

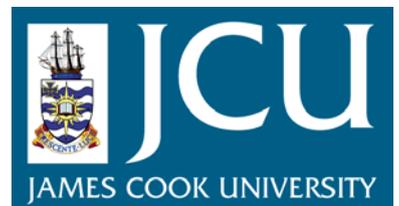
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**The impacts of human-mediated disturbances on  
birds and reptiles in tropical savannas.**

PhD thesis submitted by  
Leonie Ellen Valentine  
B.Sc., Dip. Res. Met. James Cook University  
December 2006

For the degree of Doctor of Philosophy  
School of Marine and Tropical Biology  
James Cook University  
Townsville, Queensland 4811  
Australia

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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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### Declaration

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## **Statement of contribution of others**

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Some data chapters in this thesis include work published in collaboration with my supervisors Dr Lin Schwarzkopf, Prof. Christopher 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

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### 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?

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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.

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## Abstract

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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 environment 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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