CAN GROUND COVER FUNCTION AS A SURROGATE FOR BIODIVERSITY CONDITION IN THE RANGELANDS?

*Juliana McCosker *[1], John Rolfe [2] and Rod Fensham[1]*

[1] Environmental Protection Agency, PO Box 906 Emerald QLD 4720

[2] Central Queensland University Rockhampton QLD 4701

INTRODUCTION

Landholders in rangeland areas need to consider the potential impacts of grazing management on the ecosystem in which they operate, to ensure that they maintain the ecological requirements for the ecosystem to persist. However, information about condition of ecosystems is typically complex to collect, assess and interpret. To meet landholder needs, some simple measures of condition and trend need to be available. In this paper, the potential use of ground cover as a surrogate for biodiversity condition is tested in relation to grazing woodlands of central western Queensland.

The development of a bare ground index and then subsequently the inverse of that as a ground cover index have potential advantages in allowing remote assessments to be performed. These indices may allow an ecosystem to be classified rapidly in terms of ground cover at a landscape level. If ground cover can be proven to have a sound correlation with biodiversity indicators then ground cover indexes could be effective tools for providing a rapid assessment of biodiversity condition of an entire ecosystem across its distribution, in both a spatial and temporal context.

This study tests the validity of this hypothesis by focusing on a single ecosystem, namely silver-leaved ironbark woodlands which cover over 1 million hectares across the Desert Uplands bioregion. Production from grazing in these woodlands has increased over time through a more even spread of waters, the use of feed supplements, introduction of exotic plant species and some clearing of vegetation. It is still unclear what the long-term grazing capacity is and what the trade-offs are in terms of ecosystem integrity and composition involved in the various possible grazing regimes.

REVIEW

Biodiversity is often equated with heterogeneity and complexity; with a strong emphasis on species and populations to describe and measure the ecosystems' diversity. Functional complexity, in terms of energy and nutrient flow patterns, also need to be considered in the description and analysis of ecosystem diversity (Tainton *et al.* in Hodgson and Illius 1996).

Ground cover is functionally related to a number of key indicators of land condition, including runoff and soil loss (Scanlan and McIvor 1993, Dube *et al.* 1999). Therefore a measurement of ground cover and types of ground cover or inversely bare ground should give a good correlation to land condition and with that ecological integrity.

Plant composition, bird composition and ground cover are all inter-related biodiversity indicators or sets of biotic, environmental, pressure and landscape attributes that best signal the effects of pressures caused by human activity on the integrity of the ecosystem (Smyth *et al.* 2003). Plants reflect the physical environment, are the primary target of many pressures acting on the rangelands and are relatively amenable to measurement. Therefore, plant measurements have considerable potential to be effective indicators of the response of rangeland biodiversity to land use (Landsberg and Crowley 2004). Plant species have relationships between their basal area and their above ground biomass (Day et al. 1997). This in turn is related to the pasture plants above ground standing yield and cover (Scanlan and McIvor 1997).

Spatially explicit satellite image data is an attractive monitoring option for estimating ground cover and trends over large areas. In order to quantify the assessment of condition from satellite imagery, it needs to be correlated with estimated ground cover and validated via multi-temporal image analysis, together with multi-temporal datasets. Ground cover is used in satellite imagery measurements of range condition, rather than grass basal area because of the inability of satellites to measure grass basal areas (satellites have a vertical view) (Taube 2000). Field based data for calibration, validation and adequate image interpretation of cover indices is needed to ensure a consistent relationship to cover amount, both spatially and temporally (Pickup *et al.* 1993).

METHODOLOGY

In this project, tests were performed to assess the potential for remote sensing data to predict ground cover accurately across a range of field conditions. The sites were located in the Desert Uplands bioregion which is has summer dominant rainfall averaging between 350 and 600mm per year. Rainfall variability is moderate to high. The silver-leaved ironbark woodlands of the Desert Uplands bioregion cover over a million hectares and is the most widespread ecosystem with grazing production values in the bioregion. Ninety-one field sites were established across the distribution of the silver-leaved ironbark woodlands in the Desert Uplands bioregion. Sites were selected from the digital bare ground index 2006 raster data generated by the Department of Natural Resources and Water (NRW) with sites selected for a range of ground cover categories – a) from under 25%, b) from 26% to 50%, c) over 51% to 75%, and d) over 75%. While these sites were not selected by their distance from water, this distance was measured for each site. The sites are located over 25 properties. The details of paddocks in which the sites were located were recorded, such as -the size of the paddock, the vegetation type configurations in the paddocks, the number of waters in the paddock and the number and type of stock and duration of stocking in the paddock.

At each site, a 100m tape was run north-south and another east-west with a GPS taken at the centre point. A point intercept method was used to provide 200 recordings of cover in three canopy categories – understorey, mid-storey and upper-storey. Five 0.25m by 0.25m quadrats were cut at 20m intervals along the north-south transect, stored in paper bags, dried for 48hours at 280^0C and dry weighed to establish a biomass as kilos per hectare.

Along the north-south transect line – eight vegetation subplots were established measuring 10m by 2m in which each plant species was recorded. The frequency of occurrence provides a measure of abundance (0-8) for each species at each site. The field sites were assessed in May 2007, at the end of wet season. Each site was then correlated with the remote sensing data for a similar time period.

In order to compensate for the high numbers of zeros for many species, the abundance score was averaged over segments of ten sites (eleven for the last segment) after ordering sites by the bare ground index.

RESULTS

The bare ground index of September 2006 was found to be strongly correlated to the actual ground cover measurements taken in May 2007 and the biomass measurements taken in May 2007.

The results showed that 25 plant species were found to have significant negative correlations to increasing bare ground cover (Table I). Of these 25 species 15 were native perennial grass species. Six plant species were found to have significant positive correlations to increasing bare ground cover (Table I).

To negate the effect of zero data points in the results, the number of each species recorded for ten sites was averaged to provide 9 averaged records rather than 91 records for ground cover. An example of the relationship between ground cover and abundance for *Sehima nervosum*, a perennial grass is shown in Figure A. Both the perennial grasses and the total plant species composition were significantly correlated with bare ground by R= .9034 with a probability of.001 and R= .9064 with a probability of .001 respectively.

Figure A. Graph of abundance of *Sehima nervosum* against percentage ground cover

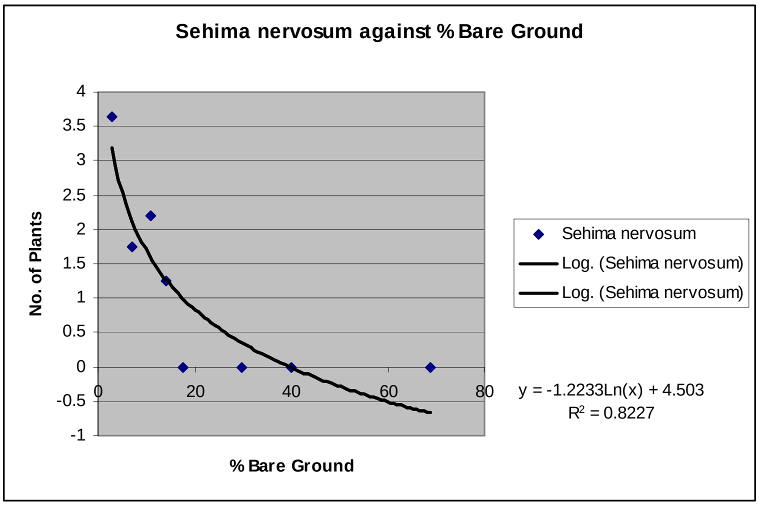


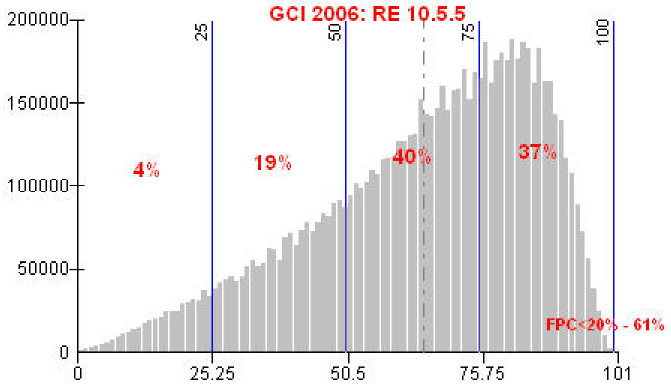
Table I. Showing the species with significant correlations to bare ground cover percentage

Plant Species	r	*P*	Direction
Aristida calycina	0.993	0.001	-
Fimbristylis dichotoma	0.983	0.001	-
Tripogon lolliformis	0.941	0.001	-
Chrysopogon fallax	0.910	0.001	-
Sehima nervosum	0.907	0.001	-
Themeda triandra	0.876	0.001	-
Gomphrena celosioides	0.862	0.001	+
Enneapogon lindleyanus	0.849	0.001	-
Themeda avenacea	0.839	0.01	-
Cynodon dactylon	0.830	0.01	+
Rhyncosia minima	0.815	0.01	-
Brunoniella australis	0.807	0.01	-
Digitaria brownii	0.790	0.01	-
Panicum effusum	0.776	0.01	-
Bothriocloa ewartiana	0.776	0.01	-
Triodia pungens	0.767	0.01	-
Acacia coriacea	0.736	0.01	-
Sida fibulifera	0.736	0.01	+
Phyllanthus fuerhornii	0.735	0.05	-
Galactia tenuifolia	0.704	0.05	-
Hybanthus enneaspermus	0.700	0.05	-
Abutilon sp.	0.695	0.05	+
Dianella longifolia	0.694	0.05	-
Canthium oleifolium	0.693	0.05	+
Eragrostis sororia	0.678	0.05	-
Digitaria ammophila	0.668	0.05	-
Stylidium eriorrhizum	0.655	0.05	-
Spermacoce brachystemma	0.651	0.05	-
Scleroleana birchii	0.647	0.05	+
Jasmium didymum	0.635	0.05	-
Eulalea aurea	0.624	0.05	-

DISCUSSION

However, the results confirm that there is a strong correlation between bare ground and many important and indicative plants species such as the 15 perennial grasses and very palatable forbs such *Rhyncosia minima*. Those species with positive correlations with bare ground are the species that are indicative of poor condition such as *Gomphrena celosioides* and *Scleroleana birchii*. Also the bare ground index is effective a predicting levels of bare ground. These results suggest that a bare ground index has the potential to provide some indication of ecological integrity and diversity in this ecosystem. However, this ground cover index is only valid for 61% of the silver-leaved ironbark distribution as that is area which has foliage projective cover of leas than 20%. Figure B below shows the histogram of the ground cover index for the whole distribution of silver-leaved ironbark across the Desert Uplands bioregion. The curve is skewed towards the right suggesting that the ecosystem has predominantly high ground cover. The low figures show the area heavily impacted by grazing – those areas with less than 25% ground cover represent only 4% of the entire ecosystem. These barer areas are mainly associated with stock watering points. The plant species with significant negative correlations to increasing bare ground will indicate silver-leaved ironbark woodlands in good ecological condition and high ground cover. Continued development of better information about ecological condition back to landholders should help maintain the condition of this ecosystem.

Figure B. Histogram of ground cover index for silver-leaved ironbark ecosystem



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