Patterns in the Composition and Distribution of the Vertebrate Fauna, Desert Uplands Bioregion, Queensland.

Thesis submitted by
Alexander Sulev Kutt BA, BSc (Hons) *Melb.*
in March 2004

for the degree of Doctor of Philosophy
in the School of Tropical Biology,
James Cook University of North Queensland

Statement of Access

I, the undersigned, the author of this thesis, understand that James Cook University of North Queensland will make it available for use within the University Library and, by microfilm or other means, allow access to users in other approved libraries. All users consulting this thesis will have to sign the following statement:

"In consulting this thesis I agree not to copy or closely paraphrase it in whole or in part without the written consent of the author; and to make proper public written acknowledgment for any assistance which I may have obtained from it."

Beyond this, I do not wish to place any restrictions on access to this thesis.

…… …….

(Alex Kutt) *(Date)*

Statement on Sources

I declare that this thesis is my own work and has not been submitted in any form for another degree or diploma at any university or other institution of tertiary education. Information derived from then published or unpublished work of others has been acknowledged in the text and a list of references is given.

…… …….

(Alex Kutt) *(Date)*

Abstract

Approximately 20% of the Australian continent consists of tropical savanna rangelands, landscapes of dense native grass and scattered trees, dominated by cattle grazing. However a common problem in reviewing ecological patterns and processes of tropical savanna rangelands is the lack of adequate biological data for such conservation planning. James *et al.* (1995) and Fisher (2001a) recommended a framework for undertaking research in Australia's rangelands including identifying spatial and temporal patterns of biota, quantifying the impact of pastoralism, developing concepts and tools for regional conservation planning and identifying the effects of fire. The primary objective of this study was, using the framework described above, to examine the patterns within, and environmental controls on, the vertebrate fauna assemblage in the Desert Uplands Bioregion.

The Desert Uplands Bioregion

The Desert Uplands is one of six tropical savanna bioregions that occur in Queensland. It is very poorly studied, with quite meagre information regarding its native biota. Its climate is semi-arid and the vegetation consists predominantly of *Acacia* and *Eucalypt* woodlands, ephemeral lake habitats and grasslands. Of the original 6.8 million hectares of vegetation cover in the Desert Uplands, by 1999 over 900,000 hectares, representing almost 14% of the bioregion, were cleared. National Parks and resource reserves in the Desert Uplands currently cover 182,100 hectares, or 2.6% of the bioregion. Including data from this study, 431 vertebrate species (24 amphibians, 229 birds, 61 mammals, 117 reptiles) have been recorded in the bioregion, and this total includes 59 species of conservation significance. Beef cattle grazing is the major form of primary production, with a majority of the land being leasehold (>70%).

Zoogeographic context

The broad zoogeographic context of the Desert Uplands bioregion was investigated by examining composition of the vertebrate fauna in comparison to neighbouring Queensland bioregions and those across the northern Australian tropical savannas.

Given its recognition as a discrete entity, the Desert Uplands Bioregion should support landscapes and biota that are distinct from neighbouring bioregions. The region also includes a number of recognised biogeographic barriers and the confluence of three major drainage basins. Correlation, ordination and variation in measures of Beta-diversity were used to investigate patterns in the variation in species richness, composition and environment.

This broad overview of bioregional patterns of vertebrate assemblages identified the Desert Uplands fauna as, on the one hand, being typical of semi-arid regions and, on the other hand supporting a fauna of intergradation and replacement. Both inland and coastal elements are represented. Historically, the frontier of marked climate gradients would have oscillated across the Desert Uplands, and the distribution of many vertebrate fauna examples suggests this bioregion is central to vicariant speciation. A number of species typical either of more mesic or xeric environments reaches the edge of their range within the Desert Uplands. Three endemic reptiles were recorded which suggests a degree of isolation and speciation in this landscape.

Vertebrate fauna composition patterns

A systematic quadrat-based vertebrate fauna survey of the Desert Uplands Bioregion was undertaken to investigate the patterns of distribution, composition and abundance of species, and the environmental factors that determine these. A standardised quadrat array was used as the basic sampling unit, stratified by regional ecosystems – unique combinations of land units, vegetation and soils. Generalised linear modelling was used to investigate the relationship of environmental factors to within-quadrat species richness and species abundance. Gradients in vertebrate composition were examined using multivariate classification and ordination, and correlation with environmental variables.

The Desert Uplands fauna consisted of a mix of vertebrate species some restricted to particular habitats and environmental extremes (e.g. hummock and tussock grasslands), and others, which were more catholic, forming indistinct and overlapping suites of woodland species. This latter group was characterised by a core assemblage complemented by a series of more patchily distributed species that responded in various

ways to subtle environmental shifts (e.g. in substrate type, ground and canopy cover). Models exploring variation in species richness identified a positive relationship with structural complexity of the vegetation. Overall the patterns of species composition and distribution were commensurate with those recorded in the Mitchell grass, *Acacia* and *Eucalyptus* woodlands across the northern tropical savannas.

Regional ecosystems and other surrogates of vertebrate fauna diversity

An essential component of biodiversity conservation is selecting areas where conservation management effort will be concentrated. As regional ecosystems are the primary classification used for conservation planning in the Desert Uplands, the adequacy of this land unit as a surrogates for vertebrate fauna composition and distribution, and in particular sites of high species richness or sites with a high number of species of conservation significance, was examined using correlation, analysis of variance and measures of habitat breadth. The surrogate value of other land classifications was also tested using analysis of similarity. The patterns of spatial fidelity between the richness and composition of flora and fauna assemblages recorded was investigated via linear and matrix correlation. A minimum-set algorithm was used to investigate complementarity between regional ecosystems, vertebrate fauna and plant taxa using the quadrat samples.

In general, regional ecosystems types were found to have a broad correspondence to fauna composition variation, though there was clear partitioning in species composition between the more distinctive regional ecosystem types (e.g. grasslands versus woodlands), and blurring between types that were structurally similar. The spatial fidelity between biotic assemblages at a quadrat level was also varied, but was strongest between related groups (all vertebrates and component taxa, all plants, and upper ground strata). The minimum-set algorithm indicated that selecting quadrats to reserve species-rich taxa (ground cover plants, birds) will capture a majority of other species, but does not necessarily guarantee these will fully reserve the complement of rare species. Where there was high disparity in species richness, composition and structural heterogeneity between sites, there was better complementarity. This suggests that site complementarity techniques may be inadequate as a planning tool for targeting rare, unusual, seasonal or intangible biotic assemblages.

Effects of grazing and fire on fauna and flora.

The impacts of pastoral land use and fire history was investigated within a single widespread regional ecosystem - open *E. similis* woodland with *Triodia pungens* ground cover. Many properties have long or permanently ungrazed paddocks within this vegetation type due to the presence of heartleaf poison bush *Gastrolobium grandiflorum*. Using a subset of standardised quadrat samples, the impact of fire age and grazing history and the interaction of these two processes on fauna and plant composition were examined. Statistical investigation included analysis of similarity and ordination, and generalised linear modelling was used to explore in detail the species and group response to the treatments and interaction terms.

Fire and grazing had a significant influence on the distribution and abundance of a number of fauna and flora species and guilds with the impact of both processes combining to mute or accentuate the measured species responses. Time since fire is the best predictor of vertebrate species composition, while for ants grazing class was superior. However for terrestrial species such as reptiles and small mammals, the grazing effects were quite marked. There were several fire and grazing increaser and decreaser species with an interaction between fire and grazing clearly evident for some species (*Pseudomys desertor* and *P. delicatulus*). Shifts in structure of plant communities partially accounted for these patterns. These results suggest that in tropical savanna pastoral landscapes both grazing and fire effects should be quantified to avoid measuring spurious species responses. There is often suggestion that intermediate grazing pressure causes neutral biodiversity impacts, irrespective of fire effects, however these results indicate that even light to moderate grazing may result in some community disarray.

Table of Contents

List of Tables

List of Figures

Acknowledgements

A large number of people and organisations assisted in the successful completion of this project. I wish to acknowledge their help with sincere and heartfelt thanks.

Jeanette Kemp, Queensland Herbarium, Environmental Protection Agency, Townsville.

John Woinarski, Alaric Fisher, Owen Price, Greg Connors, Craig Hempel and Damien Milne, Biodiversity Unit, Department of Infrastructure, Planning and Environment, Northern Territory.

The landholders of the Desert Uplands especially: the Herrods (Moonoomoo, Yarrowmere), the Hollingsworths (Ulcanbah), the Lyons (Wambiana), the Leggets (Ulva), the Houses (Fortuna), the Mitchells (Albionvale), the Darts (Bannockburn), Harringtons (Ashton), the Yores (Fleetwood) and the rangers at Moorinya, Forest Den and White Mountains National Parks.

The Desert Uplands Build-up and Development Committee in particular: Margaret House (Fortuna) and Lesley Marshall (Swanlea).

Gethin Morgan, Murray Whitehead, Mal Lorimer, Dave Hannah, Nikki Thurgate, Juliana McCosker and Sharon King, Queensland Environmental Protection Agency and John Thompson, Queensland Herbarium, Brisbane.

Richard Pearson and Chris Johnson, School of Tropical Biology, James Cook University.

Alan Andersen and Tony Hartog, CSIRO Sustainable Ecosystems, Darwin.

Stephen Van Dyck, Andrew Amey, Patrick Couper, Jeanette Covacevich and Heather Janetski from the Queensland Museum.

Funding for the project was provided by: the Australian Heritage Commission, Tropical Savannas CRC, Queensland Environmental Protection Agency, James Cook University, Royal Geographic Society of Queensland and Australian Geographic.