Gradients of Functionality of Australian Rangeland Landscapes: Assessing Changes over Time with Remote Sensing

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Gradients of functionality of Australian rangeland landscapes : Assessing changes over time with remote sensing

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Introduction Unlike Australia's temperate ecosystems , the tropical savanna landscapes are in relatively unmodified condition . Disturbances such as fire , logging/thinning and grazing occur within these landscapes and can be both temporally and spatially variable , increasing landscape heterogeneity but rarely resulting in well-defined patch boundaries . Instead the tree stratum and underlying grassy ground layer varies continuously at the local-scale . Traditional models for analysis of heterogeneity in landscape structure and relevant functionality for fauna species have depicted landscapes as static arrays of vegetation patches with discrete boundaries between habitat and matrix patches . However , many rangeland and savanna landscapes with gradual spatial and temporal variation in structure do not fit this model .

Many species require more than one type of habitat during different life stages or for different functions such as foraging or nesting . Thus , to gain an understanding of change in ecological function with change in landscape structure it is important to recognise the ecological value of a variety of landscape components , and their changes over time . Few previous studies have considered these varying requirements .

This work aims to provide quantitative and continuous measures of habitat quality of relevance to fauna in a tropical savanna landscape . In addition this work will investigate how these measures of habitat quality vary over time by looking at time series of remote sensing imagery , and measure how important temporal changes are for biodiversity .

Materials and methods This study is based in the Desert Uplands bioregion of Queensland , Australia . The Desert Uplands are tropical savannas characterised by open eucalypt and acacia woodlands with grassy understory occurring on alluvial sand and clay soils and flat sand and earth plains . The region experiences a highly variable summer dominant rainfall varying between 350-600mm annually . Taking advantage of remote sensing technology , we map and model changes in amount and spatial configuration of different habitat elements from a time series of Landsat imagery . An object-oriented approach within the software Definiens Professional 5 .0 allows identification of key habitat elements within the imagery , in particular grass cover and tree cover followed by classification of the imagery into cover maps . Using spatial filters within ArcGIS we create continuous surfaces of the vegetation elements , and include information on water availability as a relevant habitat element . Generalised linear modelling and information theoretic approaches are used to describe the relative importance each of the habitat variables for the diversity , presence and abundance of a variety of small mammals , reptiles and birds . Habitat variables are weighted and combined to create a continuous surface measuring overall habitat quality for each image in the time-series . Further modelling establishes the relationship between the temporal variation in habitat quality and the diversity and abundance of fauna .

Results and discussion This work establishes a quantitative relationship between continuous spatial variation of habitat elements and the diversity and abundance of fauna . Our results show that there is much variation in the response of individual species to the variation in spatial structure of different habitat elements . Weighting and combining the habitat elements by relative importance results in a continuous surface of overall habitat quality . This model remains ecologically relevant as the new measures can explain a significant proportion of spatial variation in abundance of individual species and diversity of species . Temporal variation in landscape function , which is often ignored due to time and resource constraints , is also of importance . Significant temporal variation in species diversity and abundance occurs and is well-explained by our model of variation in habitat quality .

Conclusions Using remote sensing technology and time series data allowed us to successfully describe how landscape function can vary across a spatial continuum and through time . The approach used in this study was ecologically relevant as it took into account the different habitat requirements of a variety of species , instead of assuming a generic response to landscape structure covering multiple species . This study was also able to take into account temporal variation in landscape structure and function which is a common shortcoming of most studies of the influence of landscape structure and composition on fauna . Of particular relevance to savanna ecosystems is the ability to quantitatively measure continuums in habitat structure since these landscapes rarely exhibit distinct boundaries between vegetation cover types , nor are the fauna limited to one vegetation type .