The impacts of human-mediated disturbances on birds and reptiles in tropical savannas.

PhD thesis submitted by
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December 2006

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A land ethic… reflects the existence of an ecological conscience, and this in turn reflects a conviction of individual responsibility for the health of the land. Health is the capacity of the land for self-renewal. Conservation is our effort to understand and preserve this capacity.

Aldo Leopold

Top – Rufous Whistler (*Pachycephala rufiventris*), management burning along roadsides, rubber vine (*Cryptostegia grandiflora*) flower bud, *Carlia pectoralis* (male)

Bottom – Grazed tropical savanna, Dreghorn Property, Einasleigh Uplands.

Photo credit: Leonie Valentine.

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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 Information derived from the published or unpublished work of others has been duly acknowledged in the text and a list of references is given.

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Statement of contribution of others

Some data chapters in this thesis include work published in collaboration with my supervisors Dr Lin Schwarzkopf, Prof. Christoper N. Johnson and Dr Anthony Grice. Chapters 4 – 7 involve work conducted on study sites established by Commonwealth Science and Industry Research Organisation – Sustainable Ecosystems (CSIRO-SE) and Tropical Savannas - Cooperative Research Centre (TS-CRC). Brady Roberts (a collaborator) assisted with data collection in Chapter 3. While undertaking this research, I was responsible for the project design, obtaining research funding, collecting all field and laboratory data, statistical analysis and interpretation, and synthesis and preparation of manuscripts for submission to peer reviewed journals.

I obtained financial support from James Cook University, Tropical Savannas – Cooperative Research Centre, The Norman Wettenhall Foundation, Birds Australia and The Linnean Society of New South Wales. Funding to present research at conferences was obtained from James Cook University, Tropical Savannas – Cooperative Research Centre, The Society for Conservation Biology and The Ecological Society of Australia.

Declaration on ethics

All data collected adhered to the legal requirements of Australia (Scientific Purposes Permit WISO00130802) and the ethical guidelines for treatment of animals of James Cook University (Animal Ethics Approval A714_02).

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Preface

Publications arising from this thesis

Chapter 2 – Valentine, L.E. (2006) Habitat avoidance of an introduced weed by native lizards. *Austral Ecology*, **31**, 732-735.

Chapter 3 – Valentine, L.E., Roberts, B., and Schwarzkopf, L. (2007) Mechanisms driving weed avoidance by native lizards. *Journal of Applied Ecology,* **44**: 228-237.

Chapter 4 – Valentine, L.E. and Schwarzkopf, L. (submitted) Weed management burning alters reptile assemblages in tropical savannas. *Journal of Applied Ecology*.

Chapter 5 – Valentine, L.E., Schwarzkopf, L., Johnson, C.N., Grice, A.C. (2007) Burning season influences the response of bird assemblages to fire in tropical savannas. *Biological Conservation*, doi: 10.1016/j.biocon.2007.01.018.

Chapter 6 – Valentine, L.E., Schwarzkopf, L. and Johnson, C.N. (in prep) Responses of bird feeding groups to repeated burning in tropical savannas.

Chapter 7 – Valentine, L.E. (in prep) Mosaic burning: are land managers homogenising bird assemblages?

Acknowledgements

I would like to thank my supervisors Assoc. Professor Lin Schwarzkopf, Professor Chris Johnson and Dr Tony Grice for their continued support throughout my project. Oftentimes, my supervisors believed more in my ability than myself and they have constantly encouraged me in a reassuring manner. I particularly admire Lin's honesty, and I thank her for her genuine interest in my work, well and truly above and beyond the role of supervisor. I also greatly appreciate her open-door policy, willingness to be interrupted, and enthusiasm for my research. I have enjoyed all of our talks over the last few years and hope to keep our good working relationship in the future. Chris has always been an inspiring researcher and it has been an honour and a pleasure, to work with him. Tony's enthusiasm for the project and love of bird-talk has been fabulous. I would also like to thank Richard Pearson (HOS, Tropical Biology) and Gordon Duff (CEO, Tropical Savannas) for their continued support and interest in my project.

I obtained financial support from James Cook University (mostly through the School of Tropical Biology), Tropical Savannas – Cooperative Research Centre, The Norman Wettenhall Foundation, Birds Australia and The Linnean Society of New South Wales. Funding to present research at conferences was obtained from James Cook University, Tropical Savannas – Cooperative Research Centre, The Society for Conservation Biology and The Ecological Society of Australia. The experimental study sites (used in Chapters 4-7) were originally established and maintained by CSIRO-SE, and I owe a great debt of gratitude to CSIRO-SE staff for allowing me to use these study sites.

A big thank you to John Ludwig, who introduced me to the wonders of multidimensional scaling and the fabulous multivariate statistical program PC-ORD, thank you!! I thank John Ludwig, Roger Lawes, Rebecca Fisher and Ross Alford for encouraging my ventures into the statistical realm. I particularly appreciated Roger's willingness to listen to my questions on statistics, and his ability to reply in a comprehensible fashion. Many thanks to the numerous technical and support staff, particularly Robb Gegg, Gordon Bailey and Sue Reilley, at James Cook University who made life easier in so many ways. Likewise, many thanks go to Tropical Savannas

CRC staff, particularly Penny Wurm and Kate O'Donnell for supporting my research. Jill Landsberg and Alex Kutt also provided wonderful encouragement.

This study involved working on grazing properties, and would not have been possible without the collaboration of the Smith (Dreghorn), the Knouth (Cameron Downes) and the Healing (Warrawee) families. A heart-felt thank you is extended to Kirk, Bron, Shannon and Eiren Smith, and Paul Twine for welcoming me into their family and accepting me as I am. Thank you for the red-wine, blue cheese and magic moonlit nights on the beautiful Burdekin River. I big thank you also to Ivan Bun, the most unlikely herpetologist I've met, for delightful evenings at red-rock!

A number of people have read manuscripts or chapters, and I thank Lin Schwarzkopf, Chris Johnson, Tony Grice, Steve Johnson, Paul Williams, Simon Cook, Michael Marnane, Ian Radford, Brett Goodman, Joanne Isaac, Nicole Kenyon, Brad Murray, Barry Fox, Richard Hutto and two anonymous reviewers for their constructive comments. This project was aided by the numerous people (mostly close friends) who volunteered their time to accompany me on field trips, and on occasion, dig pit-fall traps in the middle of summer. Thank you for your time and effort: Innana Deleyev, Brady Roberts, Nicole Kenyon, Alysia Lim, Pernille Hansen, Carrie Preite, Gemma Tillack, Debra Coleman, Leanne Ezzy, Deb Bower, Basil Byrne, Beth Mott, Kate Valentine, Rebecca Fisher, Michael Marnane and Shaun Wilson. Also, thank you to Eiren Smith, Paul Twine, Shannon Smith and Josh Formosa, for helping me remove the dreaded pit-fall traps. Thanks also to Faye Christidis who was patient enough to help me sort numerous arthropod samples.

Despite an ocean separating us for several years, my partner Michael Marnane has provided constant support and love throughout my PhD. Michael, I have so much to thank you for: giant freddo frogs; yummy home-made pesto sauce; and the most fabulous Café Lattes; not to mention the amazing wildlife adventures we've shared throughout the world. The last 18 months you have suffered through terrible health conditions with a quiet strength that is truly inspiring. I am constantly amazed at your positive attitude in the face of adversity, and I continue to be humbled by your generosity. Thank you for making life interesting and challenging, but always full of laughter and love.

To my family, Peter, Val, Polly and Kate, I am enormously grateful for all of your love. My wonderful mum has constantly listened to my PhD woes, and provided tissues, food, money and cuddles when necessary. My brilliant dad has always encouraged my love of wildlife, and I am so grateful for his wisdom in all things. I truly do have an incredible father. My extended family also include the Johnsons: Bronwyn, Steve, Mat and Sarah, who have been part of our life for as long as I can remember. I thank Bron and Steve for encouraging my science career, and were Bron still here, I'm sure a mango tiramisu would be in order.

I was lucky enough to work at James Cook University where I met the most wonderful friends. In particular, Yvette Williams, Rebecca Fisher and Carolyn Smith have travelled the PhD roller-coaster ride by my side, and oftentimes, holding my hand. Words can not express my gratitude for your unconditional love and support. For the last year, well several if truth be told, Michael Marnane, Shaun Wilson and Rebecca Fisher have endured my surly disposition, grumpy moods and outbursts with outstanding patience. Thank you for standing by me, and for sharing a truly great friendship. Several other friends also deserve special mention, including: Sam Fox, Simon Cook (for the most entertaining guide to writing papers), Pernille Konow, Joanne Isaac (for constant encouragement) and Beth Mott. A number of other friends from Biological Sciences have provided daily encouragement, including: Brett Goodman, Euan Ritchie (long live the mammal lab), Jen Martin (nuzzle buddy), Steve Williams (for fabulous margaritas!), Jane Degabriel, Ben Moore, Deb Bower (for all-round enthusiasm), Basil Byrne (for everything), Maya Srinivasan, Janelle Eagle, Nicole Kenyon, Selma Klanten, Ailsa Kerswell and Will Robbins. I am also grateful to my wonderful friends, Alysia Lim, Charna Murray and Siew-ling Perkins who have tolerated my PhD obsession. I promise not to neglect you so in the future!

Finally, I must thank the spectacular tropical savannas and the amazing wildlife who call them home. These landscapes of scattered trees and grass are full of grace and beauty. There is a magic moment in tropical savannas, when the afternoon sunlight softly filters through eucalypt trees and shrouds the landscape with a warm gold glow that makes my heart soar.

Abstract

Disturbances influence the structure of many ecosystems, determining environmental and biological heterogeneity. Human-mediated disturbances, including introduced plant species and fire, have the ability to alter ecosystem-level processes and properties, modify habitat structure and, as a consequence, influence faunal assemblages. This thesis examines the impacts of introduced plant species and fire management practices on vertebrate assemblages in grazed tropical savannas in northern Queensland.

Invasive introduced plant species pose a major threat to native environments. Rubber vine (*Cryptostegia grandiflora*) is an environmental weed that invades native riparian habitats in northern Australia. Small ground-dwelling lizards may be negatively affected as rubber vine replaces and fragments native habitat. Field observations of reptiles in habitat invaded by rubber vine recorded only a single lizard in rubber vine vegetation, compared to 131 lizards in nearby native vegetation. As rubber vine vegetation contains features that superficially resemble native habitat, such as leaf litter, the avoidance of rubber vine suggests that rubber vine has underlying characteristics that create a suboptimal environmental for lizards.

Two species of native skinks (*Carlia munda* and *C. pectoralis*) and the invasive plant rubber vine were used as a model system to determine possible underlying mechanisms driving avoidance of non-native plants by fauna. In semi-natural enclosures, lizards discriminated between leaf litter types: 85% of *C. pectoralis* and 80% of *C. munda* chose native leaf litter over rubber vine, indicating a clear preference for native habitat. In comparison to native habitat, rubber vine provided a suboptimal environment for litter-dwelling lizards with lower ambient temperatures, reduced availability of prey and a reduction in camouflage from predators (dissimilar leaf and lizard shapes). Thus, three possible mechanisms were identified by which an introduced plant species can alter the availability of resources in an environment, making it less attractive to native fauna. As rubber vine is a Weed of National Significance, management of this species is a priority.

Fire plays a pivotal role in structuring ecosystems and often occurs as a human-mediated disturbance for land management purposes, including management of introduced plants. Rubber vine is susceptible to fire, and burning for weed control may be implemented in riparian zones of tropical savannas where rubber vine is prevalent. Although tropical savannas are considered fire-adapted ecosystems, riparian vegetation and associated fauna may be less resilient to the effects of fire. Variations in fire regimes alter the environment in different ways, and the type of fire may govern the response of faunal assemblages. Using replicated experimental fire treatments, imposed on two habitats (riparian and adjacent woodland), I examined the responses of reptiles and birds in the short- and longer-term to a range of fire management practices used to control rubber vine.

An important component of fire regime is the season of burn. In tropical savannas, most fire management occurs during the dry season; however, wet season burning is often used for pastoral management and may be useful for controlling introduced plant species. Initially, only one species of reptile responded strongly to burning, with few differences detected between burning seasons. Abundances of the skink *C. munda* were higher in burnt sites and may reflect temporary changes in food availability, or a reduction in rubber vine. However, the overall structure of the reptile community was driven by habitat type (riparian versus woodland) rather than burning, suggesting most reptiles were responding to broader environmental factors. Within three years of burning, reptiles were least abundant in dry season burnt sites, a result mostly driven by the abundance of the small terrestrial gecko, *Heteronotia binoei*, which was commonly observed in unburnt and wet season burnt sites. In addition, litter-associated species, including the skink *C. pectoralis*, were rarely observed in burnt habitat and fewer species were detected in the wet season burnt sites.

Both season of burn and time since fire also significantly influenced bird assemblage responses. Within 12 months of fire, burning tended to benefit several bird species and feeding groups, with higher overall abundances of birds observed in the sites, although species that favoured dense vegetation (e.g. red-backed fairy-wren, *Malurus melanocephalus*) were rarely observed in burnt habitat. Responses of feeding groups, including insectivores, nectarivores and carnivores, suggest that burning may have temporarily increased food resources. In the short-term, assemblage of birds tended to

reflect whether or not a site was burnt, rather than burning season. However, four years following burning, dry season burnt sites were composed of a different bird assemblage than unburnt and wet season burnt sites. In addition, dry season burnt treatments were characterised by lower bird abundances, especially nectarivore and granivore feeding groups and the insectivorous white-throated honeyeater (*Melithreptus albogularis*). As dry season burning removed more vegetation than wet season burning, birds may be responding to a reduction in habitat complexity, and subsequent changes in food resources.

The frequency with which a habitat is burnt is another critical component of fire regime, and may ultimately determine faunal assemblage responses. Using a fully replicated Before-After-Control-Impact (BACI) design I examined the impacts of repeated burning on bird assemblages. In contrast to unburnt or singularly burnt sites, the repeated burning significantly reduced bird abundance and species richness. Repeat burning also altered the feeding group structure of sites. In particular, frugivorous and insectivorous birds were adversely affected by the second fire. Vegetation complexity was lower in both burning treatments, but the repeatedly burnt sites contained less native fruiting shrubs, especially currant bush (*Carissa ovata*), which was an important food and shelter source for several species. Repeatedly burning an area in a short time frame may reduce key resources, other than vegetation complexity, such as food availability or foraging opportunities.

The use of fire is considered necessary for the maintenance of tropical savannas. However, high impact individual fires may detrimentally affect habitat structure and faunal assemblages at a local scale. In particular, my results suggest that overall bird and reptile assemblages are strongly influenced by management burning, including variations in burning season and fire frequency. In an attempt to overcome potential negative impacts of burning, ecologists have suggested implementing mosaic burning, where a variety of burning regimes are employed. Although mosaic burning theoretically provides a diversity of habitat types that consequently maintain high faunal diversity, my results suggest that some measures of diversity (e.g. species evenness) may be compromised by mosaic burning.

In summary, this study provides evidence that introduced invasive plants and management burning play a key role in shaping landscapes and associated faunal communities. Fauna respond to disturbance-induced changes in microhabitat and vegetation structure, food availability or foraging opportunities, and habitat requirements (e.g. temperature). The role of multiple human-mediated disturbances in influencing faunal responses in my study is of particular importance. My research was conducted in landscapes already disturbed by grazing and invasive species, and the responses of fauna may be caused by cumulative impacts. In areas where multiple disturbances already influence landscapes, the resilience of faunal assemblages to fire management practices may be lower than previously predicted.

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