composition, higher species richness but fewer claypan specialists than the vernal pools of California. The dissimilarity in the regional floras and vegetation types from which the pool floras were recruited explain these differences.

Research Note

First record of Blainville's Beaked Whale *Mesoplodon densirostris* in Fiji

MATTHEW S. LESLIE, AISAKE BATIBASAGA, DIANA S. WEBER,
DAVID OLSON and HOWARD C. ROSENBAUM

Little is known about the conservation status and geographic range of beaked whales. This note provides the first record of a Blainville's Beaked Whale *Mesoplodon densirostris* in Fijian waters, and contributes to the available knowledge of a species poorly known in the South Pacific region. On 11 November 2003, a female beaked whale stranded near Viti Levu, Fiji. A lack of suitable references and unfamiliarity with diagnostic morphological characters inhibited species identification at the time of stranding. However, we were able to identify this specimen by using molecular genetic information and applying a diagnostic character approach. DNA sequences from the unknown specimen exhibited nucleotide character states that unambiguously identified it as a Blainville's Beaked Whale. Unfortunately, a lack of associated data collected in this particular event emphasizes a common situation around the world: untrained or poorly equipped personnel (municipalities, governmental agencies or local residents) must manage stranded marine mammals out of necessity. However, information from these events or opportunistic beach surveys assists in furthering research of conservation status and management needs.

Pacific Conservation Biology

**Order Form and Subscription information appears at the end of this document —
please complete and return it to Surrey Beatty & Sons**

Volume 12 Number 1

News and Views

News from the Australasian Section of the Society of Conservation Biology

KAREN FIRESTONE

Forum Essay

Urgent need for a systematic expansion of freshwater protected areas in Australia

RICHARD T. KINGSFORD and JON NEVILL

The continued degradation of Australia's inland aquatic ecosystems is a matter of great concern to many scientists. The following paper is a consensus statement, authored by an informal working group, and signed by several additional scientists (giving an overall total of about 50 signatures). The statement was also supported by many more who were constrained by agency obligations regarding public signature of the document. Authorship is attributed, for editorial purposes, to Richard Kingsford and Jon Nevill, the convenors of the working group. The names of the working group members and the additional signatories are listed below under "signatories".

The 40-odd endnotes of the original statement have been removed in the paper presented here. Those interested in reading this supporting information should email Jon Nevill.

Freshwater ecosystems (including inland saline wetlands and mound springs) are among the more imperilled ecosystems in the world. Australia is no exception, but their protection has lagged behind programmes of terrestrial protection. Freshwater protected areas are an essential component of biodiversity conservation programmes, but a systematic approach to their development in Australia has been slow, and hindered by incomplete ecosystem inventories at State and national levels. We examine this problem and suggest avenues for action. Further, while there is no shortage of relevant legislation and policy for protecting freshwater aquatic systems in Australia, some protective mechanisms have not yet been used, many years after their development. In some places "protection" has been only partially applied without regard to important issues of hydrologic connectivity – with species extinction as a direct consequence. The most urgent priority is to identify those aquatic ecosystems most at risk. A comprehensive national assessment of the conservation status of freshwater ecosystems should be undertaken immediately. Such an assessment would provide both a platform and an impetus for the systematic expansion of the nation's freshwater protected areas. Political will is then essential for effective conservation, utilising the plethora of conservation and management tools available.

Research Papers

Abundance and habitat associations of parrots at a hillforest site in Papua New Guinea

STUART J. MARSDEN and CRAIG T. SYMES

Despite New Guinea's importance for parrot species, there is an almost total lack of quantitative data on abundances or habitat associations of parrots on the island. We present such data for 15 parrot species within the species-rich (21 species) Crater Mountain Wildlife Management Area, Papua New Guinea. The four most abundant parrot species made up 70% of all parrots recorded in primary forest and 76% in old gardens. Several species had estimated densities of 10–60 birds per km² and we suggest that the most abundant species on New Guinea are at least as common as those on the surrounding islands. Two species of particular conservation importance, Palm Cockatoo *Probosciger aterrimus* and Pesquet's Parrot *Psittirichas fulgidus* had estimated densities of just one bird per km², while several other notably rare species included Dusky Lory *Pseudeos fuscata* and the fig-parrots *Cyclopsitta diophthalma* and *Psittaculirostris desmarestii*. Most parrot species were strongly associated with the lower and flatter areas of the site, where mature secondary forest dominated. Again, this is a pattern shared with parrots on nearby islands, and the finding emphasizes the importance of protecting lower-altitude mature forests within the region.

Present and past distribution of Australian Brush-turkeys *Alectura lathamii* in New South Wales — implications for management

ANN GÖTH, KIRSTY P. NICOL, GEOFFREY ROSS and JIM J. SHIELDS

Australian Brush-turkeys *Alectura lathamii* increasingly cause a considerable human-wildlife problem in New South Wales, especially in areas where they destroy gardens through their scratching activity. Wildlife managers lack detailed information about the overall distribution of the species, which is essential for assessing its population status and the development of sustainable management strategies. To address this, we collated 1 564 reports on Australian Brush-turkey distribution, from 1788 to April 2004. We show that the birds have disappeared from areas in the south, such as near Jindabyne, and from areas in the west, such as the Pilliga. The most obvious reasons for such a contraction are habitat destruction, hunting and predation by foxes and cats. At the same time, Brush-turkeys have recently been reported in the east, in coastal areas and the periphery of cities where the birds were previously absent or extirpated. However, we argue that such an apparent expansion should be viewed with caution, as this could partly also be explained by an increase in reporting activity, reduction in hunting pressure, and feeding by members of the public. Our analysis suggests that although the species has increased in numbers in coastal areas, it has withdrawn from regions in the southern and western part of its distribution.

Marine mammals and Japanese long-line fishing vessels in Australian waters: operational interactions and sightings

CATHERINE BELL, PETER SHAUGHNESSY, MARGIE MORRICE and BOB STANLEY

Observers from the Australian Fisheries Management Authority worked on randomly chosen Japanese long-line vessels in the Australian Fishing Zone (AFZ) between 1980 and 1997. Observer reports (n = 451) were inspected for interactions or sightings of marine mammals. An operational interaction was defined as an activity or behaviour that involved direct contact between a marine mammal and fishing gear, bait, target fish or bycatch, or indications that the marine mammal was feeding. A sighting was defined as the recording of marine mammals that passed the vessel without changing course and/or did not appear to interact with the vessel or its gear. Observers witnessed 23 interactions and made another 44 sightings of marine mammals. A further 24 interactions and sightings were relayed by crew members. Killer whales were reported most frequently; most incidences of fish being damaged, taken or frightened away were attributed to them. Eleven marine mammals were caught: two died, seven were released, and the fate of two others was not recorded. Between 1991 and 1996, when observer coverage was 11.5% overall in the AFZ, the incidence of interactions was 1.71 per million hooks set. The estimated number of interactions in that seven-year period was 157 in the AFZ. Since 1997, the long-line fishery has been conducted by Australian vessels, primarily off the east coast of mainland Australia in warm-temperate waters. A higher proportion of interactions can be expected with killer whales and short-finned pilot whales in these waters, and fewer with seals.

Toxic tucker: the potential impact of Cane Toads on Australian reptiles

JAMES G. SMITH and BEN L. PHILLIPS

Cane Toads *Bufo marinus* are a highly successful invasive species, having invaded more than twenty countries in the last 150 years. In Australia, they currently occupy more than 1 million square kilometres. Toads are highly toxic and Australian predators have no evolutionary history with the cardiac toxins in toad skin. As such, toads constitute a novel and extremely toxic prey for Australia's predators. Australia's reptiles are perhaps the largest group likely to be affected by the invasion of the toad. By examining species distributions, we conclude that 59% of agamids, 85% of the varanids and all of Australia's crocodiles and freshwater turtles are potentially at risk from toads. We then assayed eleven species of reptile; one freshwater turtle (Chelidae), two crocodiles (Crocodylidae), two dragons (Agamidae), one python (Pythonidae) and five species of monitor (Varanidae) for resistance to toad toxin. We found a high level of variation between species in resistance to toad toxin but in all cases (except for one species of crocodile) all species were easily capable of eating a toad large enough to kill them. We conclude that toads pose a real and ongoing threat to the majority of Australian reptile species we examined.

Bird communities in remnant woodland on the New England Tablelands, New South Wales

S. J. S. DEBUS, H. A. FORD and D. PAGE

We provide a geographic and landscape context for ongoing studies on bird communities in eucalypt woodland remnants on the New England Tablelands, New South Wales. We draw together several surveys that have not been published in the scientific literature, and integrate them with previously published material. A total of 142 woodland bird species, including 12 threatened species, was recorded in remnant woodland in the area above 900 m elevation from 50 km SSE to 100 km NNW of Armidale. There was a positive relationship between remnant size and bird species richness. Woodland reserves >300 ha supported significantly more species than remnants <100 ha on private land. Intensively surveyed reserves also had more species than remnants surveyed more casually. Threatened and other declining species occurred mainly in medium-sized (100–300 ha) and large reserves; foraging guilds of small to medium-sized, ground and above-ground insectivores were impoverished in degraded medium-sized and small remnants on private land. Almost the full range of woodland bird species was found at one or more sites, indicating their conservation value. However, some species were found in few sites or were only vagrants at a site. Active management will be needed to retain the current diversity of bird species in such heavily cleared landscapes.

Three evolutionarily significant units for conservation in the iguanid genus *Brachylophus*

EMMA L. BURNS, BRIAN H. COSTELLO and BRONWYN A. HOULDEN

We examined phylogenetic relationships within the genus *Brachylophus*, which comprises two endangered iguana species endemic to the South Pacific islands of Fiji and Tonga. Genetic variation among Fijian Crested Iguanas *B. vitiensis* and Fijian and Tongan Banded Iguanas *B. fasciatus* was analysed using mitochondrial DNA (mtDNA) cytochrome b (cyt b) characterized from 35 individuals from island populations. Three distinct clades of *Brachylophus* were identified. The most divergent clade comprised *B. fasciatus* from Tonga, which supports the recognition of Tongan iguanas as a separate species. Molecular clock estimates suggested that the average sequence divergence (6.4%) between Tongan and Fijian *B. fasciatus* clades equated to 7–15.8 MY of separation, confirming that extant *Brachylophus* species have a long history of evolution *in situ* in the Fijian and Tongan archipelago. Phylogenetic analyses also revealed that Fijian *B. fasciatus* and *B. vitiensis* iguana populations were not reciprocally monophyletic. One clade comprised two mtDNA haplotypes from the Fijian population of “*B. fasciatus*” iguana from Ovalau together with five *B. vitiensis* haplotypes from the Fijian islands of Monu, Monuriki, Devuilau, Waya and Yadua Taba. The other clade comprised *B. fasciatus* haplotypes from Kadavu and Gau, which was divergent from both the aforementioned Fijian clade ($d_A = 3.5\%$), and the Tongan clade ($d_A = 6.4\%$). In addition to mtDNA data, variation was assessed at microsatellite loci, and significant differentiation between iguana populations was detected. Based on both mtDNA and microsatellite analysis, the conservation priorities for these endangered lizards must be reassessed to protect iguanas as three distinct evolutionarily significant units.

Research Note

A preliminary investigation into the potential impacts of fire on a forest dependent burrowing frog species

T. D. PENMAN, F. L. LEMCKERT and M. J. MAHONY

Volume 12 Number 2

News and Views

News from the Australasian Section of the Society of Conservation Biology

NICOLA NELSON

Research Papers

Fauna-habitat relationships: a basis for identifying key stand structural attributes in temperate Australian eucalypt forests and woodlands

C. McELHINNY, P. GIBBONS, C. BRACK and J. BAUHUS

We review a representative sample of the literature concerning fauna-habitat relationships in temperate Australian eucalypt forests and woodlands as a basis for identifying some key stand structural attributes in these ecosystems. Our review identifies 56 studies in south-east and south-west Australia in which the presence or abundance of different fauna were significantly associated with vegetation structural attributes at the scale of a stand. The majority of these studies concern bird, arboreal mammal, and ground mammal habitat requirements, with relatively few studies addressing the habitat requirements of reptiles, invertebrates, bats or amphibians. We identify 34 key structural attributes from these 56 studies, by grouping similar attributes, and then representing each group with a single generic attribute. Relatively few of these attributes are incorporated into indices used to quantify fauna habitat. We highlight the need for a quantitative method for selecting which key attributes should form the basis for an index of structural complexity or other surrogate measure of faunal diversity.

Collections in space and time: geographical patterning of native frogs, mammals and reptiles through a continental gradient

R. A. HOW and M. A. COWAN

Native frog, mammal and reptile specimen data in the Western Australian Museum were examined from the western third of the Australian continent covering nearly 22 degrees of latitude and 16 degrees of longitude and encompassing tropical, desert and temperate regions. The timing of specimen data collection and collecting effort were evaluated and show that large areas of the State remain poorly sampled. The great majority of the collections have been made over the last 50 years and taxonomic status of many vertebrate species is still in review with several new species being described. Systematic surveys need to be undertaken to address the inadequacy of information on vertebrate fauna distributions over large tracts of the desert and pastoral areas of Western Australia. The distribution of taxa endemic to Western Australia, threatened and priority taxa as well as restricted-range endemic taxa were examined over equal areas based on the 1:250 000 map series that covers the western third of the Australian continent. Endemic taxa are focused in the south-west of the state and along the west coast, while restricted-range endemics are more frequently distributed along the west and northwestern coasts. Threatened and priority taxa show a similar pattern to that of endemic taxa. The similarity of areas across Western Australia, based on the composition of their vertebrate fauna, indicates that there are four broad regions corresponding to the tropical north, the mesic south-west, the semi-arid southwestern interior and the arid Pilbara and desert areas. Additionally, regional areas defined under the IBRA scheme were examined for the number of sampling locations, endemic taxa in the various faunal groups and the richness of taxa recorded. The Pilbara bioregion, one of the best-sampled areas of the State, showed limited concordance between vertebrate taxa similarity in half-degree cells and subregional boundaries and relatively high heterogeneity in vertebrate fauna distribution across the bioregion.

Is the Carpentarian Rock-rat *Zyzomys palatalis* critically endangered?

DAVID M. J. S. BOWMAN, DANIEL L. McINTYRE and BARRY W. BROOK

The Carpentarian Rock-rat *Zyzomys palatalis* is a rare conilurine rodent with a global distribution restricted to a small area of sandstone escarpments in the Gulf of Carpentaria region of the Northern Territory. Previous assessments of its World Conservation Union (IUCN) status in 1996 had classified the species as *Critically Endangered* based on the restricted area of occupancy and a putative decline in the extent and quality of its closed forest habitat due to uncontrolled landscape fires. A later population viability analysis confirmed that habitat loss was potentially the single most important threatening process. Here we argue that the species should be reclassified as *Vulnerable*, on the basis of the following new evidence: (1) the assumption that it was a closed forest specialist was not supported by a radio-tracking study, which showed that on average 43% of an individual's monitored time was spent in the forest-savannah margin, and (2) analysis of repeat historical aerial photography has shown that the core closed forest habitat has in fact increased by 36% over the last 50 years. This has led to an increase of 140 in the minimum number of equivalent *Z. palatalis* territories, from 387 to 587, when home range overlaps and utilization of the savannah margins are considered. Reclassification of the species' conservation status should be accompanied with: (i) genetic studies of

relatedness between isolated populations; (ii) monitoring and maintenance of the integrity of the landscapes, including creeklines that connect patches; and (iii) consideration of the introduction of captive bred specimens into an adjacent unoccupied fragments.

The butterfly fauna of the Griffith district, a fragmented semi-arid landscape in inland southern New South Wales

MICHAEL F. BRABY and TED D. EDWARDS

Thirty-three species of butterflies are recorded from the Griffith district in the semi-arid zone of inland southern New South Wales. The butterfly community comprises the following structure: 19 species (58%) are resident; 7 (21%) are regular immigrants; 2 (6%) are irregular immigrants; 5 (15%) are vagrants. Except for a few migratory species, most occur in relatively low abundance. Lack of similar studies elsewhere in western New South Wales precludes generalizations regarding the species richness, composition and structure of semi-arid butterfly communities. Comparison of the butterfly fauna with that from five other inland regions on the slopes and foothills of the Great Dividing Range, revealed that the Griffith district is most similar in species richness and composition to that of Deniliquin and to a lesser extent Wagga Wagga and Cowra in the south, than with two regions in the higher summer rainfall area of the north of the State (Coonabarabran-Mendooran, Narrabri-Bellata). Overall, the butterfly fauna of inland New South Wales (total of 73 species, of which 49 occur in the southern regions) is depauperate compared with that recorded from the coastal/subcoastal areas east of the Great Dividing Range. Attention is drawn to the conservation significance of several vegetation types and habitat remnants in the Griffith district. Much of the native vegetation in the district has been extensively modified since European settlement due to excessive clearing for agriculture, resulting in a highly fragmented landscape for the conservation of native flora and fauna. With the exception of the lycaenid *Candalides hyacinthinus simplex*, which is considered threatened locally, there is a general absence of narrow range endemic butterflies associated with mallee-heathland or mallee-woodland, possibly as a result of widespread land clearing practices of mallee vegetation in the past.

Avian translocations and disease; implications for New Zealand conservation

KEVIN A. PARKER, DIANNE H. BRUNTON and RICHARD JAKOB-HOFF

There is little published information on the pathogens present in New Zealand passerines. We report here on a preliminary survey of selected pathogens and haematology profiles for seven species in the Auckland region. Avian translocations are commonly used for the recovery of threatened species. Translocations may increase the risk of spreading disease to immunologically naïve populations. It is therefore important to take every opportunity to gather baseline disease data and test hypotheses associated with disease. Blood, cloacal and faecal samples were collected from Fernbird *Bowdleria punctata*, Tui *Prothemadera novaeseelandiae*, Bellbird *Anthornis melanura*, Tomtit *Petroica macrocephala*, New Zealand Robin *Petroica australis*, Whitehead *Mohua albicilla* and Starling *Sturnus vulgaris* during four translocations to and from Tiritiri Matangi Island. Birds (n = 137) were also examined for external lesions typical of avian pox. Blood samples (n = 40) were screened by microscopy for *Plasmodium* spp., *Atoxoplasma* spp. and other blood parasites and a differential white blood cell count was made. Cloacal swabs (n = 38) were cultured for *Yersinia* spp., *Salmonella* spp. and *Campylobacter* spp. Faecal samples were screened for coccidia spp. (n = 28). An unidentified coccidian sp. and a *Haemoproteus* sp. were detected in one Fernbird and one robin respectively. No other organisms with the potential to cause disease were detected. Despite the effort required to complete disease screening, we argue that disease samples and baseline haematology normal values should be collected at all opportunities. We make recommendations for future disease screening, and discuss the importance and potential significance of disease to the conservation of New Zealand's biodiversity.

Volume 12 Number 3

News and Views

SCB-A Newsletter September 2006

N. NELSON

Research Papers

The effect of recent chaining on birds in the eastern wheatbelt of Western Australia

GRAHAM R. FULTON and JONATHAN D. MAJER

The decline of woodland birds that follows from habitat fragmentation, degradation and loss of connectivity is well reported in the literature. However, reports of immediate responses by birds to these events are scant. This study, in the eastern wheatbelt of Western Australia, detected that when half of a 10 ha remnant of *Allocasuarina* shrubland was chained (vegetation knocked over and largely killed), birds responded quickly; increaser species apparently benefited and decliner species became restricted to the remaining unchained remnant of shrubland. There was some correspondence between the trends in variety and/or abundance of arthropods with those of bird species richness. Two Near-threatened species, the White-browed Babbler *Pomatostomus superciliosus* and the Crested Bellbird *Oreoica gutturalis*, were only detected in the non-chained part of the remnant. These findings clearly highlight the immediate ecological consequences of clearing of native vegetation, and highlight the importance of conserving even the smallest remaining fragments.

Causes of mortality to the endangered Southern Cassowary *Casuarius casuarius johnsonii* in Queensland, Australia

CHRISTOPHER P. KOFRON and ANGELA CHAPMAN

The Southern Cassowary *Casuarius casuarius johnsonii* is endemic to north-east Queensland, Australia, where it inhabits tropical rainforest. Of the total former cassowary habitat, only 20-25% remains, with much of this under pressure for development. The species is listed as endangered by both the Australian Commonwealth Government and the Queensland State Government. The Queensland Parks and Wildlife Service (2002) estimated 1 500–2 500 adult Southern Cassowaries remain. The primary cause of the species' decline is habitat loss and fragmentation, with motor vehicle strikes and dog attacks considered major threats for local populations. The purpose of this paper, therefore, is to quantify the causes of mortality to Southern Cassowaries, including motor vehicle strikes and dog attacks, which have not previously been quantified. We obtained data for 140 cassowary deaths from the Queensland Parks and Wildlife Service, local government councils and persons having experiences with cassowaries. The leading cause of death for 110 cassowaries from 1986–2004 was motor vehicle strikes (55%), and the second leading cause of death was dog attacks (18%). Together, motor vehicles and dogs caused 74% of the cassowary mortalities for which the causes of death could be determined. Seventy-nine of the recorded cassowary deaths (63%) were in the Mission Beach area, suggesting this local population is under tremendous pressure. We expect cassowary numbers to continue to decline, especially in the Mission Beach area. We encourage the Commonwealth, State and relevant local governments to fully implement recovery actions. We believe the goal of conserving the Southern Cassowary and its habitat in perpetuity is attainable, but it will require public commitment and political will.

Habitat use as a predictor of nest raiding by individual hedgehogs *Erinaceus europaeus* in New Zealand

CHRISTOPHER JONES and GRANT NORBURY

Predation by introduced hedgehogs *Erinaceus europaeus* is a significant cause of nest failure in threatened endemic wading birds nesting on the dry gravel beds of braided rivers in New Zealand's central South Island. Night-time movements of 10 hedgehogs (four male; six female) were investigated during the 2002 bird breeding season using spool-and-line tracking and GPS data recording. Nine of the 10 hedgehogs studied used river braids rarely and concentrated their activity in scrub and woodland habitat. One female foraged almost exclusively on the dry river braids. The ranked order of habitat preference (scrub>woodland>river braid) matched the ranked availability of hedgehogs' most common invertebrate prey, estimated by pitfall trapping, in the three habitat types. Male foraging ranges were generally larger than those of females, except for the female that foraged on the relatively resource-poor river braids, which had the second largest range overall. This animal had a much higher probability of encountering, and opportunistically raiding, nests than the others. Trapping programmes targetted at nuisance predators commonly aim to reduce overall predator abundances within a designated area using traps set along logistically convenient lines. This design reflects the implicit assumption that all target animals within the area represent an equal risk to threatened prey. Our results suggest that this assumption may not always be valid. To improve nest protection during the birds'

breeding season, we suggest that traps should be focussed in and around the nesting habitat in order to target those predators that habitually forage in the area.

Documenting floral visitors to rare Hawaiian plants using automated video recordings

MARK C. GARDENER and CURTIS C. DAEHLER

Many plant species require the services of an animal pollinator. In Hawai'i most endemic plant species are declining, yet their pollinators are often unknown because floral visitors are uncommon, or because visits occur at night, making them difficult to observe. Information about the pollination ecology of rare plants is needed to help develop a conservation strategy. We used an automated, infrared-equipped video system to record animal visits to the flowers of rare plant species on the island of O'ahu, Hawaii. Over 500 hours of recordings were made on four plant species. For the first time, a nocturnal moth was observed visiting *Cyrtandra hawaiiensis*. Also for the first time, native masked bees, presumed to be *Hylaeus connectans*, were recorded visiting the flowers of two endangered lobeliads, *Cyanea pinmatifida* and *Cyanea superba*. An introduced bird, the Japanese White-eye *Zosterops japonicus* also visited the *Cyanea* species, but it appeared to act as a nectar robber. A third lobeliad, *Clermontia kakeana*, was observed continuously for several days and nights but only visits by ants were recorded and no fruits were produced. While it was not always possible to determine the actual species of invertebrate floral visitors, the continuous nature of our video recording allowed us to document floral visitors that were not previously known. Furthermore, the recordings can be made without potential artefacts introduced by the presence of human observers near the flowers. This methodology can be used to document many difficult-to-observe ecological interactions between animals and rare plants.

Factors affecting patch occupancy by the White-browed Treecreeper *Climacteris affinis* in an agricultural landscape in north-west Victoria, Australia

JAMES Q. RADFORD and ANDREW F. BENNETT

The survival of habitat-dependent fauna within agricultural mosaics depends on their ability to occupy remnant habitat patches and move through the modified landscape. In north-west Victoria, Australia, less than 10% of the pre-European extent of Belah *Casuarina pauper* woodland remains intact due to agricultural development. The White-browed Treecreeper *Climacteris affinis*, is a small, insectivorous passerine that, in this region, preferentially inhabits Belah woodland. To assess the ability of *C. affinis* to persist in an agricultural landscape, 30 woodland sites in the Millewa landscape (34°30'S, 141°30'E) were surveyed, and patterns of patch occupancy used to examine the influence of spatial characteristics, landscape context and grazing by stock on the suitability of remnants as *C. affinis* habitat. Sites occupied by *C. affinis* were larger and less likely to be grazed by stock than vacant patches. The area-dependency of patch occupancy represents a step-threshold: *C. affinis* were not detected in remnants with less than 18.5 ha of Belah woodland but above this threshold, density was not correlated with patch area. Measures of patch isolation, the existence of linking linear "corridors" and tree density were not reliable indicators of patch occupancy. The presence of the species in remnants entirely surrounded by agricultural land suggests they are capable of crossing up to 450 m of cultivated land to prospect for habitat. The extensive network of linear vegetation and the numerous small remnants and scattered trees appear to facilitate movements of *C. affinis* in this landscape. Increasing the size of existing remnants, creating new habitat to expand the area of occupancy and maintaining landscape connectivity are priorities for the long-term management of this threatened species.

Long-term natural and human perturbations and current status of Cipperton Atoll, a remote island of the Eastern Pacific

CHRISTIAN H. JOST and SERGE ANDRÉFOUËT

Clipperton Atoll is one of the most isolated tropical island in the world and the only atoll of the eastern Pacific. Its outer slopes also make the largest coral reef of this region. Clipperton is a remarkable site for the geochemistry of its closed eutrophic stratified lagoon, the influence of both tropical eastern Pacific and Oceania gene pool on coral reef communities, the low diversity of the marine and land fauna, and for the equilibrium of its land ecosystem. The three components of the Clipperton Atoll seascape (coral reef-lagoon-land) all appear to have remarkable properties and history. All components experienced important changes in the last century due to anthropogenic (importation of

exogenous species) or natural perturbations (closing of passes, coral bleaching). Here, we review the history of these three systems (land-lagoon-coral reef) and provide new insights of the current status of the atoll based on recent surveys and high resolution IKONOS satellite imagery. Most dramatic changes occurring in the last decades include explosion in crab *Gecarcinus planatus* population, almost-complete desertification of the island and increase in Masked Boobies *Sula dactylatra* population, making Clipperton Atoll one of the most important sites for this specie in the world. This review intends to provide a sound basis to discuss the future of Clipperton balanced between conservation and development priorities, and to raise awareness on the future of a delicate ecosystem.

Cross-border trade in Saratoga fingerlings from the Bensbach River, south-west Papua New Guinea

GARRICK HITCHCOCK

Saratoga *Scleropages jardinii* (Saville-Kent 1892) is a popular aquarium and sportsfish native to southern New Guinea and northern Australia. In recent years the people of the Bensbach River area in Papua New Guinea's Western Province have been harvesting wild fingerlings for sale across the nearby international border in Indonesia's Papua Province. From there the fish are sold to dealers in other parts of Asia. The species is protected by law in Indonesia, and subject to various regulations in Australia. In Papua New Guinea there are no controls on its exploitation. Uncontrolled harvesting of fingerlings from the Bensbach and other river systems in south New Guinea has had negative impacts on local fisheries, and led to a decline in the Australian export trade in wild-caught and farm-bred Saratoga.

Hematozoa of forest birds in American Samoa — evidence for a diverse, indigenous parasite fauna from the South Pacific

CARTER T. ATKINSON, RUTH C. UTZURRUM, JOSHUA O. SEAMON,
AMY F. SAVAGE and DENNIS A. LAPOINTE

Introduced avian diseases pose a significant threat to forest birds on isolated island archipelagos, especially where most passerines are endemic and many groups of blood-sucking arthropods are either absent or only recently introduced. We conducted a blood parasite survey of forest birds from the main islands of American Samoa to obtain baseline information about the identity, distribution and prevalence of hematozoan parasites in this island group. We examined Giemsa-stained blood smears from 857 individual birds representing 20 species on Tutuila, Ofu, Olosega, and Ta'u islands. Four hematozoan parasites were identified — *Plasmodium circumflexum* (1%, 12/857), *Trypanosoma avium* (4%, 32/857), microfilaria (9%, 76/857), and an *Atoxoplasma* sp. (<1%, 2/857). Infections were found in seven indigenous bird species from the archipelago. Overall prevalence of infection varied significantly among bird species, individual islands, and between Tutuila and the more isolated Manu'a group of islands. Infections with *Plasmodium*, *Trypanosoma*, and filarial worms occurred throughout the archipelago, including islands without introduced birds. There was a statistically significant difference in the overall prevalence of infection before and after Hurricane Olaf in February 2005, suggesting that catastrophic hurricanes may influence the dynamics of parasite infections. Given the central location of American Samoa in the South Pacific, it is likely that avian malaria and other hematozoan parasites are indigenous and widespread at least as far as the central South Pacific. Their natural occurrence may provide some immunological protection to indigenous birds in the event that other closely related parasites are accidentally introduced to the region.

Shore-based recreational angling in the Rottnest Island Reserve, Western Australia: Spatial and temporal distribution of catch and fishing effort

C. B. SMALLWOOD, L. E. BECKLEY and N. R. SUMMER

The Rottnest Island Reserve, located off southwestern Australia, is one of the most popular recreational fishing locations in Western Australia. In the reserve, standard Western Australian recreational fishing regulations apply and there are two small "no-take" conservation sanctuary areas. A roving creel survey of shore-based recreational angling in the reserve was conducted from January to December 2003. In total, 1 053 anglers were recorded which included individuals, families, school groups and angling club members. The total annual shore-based angling effort for Rottnest Island was calculated to be 23 899 angler outings and the total catch estimated at 53 994 retained fish. Fishing effort was concentrated in the settlement area on the eastern side of the island and the highest levels of catch and effort were

recorded in April, May and July. During the survey, 33 fish species were identified in the catch and the small, pelagic species Australian Herring *Arripis georgianus* dominated with 7.27 tonnes caught during the study. Shore-based anglers also caught and released a large number of non-target species. The survey has provided spatial and temporal data that can be used as a benchmark and to support decision making by the Rottneest Island Authority with respect to biodiversity conservation and the Department of Fisheries with regard to management of shore-based recreational angling in the Rottneest Island Reserve.

Volume 12 Number 4

Forum Essay

Conservation aspects of geothermal vegetation

PETTERI MUUKKONEN

News and Views

SCB-A Newsletter December 2006

HARRY F. RECHER

Research Papers

Breeding-habitat and nest-site characteristics of Scarlet Robins and Eastern Yellow Robins near Armidale, New South Wales

S. J. S. DEBUS

I studied the selection of breeding habitat and nest microhabitat in Scarlet Robins *Petroica multicolor* and Eastern Yellow Robins *Eopsaltria australis*, in remnant woodland on the New England Tablelands of New South Wales in 2000–2002. Yellow Robins used breeding territories ($n = 10$) with significantly higher densities of rough-barked saplings, acacias and other (non-*Acacia*) shrubs than Scarlet Robin breeding territories ($n = 10$) and plots lacking Yellow Robins ($n = 7$). Yellow Robins nested mostly in gully and lower-slope positions, with a southerly aspect, >40 m from the woodland edge, whereas Scarlet Robins nested mostly on upper slopes and ridges, with no preferred minimum distance from the woodland edge. Most Yellow Robin nests (86% of 58) had overhead foliage within 1 m, shielding them from above, whereas over half (58% of 54) of Scarlet Robin nests were in unconcealed positions. Yellow Robin nests had significantly greater density of cover, and the surrounding

habitat was more complex, than for Scarlet Robin nests, in 0.13-ha plots centred on the nest. Breeding success and fledgling survival in the Yellow Robin were positively related to the density of acacias, non-*Acacia* shrubs and rough-barked saplings (but not gum saplings) in breeding territories. Fledging success and juvenile survival in the Yellow Robin were also positively related to habitat complexity around nest-sites (but not distance to nearest cover, or items of cover within 20 m). Scarlet Robins had exposed nests and suffered high nest predation, with too few successful nests for comparison with unsuccessful nests. Habitat conservation for the Yellow Robin should address the complexity of the ground, shrub and sapling layer in woodland remnants; that for the Scarlet Robin may need to address foraging substrate and ecologically based control of nest predators.

The successful eradication of two blackberry species *Rubus megalococcus* and *R. adenotrichos* (Rosaceae) from Santa Cruz Island, Galapagos, Ecuador

C. E. BUDDENHAGEN

Eradication programmes were initiated against infestations of the introduced blackberry species *R. adenotrichos* and *R. megalococcus* on Santa Cruz Island, Galapagos, Ecuador in 1999 and 2000 respectively. The species were judged to be likely invaders even though neither produced viable seeds in Galapagos. Prior to eradication in 2003 these infestations occupied an area of less than a quarter hectare. I estimate the time and dollar cost of eradication of *R. adenotrichos* and *R. megalococcus* to be US\$11,322 US dollars/1 738 hours. More than half of these costs were sustained in extensive systematic searches of 330 ha surrounding known infestations. Herbicide accounted for less than 1% of total costs. Control was undertaken using the herbicides glyphosate, and a combination of metsulfuron methyl and picloram. I recommend using teams of workers dedicated to eradicating known or potentially invasive species early in the invasion process or prior to establishment in Galapagos.

Abbreviations: Global Environment Facility (GEF), United Nations Development Program (UNDP), Charles Darwin Research Station (CDRS), active ingredient (ai).

The role of intense nest predation in the decline of Scarlet Robins and Eastern Yellow Robins in remnant woodland near Armidale, New South Wales

S. J. S. DEBUS

A study of open-nesting Eastern Yellow Robins *Eopsaltria australis* and Scarlet Robins *Petroica multicolor*, on the New England Tablelands of New South Wales in 2000–02, found low breeding success typical of eucalypt woodland birds. The role of intense nest predation in the loss of birds from woodland fragments was investigated by means of predator-exclusion cages at robin nests, culling of Pied Currawongs *Strepera graculina*, and monitoring of fledging and recruitment in the robins. Nest-cages significantly improved nest success (86% vs 20%) and fledging rate (1.6 vs 0.3 fledglings per attempt) for both robin species combined ($n = 7$ caged, 20 uncaged). For both robin species combined, culling of currawongs produced a twofold difference in nest success (33% vs 14%), a higher fledging rate (0.5 vs 0.3 per attempt), and a five-day difference in mean nest survival (18 vs 13 days) ($n = 62$ nests), although sample sizes for nests in the cull treatment ($n = 18$) were small and nest predation continued. Although the robin breeding population had not increased one year after the cull, the pool of Yellow Robin recruits in 2001–03, after enhanced fledging success, produced two emigrants to a patch where Yellow Robins had become extinct. Management to assist the conservation of open-nesting woodland birds should address control of currawongs.

Relating spatial and temporal patterns in floristics with vegetation mapping: an example from Fraser Island, south-east Queensland, Australia

BEN E. LAWSON and GRANT WARDELL-JOHNSON

The use of mapped polygons to represent vegetation patterns is becoming more widespread in conservation planning and natural resource management. The degree of homogeneity (i.e., one vegetation unit per polygon) of these polygons influences the efficacy of mapped patterns. It was observed that Fraser Island, south-east Queensland (SEQ) exhibited near complete map unit homogeneity relative to adjacent mainland areas. We sought to establish whether this homogeneity had an ecological or cartographic basis. Floristic presence-absence data from 50 quadrats, each sampled over three consecutive years, were analysed using cluster analysis (UPGMA) and ordination (SSH MDS) to define and compare eight numerically-derived plant community types with eight *a priori* regional ecosystem types derived from mapping of the island. Strong congruence between the two approaches was evident, suggesting that the mapping effectively portrayed ecological patterns. Floristic composition and species richness remained consistent at most quadrats for three consecutive years. Perennial woody species (including tree and shrub species) showed significant ($P < 0.05$) variation between regional ecosystem units and between plant community groups, but was stable through time. Conversely, the herb assemblage showed significant temporal variation and poor fidelity to vegetation classifications. High levels of map unit homogeneity were shown to extend to five barrier sand islands of SEQ across various map scales and map authors in these sandy environs. We conclude that homogeneity in mapped polygons on Fraser Island is a consequence of discrete boundaries and the associated distinctive floristics of the vegetation communities in this area. We suggest focussing limited mapping resources to areas of high polygon heterogeneity, instead of areas such as the SEQ sand islands which appear well represented by existing mapping.

Intraspecific variation in detection of bird-habitat relationships: declining birds in southern Australian woodlands

MARTINE MARON and ALAN LILL

An understanding of the responses of declining bird species to habitat loss, fragmentation and degradation is essential for their conservation. However, species' relationships with particular threatening processes may vary in different systems, and long-term variability in bird communities and differences in sampling protocols may cause different real or apparent habitat relationships to be detected in the same system at different times. We investigated temporal variation in detection of relationships between habitat remnant size, isolation and degradation and the presence of several bird species that are known to be declining in southern Australia. Habitat relationships detected for these species were compared with a) those detected for the same species in the same remnants in surveys undertaken seven years previously, and b) those reported from other fragmented, southern Australian systems. Most of the relationships displayed by the study species in other landscapes were not apparent in this system, and there were temporal differences in the detected landscape and habitat relationships of several species. These findings indicate that the effects of habitat fragmentation can appear to vary in their impact on a species among landscapes, as well as through time, which complicates considerably the task of conservation managers. Correlative relationships between species' presence and habitat characteristics can be misleading if the mechanisms through which the habitat factors influence species are not understood.

Overview of the conservation status of Australian frogs

JEAN-MARC HERO, CLARE MORRISON, GRAEME GILLESPIE, J. DALE ROBERTS,
DAVID NEWELL, ED MEYER, KEITH McDONALD, FRANK LEMCKERT,
MICHAEL MAHONY, WILL OSBORNE, HARRY HINES, STEVE RICHARDS,
CONRAD HOSKIN, JOHN CLARKE, NAOMI DOAK and LUKE SHOO

A review of the current conservation status of Australian amphibians was recently completed as part of a World Conservation Union (IUCN) sponsored Global Amphibian Assessment (GAA). Fifty of 216 amphibian species (23%) in Australia are now recognized as threatened or extinct in accord with IUCN Red List Categories and Criteria. Here we report on the categories and criteria under which individual species qualified for listing and provide a summary of supporting information pertaining to population and distribution declines. Major threatening processes contributing to listing of species are also reviewed.

Assessing the risk of boat strike on Dugongs *Dugong dugon* at Burrum Heads, Queensland, Australia

R. N. MAITLAND, I. R. LAWLER and J. K. SHEPPARD

The risk of mortality due to boat strike is increasingly being recognized as an important management issue for marine wildlife, including Dugongs *Dugong dugon*. Ameliorating the effects of boat strike requires assessment of how that risk varies over the management area. This is dependent on the distribution and movements of both Dugongs and boats and on the physical characteristics of the area, particularly depth. In this study we assess these features for a small community that is dependent on tourism centred around recreational fishing and which is home to a regionally significant Dugong population. During one of the most popular holiday times, boats accessing the favoured fishing site pass directly through the core area of Dugong activity. Our data show that boat strike risk to Dugongs can be lowered significantly with minimal imposition on boaters. Boaters can avoid the area of highest risk by travelling around it in deeper water. However, this straightforward solution is only possible because of the restricted spatial scale of Dugong activity and the proximity of a deepwater channel enabling boaters to easily avoid shallow areas where boat strike risk is highest.

Pacific Conservation Biology

**Order Form and Subscription information appears at the end of this document —
please complete and return it to Surrey Beatty & Sons**

Volume 13 Number 1

News and Views

SCB-A Newsletter March 2007

HARRY F. RECHER

Research Papers

**Prestige, taboo, and sustainability: predicting
wildlife population trajectories in indigenous commerce**

CLARK S. MONSON and PAUL ALAN COX

Commercial traffic in plants and animals has led to severe declines for some species, while others have experienced few if any negative impacts. Given the uncertainty regarding which species are likely to be adversely affected by monetized trade, it would be useful to have a model that could predict wildlife population trajectories of wild-gathered species subsequent to commercialization. We suggest that the indigenous conservation strategy of “taboo” offers important insights into identifying species that are susceptible to over-exploitation through commercial traffic. We describe an economic conservation/extinction model based on the dual concepts of taboo and optimal foraging strategy and examine the model through a detailed case study of vulnerability to perturbation in the case of commercial traffic in Pacific island flying foxes. We suggest that the virtual eradication of flying foxes from the island of Guam during the Twentieth Century resulted from a cultural predilection among the indigenous Chamorro people for consuming flying foxes coupled with the cultural loss of the traditional taboo conservation system on the island.

**Distribution of the introduced parasitic fly *Philornis downsi* (Diptera,
Muscidae) in the Galapagos Islands**

DAVID A. WIEDENFELD, GUSTAVO A. JIMÉNEZ U., BIRGIT FESSL,
SONIA KLEINDORFER and JUAN CARLOS VALAREZO

The avifauna of the Galapagos Islands is characterized by a small number of endemic species, including the 13 species of Darwin’s finches. The introduced fly parasite *Philornis downsi* reduces nestling survival and growth rate of altricial birds, and can cause mortality and morbidity of the nestlings. We examined the occurrence of *Philornis downsi* among islands and at different elevations. The parasite was found in nests from 11 of 13 islands sampled. The two islands on which *P. downsi* was not found were Española and Genovesa, both arid islands with no humid highlands and distant from the centre of the archipelago. Parasite infection intensity was greater in nests at higher elevations, and on islands that have moist highlands, which may serve as a reservoir for the flies. A full understanding of the fly’s ecology may permit the development of eradication or control methods, or at least mitigation of its effects on the birds.

La avifauna de las islas Galápagos es caracterizada por tener un pequeño número de especies endémicas, incluidas las 13 especies de Pinzones de Darwin. La introducida mosca parásita *Philornis downsi* afecta la sobrevivencia y el crecimiento de los pichones, y hasta puede causar mortalidad y morbilidad a los pichones. Se determinó la presencia de *Philornis downsi* en las islas en diferentes altitudes. La mosca parásita fue encontrada en los nidos de las aves en 11 islas de las 13 muestreadas. Las dos islas que no se encontró fueron Española y Genovesa. Ambas islas son áridas, no tienen zonas húmedas y son distantes del centro del Archipiélago. Las pupas de la mosca fueron más abundantes en los nidos que se encontraban en las zonas altas y en islas que tenían mayor elevación, lo cual puede ser el sitio de reservorio de la mosca. Entendimiento completo de la ecología de la mosca puede permitir el desarrollo de metodologías de erradicación o control, o por lo menos la mitigación de sus efectos en las aves.

**A preliminary study of regeneration in wild populations of threatened
endemic Hawaiian palms (*Pritchardia*; *Arecaceae*)**

MELANY H. CHAPIN, MIKE MAUNDER and KATHERINE E. HORAK

Island floras have been subject to catastrophic changes since human colonization; the Hawaiian Islands exemplify this pattern of species decline and ecological change. Archaeological and historic findings support the former existence of coastal, lowland and interior *Pritchardia* dominated forests. Wild *Pritchardia* populations are highly fragmented and exhibit poor or absent regeneration in the wild. This study records seed predation, goat grazing, pig damage, and human harvesting on six wild populations of three species and outlines requirements for the long-term management of wild populations. Only one population of the six studied was found to contain seedlings. Recommended conservation management strategies are outlined.

Evidence for the presence of a second species of mongoose in the Fiji Islands

CRAIG G. MORLEY, PATRICIA A. McLENACHAN and PETER J. LOCKHART

The small Indian Mongoose *Herpestes javanicus* was introduced in the late nineteenth century into Fiji and is now found throughout the two main islands of Fiji (Viti Levu and Vanua Levu) and on another 11 small outer islands. When trapping mongoose as part of an investigation into the spread of leptospirosis around Suva, six large red-coloured mongoose were also captured. The body measurements (weight, length and hind-foot size) of these red-coloured mongoose were significantly larger than a random sample of the grey-coloured mongoose *H. javanicus* normally seen. To clarify whether the red-coloured mongoose was a different species or just a different colour morph of *H. javanicus*, mitochondrial cytochrome B *cytb* DNA sequences were determined from muscle tissue of four red-coloured individuals. Phylogenetic analyses using *cytb* sequences show that while the red-coloured mongoose belongs to an Asian clade, it is not *H. javanicus* or *H. edwardsi*. Further research is needed to determine the identity and origin of the red-coloured mongoose and to ascertain its prevalence in Fiji.

Conservation and use of the Hawksbill Turtle — public valuation and attitudes: an Australian case study

CLEM TISDELL, HEMANATH SWARNA NANTHA and CLEVO WILSON

Managing Hawksbill Turtle *Eretmochelys imbricata* populations for use and conservation requires (i) adequate scientific understanding of their population status and dynamics and (ii) consideration of the public's attitudes to this species. This study employs sample surveys to assess the Australian public's attitudes towards the Hawksbill Turtle, their knowledge of it, their views about its sustainable commercial harvesting, and their willingness to pay for the species' conservation. Contingent valuation reveals that the sample's willingness to contribute to the conservation of the Hawksbill Turtle rose relative to other reptile species when respondents were better informed, and that it is high in comparison to selected threatened Australian bird and mammal fauna. Most of this stated contribution is based on the intrinsic (non-use) value associated with this turtle. The Australian public probably will only accept harvesting of the Hawksbill Turtle if its sustainability is assured and its population is considered to be more secure. The CITES categorization of the Hawksbill as an Appendix I species hampers the development of techniques for its sustainable use.

Are regional ecosystems compatible with floristic heterogeneity? A case study from Toohey Forest, south-east Queensland, Australia

GRANT W. WARDELL-JOHNSON, BEN E. LAWSON and ROBERT H. COUTTS

The recognition and effective portrayal of floristic heterogeneity is a complex issue for land classification. This study in Toohey Forest, south-east Queensland, examines the effects of mapping scale and environmental variables on a floristically heterogeneous area. Current Version 4.1 regional ecosystem mapping at 1:100 000 scale maps Toohey Forest as a single regional ecosystem unit "12.11.5", described as an "open forest complex with *Corymbia citriodora*, *Eucalyptus siderophloia*, *E. major* on metamorphics ± interbedded volcanics". Plant taxa data from 50, 20 × 20 m sites comprising 247 native vascular plant taxa were collected, along with data for 17 environmental variables and 10 species richness categories. *A priori* site groupings of 1:12 500 scale vegetation mapping and a geomorphic classifications of the area were examined using cluster analysis (UPGMA, Bray-Curtis Metric, $\beta = -0.1$) and ordination (SSH MDS). Biplots of several variables (shrub species richness, total species richness, per cent rock cover, CEC, carbon and phosphorus) were significantly ($P < 0.05$) correlated with the ordination axes derived from each of the two strata levels and the total taxa, for both geomorphological and vegetation mapping. Several variables (shrub, vine,

woody and introduced species richness, and carbon, nitrogen, phosphorus, pH and CEC) varied significantly ($P < 0.05$) across both geomorphic categories and 1:12 500 scale vegetation community mapping. The ongoing reduction in regional ecosystem mapping scale, centred on the use of fine-scale geomorphology mapping, is likely to improve the representation of floristic patterns in heterogeneous environments.

Ranking coral ecosystem “health and value” for the islands of the Hawaiian Archipelago

PAUL L. JOKIEL and KU'ULEI S. RODGERS

An evaluation of the “health” and “value” of the Northwestern Hawaiian Islands (NWHI) in relation to the main eight Hawaiian Islands (MHI) was undertaken as part of the process for evaluating the NWHI for possible designation of this area as a National Marine Sanctuary. Biological information for the NWHI region is very limited due to its extreme isolation, but sufficient data on five important biological indicators were developed for both the NWHI and the MHI. These include: reef fish biomass, reef fish endemics, total living coral cover, population of the endangered Hawaiian Monk Seal *Monachus schauinslandi*, and the number of female Green Sea Turtles *Chelonia mydas* nesting annually on each island. These diverse data sets were used in a simple integrated scoring and ranking scheme for all the islands of the archipelago. The resulting composite scoring is essentially an index of biological integrity. The final result graphically demonstrates the value of the NWHI in a manner easily understood by the public, government decision makers and managers. Further, the contrast of the NWHI to the MHI illustrates the diminished condition of reefs close to human population within the Hawaiian Archipelago. This approach proved to be very useful in the integration of diverse data sets.

Research Note

Urban Countryside Biogeography: a decade of comparing the avifauna of a Sydney suburb and reserve

PAUL R. EHRLICH

Volume 13 Number 2

News and Views

News from the Australasian Section of the Society of Conservation Biology: June 2007

HARRY F. RECHER¹

Theme: Dispersive Fauna

Conservation Challenge of Dispersive Fauna

HARRY F. RECHER

The conservation challenge of sustaining spatially dependent evolution

DON A. DRISCOLL

Maintaining evolutionary processes is a fundamental tenet of biodiversity conservation. Dispersal in the guise of range expansion may take place over many generations and is a key evolutionary process. Range expansion enables evolutionarily novel gene combinations in single populations to become widespread taxonomic units, it enables homogeneous populations to reach refuges which may later become isolated and diverge, and range expansion may enable species to track their environmental niche as climates change. Land management practices that impede permeability also inhibit range expansion. Land clearing, grazing, inappropriate fire regimes and introduced species have the potential to block dispersal, preventing range expansion and eliminating spatially-dependent evolutionary processes. To achieve the goal of maintaining natural processes of evolution, landscape permeability needs to be understood and re-established in the many places where it has likely been lost.

The extent of dispersive movement behaviour in Australian vertebrate animals, possible causes, and some implications for conservation

SANDY GILMORE, BRENDAN MACKEY and SANDRA BERRY

We review categorizations of, and published evidence for, large-scale or dispersive movement in Australia's vertebrate fauna. For the purposes of this paper, dispersive movements are defined as any large scale movements, relative to an individual's territory or to the population breeding range. A continuum in dispersive behaviours can be recognized between regular annual migration and less regular more opportunistic and either more or less extensive re-colonization movements. We argue that dispersive movements can be explained in terms of individuals maximizing Darwinian fitness through optimizing net energy intake traded off against mortality risk, as these vary over space and time. We find that migration, nomadism and other forms of dispersive behaviour can be considered to differ, not in type, but merely in degree. Our review revealed evidence of dispersive movement for 36 (16%) freshwater fish species, 2 (1%) frogs, 5 (0.6%) land and freshwater reptiles, 7 (100%) marine reptiles, 342 (51%) land and freshwater birds, 88 (56%) marine birds, 27 (8%) land and freshwater mammals, and 28 (50%) marine mammals. The *Environmental Protection and Biodiversity Conservation Act 1999 (EPBC Act)* is the Australian Government's main legal instrument for the conservation of biodiversity. While it recognizes, and has special provisions for, international migratory species, the Act does not recognize the special conservation challenges of continental dispersive fauna. The continental dispersive fauna not recognized by the Act includes 246 bird species. We conclude that the *EPBC Act* needs to be amended to explicitly account for the national conservation responsibilities of the Australian Government with respect to dispersive fauna.

Spatial patterns of a Southern Bell Frog *Litoria raniformis* population in an agricultural landscape

SKYE WASSENS, DAVID A. ROSHIER, ROBYN J. WATTS and ALISTAR I. ROBERTSON

We investigated changes in the spatial organization of individuals within a population of endangered Southern Bell Frogs *Litoria raniformis* over an eight-month period. Our results identified strong temporal changes in both spatial organization and the apparent location of *L. raniformis* within the study site. Ripley's K Function analyses showed that the position of individuals relative to one another shifted from random immediately after the study site was flooded ($p < 0.005$), to strongly clustered at spatial scales between 0–1 500 m during the peak breeding period ($p < 0.005$). The majority of flooded areas were dry by April and May and individuals again became aggregated within the remaining waterbodies.

Conservation of the Swift Parrot *Lathamus discolor* — management lessons for a threatened migratory species

DEBBIE SAUNDERS, RAYMOND BRERETON, CHRIS TZAROS,
MARK HOLDSWORTH and ROB PRICE

Conserving habitat for wide-ranging fauna species provides a challenge because impacts on these species tend to be dismissed based on the assumption that there is sufficient habitat in other areas of its range. This incremental loss of habitat is a serious conservation issue for a diversity of bird species. As knowledge of wide-ranging and migratory bird species increases, it often becomes evident that they select specific sites on a regular basis (i.e., the species exhibit site fidelity). Gaining a better understanding of site fidelity and selective habitat use for wide-ranging species is clearly important, but also extremely challenging. In this paper, challenges associated with conservation of the migratory and wide-ranging Swift Parrot *Lathamus discolor* are discussed as an example of how a recovery programme has aimed to address such conservation and management challenges. Despite the small population size (less than 2 500 birds), broad distribution (1 250 000 km²) and often cryptic nature, the implementation of the national recovery programme has been successful in the identification and protection of important habitats. This has been made possible by involving large numbers of volunteers who collect long-term sighting and habitat data over large areas, together with more detailed ecological research. This information is then used to inform the conservation assessment process and to improve habitat conservation throughout the range of the species.

Potential applications of remotely sensed vegetation greenness to habitat analysis and the conservation of dispersive fauna

SANDRA BERRY, BRENDAN MACKEY and TIFFANY BROWN

Remotely sensed (satellite) time-series estimates of GPP (gross primary productivity) provide potentially useful information about vegetation-based habitat resources. These data are now available for the entire continent at a range of scales commensurate with those of dispersive animals, particularly bird species with large scale and irregular patterns of movement. The physical basis by which GPP can be estimated from satellite sensed vegetation greenness (NDVI) is explained, and previous habitat applications of NDVI reviewed. The results of GPP time-series analyses are presented based on a 10-year continental AVHRR data set for Australia and a five-year MODIS sequence for a portion of the Channel Country. The relationship between GPP and other trophic levels is discussed, along with possible applications to conservation biology.

Monitoring continental movement patterns of the Australian Bustard *Ardeotis australis* through community-based surveys and remote sensing

MARK ZIEMBICKI and JOHN C. Z. WOINARSKI

Many birds of Australia's arid and monsoonal regions are characterized by dispersive or nomadic movements and large population fluctuations in response to variable climatic conditions. These characteristics, compounded by our generally limited knowledge of bird movements and population dynamics (in part due to limited research effort in these sparsely-populated rangelands), complicate population monitoring and conservation for such species.

Here we employ mail surveys of landholders across continental Australia to assess the distribution and movement patterns of the Australian Bustard *Ardeotis australis*. We combine data from these simple mail surveys with more sophisticated techniques that allow for tracking the flux in rainfall patterns and vegetation greenness over broad spatial and temporal scales, to identify and describe the responses of bustards to seasonal and climatic variability.

Our results demonstrate that residency patterns of bustards vary widely across Australia. The seasonality of bustard occurrence is generally more pronounced in regions characterized by predictable seasonal conditions. Seasonal patterns are also evident in more climatically unpredictable regions, although here they may be increasingly overlaid by more idiosyncratic movements as a result of longer term variation in rainfall and associated patterns of primary productivity. We found limited evidence that bustards respond to inter-regional irregularities in rainfall events, suggesting that nomadic movements are generally not continental, but rather intra-regional. However, longer term data sets that cover several more, or more extreme, climatic fluctuations than that considered here, are needed to assess these relationships adequately.

To a lesser degree and differently between regions, respondents reported that bustards are also associated with fire, grasshopper outbreaks, crop agriculture and drought. They are most abundant across the savannahs of northern Australia extending to parts of the Pilbara and recently cleared regions of the Brigalow Belt in eastern Queensland. In southern Australia, bustards are perceived as short-term, irregular visitors whereas more permanent populations persist in northern and northeastern regions. While there are inherent limitations to such data, the study illustrates the utility of incorporating rangeland users into the types of large-scale monitoring programmes required to assess the distribution and movement patterns of highly mobile birds or species characterized by large population fluctuations.

ORDER FORM

To: Surrey Beatty & Sons, 43 Rickard Road, Chipping Norton, NSW, Australia 2170

Telephone: (02) 9602 3888 Facsimile: (02) 9821 1253

Email: surreybeatty@iform.com.au

Annual subscriptions:

Individual —

Aust./NZ **Aud\$82.00** (incl. GST)

Libraries —

Aust./NZ **Aud\$290** (incl. GST)

Other countries **Aud\$108** (US\$84)*

Delivered by air

Other countries **Aud\$326** (US\$254)*

Delivered by air

*Indigenous Pacific Islanders and their Libraries pay 75% of advertised rates.

Subscription

Back issues of complete volumes may be purchased at current subscription rates.
Single issues can be purchased separately at \$28 each for individual; \$76 each for libraries.

Theme issues \$36 each for individuals; \$80 each for libraries.

Theme issues:

Vol. 10, Nos 2 and 3 (combined issue) \$72 each for individuals; \$160 each for libraries

Vol. 1 No. 3, Landscape Ecology

Vol. 2, No. 1, Conservation Biology in New Zealand

Vol. 3, No. 3, Conservation and Management of Australasian Birds

Vol. 5, No. 4, Seagrass Conservation Issues

Vol. 6, No. 4, Biodiversity conservation in Papua New Guinea

Vol. 8, No. 1, Veterinary Conservation Biology: Wildlife Health and Management in Australasia

Vol. 9, No. 1, Farming for the Future

Vol. 10, Nos 2 and 3 Inverting the paradigm

Vol. 11, No. 1, Forests/Forestry

Vol. 13, No. 2, Dispersive Fauna

Volume 1 — No. 1 No. 2 No. 3 No. 4

- Volume 2 — No. 1 No. 2 No. 3 No. 4
- Volume 3 — No. 1 No. 2 No. 3 No. 4
- Volume 4 — No. 1 No. 2 No. 3 No. 4
- Volume 5 — No. 1 No. 2 No. 3 No. 4
- Volume 6 — No. 1 No. 2 No. 3 No. 4
- Volume 7 — No. 1 No. 2 No. 3 No. 4
- Volume 8 — No. 1 No. 2 No. 3 No. 4
- Volume 9 — No. 1 No. 2 No. 3 No. 4
- Volume 10 — No. 1 No. 2* No. 3* No. 4
- Volume 11 — No. 1 No. 2 No. 3 No. 4
- Volume 12 — No. 1 No. 2 No. 3 No. 4
- Volume 13 — No. 1 No. 2

* Combined issue

Please send copies of Pacific Conservation Biology or accept my Subscription and charge to my credit card/my cheque is enclosed for \$.....

Bankcard Mastercard Visa

Credit Card No.Expiry date.....

Name on Card:.....Signature.....

Contact phone number..... Receipt required: Yes/No

Please post to:

.....

ABN 34 001 433 521