PROCEEDINGS OF THE AUSTRALIAN RANGELAND SOCIETY BIENNIAL CONFERENCE

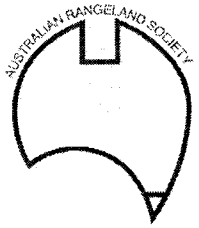
Official publication of The Australian Rangeland Society

Form of Reference

The reference for this article should be in this general form;
Author family name, initials (year). Title. *In*: Proceedings of the nth Australian Rangeland Society Biennial Conference. Pages. (Australian Rangeland Society: Australia).
For example:
Anderson, L., van Klinken, R. D., and Shepherd, D. (2008). Aerially surveying Mesquite *(Prosopis* spp.) in the Pilbara. *In*: 'A Climate of Change in the Rangelands. Proceedings of the 15th Australian Rangeland Society Biennial Conference'. (Ed. D. Orr) 4 pages. (Australian Rangeland Society: Australia).

Disclaimer

The Australian Rangeland Society and Editors cannot be held responsible for errors or any consequences arising from the use of information obtained in this article or in the Proceedings of the Australian Rangeland Society Biennial Conferences. The views and opinions expressed do not necessarily reflect those of the Australian Rangeland Society and Editors, neither does the publication of advertisements constitute any endorsement by the Australian Rangeland Society and Editors of the products advertised.



The Australian Rangeland Society

LIMITATIONS OF VEGETATION SURVEYS IN CHARACTERISING ARID PLANT SPECIES RICHNESS

K.D. Clarke, M.M. Lewis and B. Ostendorf

School of Earth & Environmental Sciences, University of Adelaide,
Waite Campus, Urrbrae, SA 5064
Email: kenneth.clarke@adelaide.edu.au

ABSTRACT
The study examined the ability of two ground survey methods to thoroughly characterise the woody-perennial species richness of single sample sites or environmental regions. It focused on the Stony Plains Interim Biogeographic Regionalisation of Australia (IBRA) in the South Australian rangelands, and analysed field survey data collected by two government agencies for biodiversity assessment and land condition monitoring. Species-richness/sampling-effort relationships were analysed to determine the adequacy of sampling. To ensure the validity of the analysis a method was developed to remove any potential temporal bias from the species-richness/sampling-effort relationships. It was demonstrated that the species richness of the majority of single sites and regions was not adequately characterised. Two important conclusions can be drawn from the results of this study. Firstly, that further sampling would change our understanding of the suite of woody-perennial vegetation species typical of those regions which have not yet been adequately characterised. Secondly, that regional estimates of species richness derived from this field survey data should be used with caution.

INTRODUCTION
Increased interest in biodiversity conservation has resulted in government Natural Resource Management (NRM) bodies requiring improved reporting on biodiversity condition in Australia's rangelands (Smyth et al. 2004). However the term biodiversity is complex and has come to encompass a great many variables which can be associated with ecosystem health, and thus identifying what to monitor is a difficult task. Species richness has been identified as one of the few suitable surrogates for biodiversity (Sarkar 2002). Furthermore, there is reason to believe that vegetation species richness can act as an indicator of total species richness at extensive scales (Currie and Paquin 1987; Badgley and Fox 2000; Hawkins and Porter 2003; Hawkins et al. 2003).

Vegetation species richness is typically measured through field sampling at specific sites and times. In the South Australian arid rangelands conventional field sampling is conducted by two State Government programs. However the ability of these ground survey programs to adequately record vegetation species richness is un-tested. Hence the aim of this study was to determine whether conventional ground survey methods were able to adequately characterise the woody-perennial vegetation species richness for single sites and/or regions.

METHODS
Study Area
The study focused on the Stony Plains region, as defined in the Interim Biogeographic Regionalisation of Australia (IBRA) version 5.1 as well as other adjacent IBRA sub-regions in South Australia, and stretches from the top of the Spencer Gulf to the Northern Territory border (Figure 1). Average annual rainfall across the study area ranges from 100 to 300 mm per annum, and the area is typified by chenopod shrubland (Laut et al. 1977).

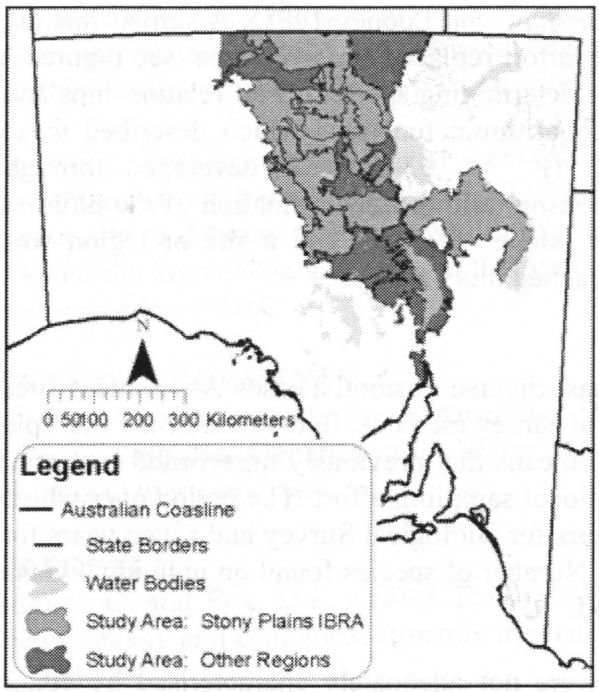


Figure 1: Study area extent and location

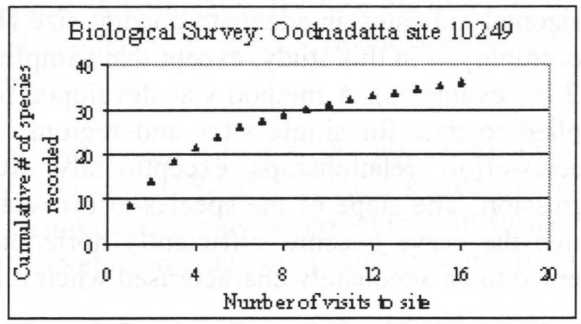


Figure 2: Species-effort relationship for a single site

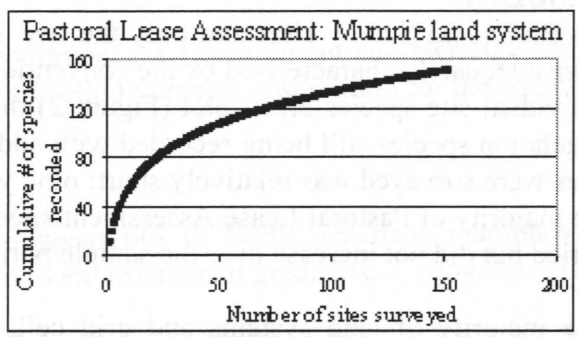


Figure 3: Species-effort relationship for a region

Vegetation Survey Data

The data analysed in this study came from two conventional vegetation surveys, the Department for Environment and Heritage's Biological Survey of South Australia (BSSA) and the Department of Water Land and Biodiversity Conservation's South Australian Pastoral Lease Assessment (SAPLA). The two surveys have different goals and therefore different data collection methodologies. The Biological Survey of South Australia aims to create an inventory of native species and is biased towards remnant vegetation and probably less degraded sample sites. Alternatively the South Australian Pastoral Lease Assessment is designed to monitor the affect of grazing on land condition; sites are all placed a consistent distance from watering points and may be more degraded than their surrounds. There are 892 Biological Survey sites and 1185 Pastoral Survey sites within the study area.

Individual Sites

When considering single sites, the number of return visits was used as the measure of sampling effort. Four Biological Survey sites and 23 Pastoral Lease Assessment sites met the criteria for analysis as single sites, having been visited six or more times.

Region Stratification

To examine the ability of the two ground surveys to characterize species richness of regions, two types of region were used to stratify the data; the IBRA land systems and an arbitrary 100 km grid. The study area is covered by 48 land systems of differing sizes and 30 x 100 km grid cells. In the regional analysis, the number of sample sites was used as the measure of sampling effort.

Species-effort Analysis

Species-area curves have long been used in ecology to determine when a region is adequately characterised by a ground survey. These curves compare the number of species recorded against the area surveyed. As the surveyed area increases the number of species recorded

increases, but with diminishing returns. The point at which the curve becomes sufficiently horizontal indicates an adequate quadrat size (Kershaw and Looney 1985). A similar method was employed in this study, except that sampling effort replaced surveyed area (see Figures 2 & 3 for examples). A method was developed for determining species-effort relationships and applied to data for single sites and regions. Logarithmic functions which described these species-effort relationships exceptionally well (R^2 >= 0.96) were developed through regression. The slope of the species-effort relationship allowed determination of the point at which the curve became sufficiently horizontal (slope <= 0.25), and a site or region was deemed to be adequately characterised when it reached this point.

RESULTS

No Biological Survey sites and only the two least diverse Pastoral Leases Assessment sites were adequately characterised by the conventional survey methods. In the case of the example individual site species-effort plot (Figure 2) this means that previously unrecorded perennial vegetation species still being recorded with additional sampling effort .The period over which sites were surveyed was relatively short: nine years for Biological Survey and seven years for the majority of Pastoral Lease Assessment sites. Number of species found on individual visits varied but did not increase over the sample period.

The majority of land systems and grid cells were not adequately characterised by either ground survey method. In other words, many species would be found with additional sampling effort. Only the two largest land systems were adequately characterised by BSSA and four of the nine largest land systems were adequately characterised by SAPLA. The BSSA data did not adequately characterise any 100 km grid cells and the SAPLA data only adequately characterised two 100 km grid cells. For those sites, land systems and grid cells where perennial plant richness was not adequately characterised, the number of surveys which would be required was predicted from the developed regression formulas. These estimates were conservative.

DISCUSSION & CONCLUSIONS

The aim of this study was to determine whether conventional ground survey methods were able to adequately characterise the woody-perennial vegetation species richness of single sites and of regions in a portion of the Southern Australian rangelands.

It was demonstrated the neither the Biological Survey of South Australia nor the South Australian Pastoral Lease Assessment surveys were capable of recording all woody-perennial species present at an individual site with a single sampling. Furthermore only two sites with six or more visits were adequately characterised. It could be argued that the inability of either ground survey method to adequately characterise individual sites could be due to ageing successional vegetation communities or general improvements in landscape condition over the sampling period. However the sampling intervals are relatively short and perennial vegetation composition would be unlikely to change through succession over such a short time, especially in the arid study area. There is also no evidence for a general improvement in landscape condition over the sampling period. It is therefore reasonable to conclude that the majority of sites, which have been sampled on three or fewer visits are not adequately characterised.

Stratification of the ground survey data by region demonstrated that perennial species richness of the majority of land systems and grid cells was not adequately characterised. This is significant because it indicates that further sampling of the majority of regions would result in

the discovery of additional woody-perennial species and therefore change our understanding of the suite of species which characterise these regions. Additionally, because the majority of regions are not adequately characterised, regional estimates of species richness developed from this field survey data should be used with caution.

This study has demonstrated that conventional vegetation surveys do not adequately characterise woody perennial species richness in a portion of South Australia's rangelands. However these datasets contain a wealth of information and it may be possible with further work and the knowledge gained from this study to develop an index of species richness from the ground survey data.

ACKNOWLEDGEMENTS
We would like to thank the South Australian Department for Environment and Heritage and the South Australian Department for Water Land and Biodiversity Conservation for the use of their data in these analyses.

REFERENCES
Badgley, C. and Fox, D.L. (2000). Ecological biogeography of North American mammals: species density and ecological structure in relation to environmental gradients. *J. Biogeog.* 27: 1437-1467.

Currie, D.J. and Paquin, V. (1987). Large-scale biogeographical patterns of species richness of trees. *Nature* 329: 326-331.

Hawkins, B.A. and Poerter, E.E. (2003). Water-energy balance and the geographic pattern of species richness of western Palearctic butterflies. *Ecol. Ent.* 28: 678-686.

Hawkins, B.A., Porter, E.E. and Diniz-Filho, J.A.F. (2003). Productivity and history as predictors of the latitudinal richness gradient of terrestrial birds. *Ecology* 84(6): 1608-1623.

Laut, P., Keig, G., Lazarides, M., Loffer, E., Margules, C., Scott, R.M. and Sullivan, M.E. (1977). Environments of South Australia: Province 8, Northern Arid. Canberra, Division of Land Use Research, CSIRO: 116-168.

SarKar, S. (2002) Defining "Biodiversity"; Assessing Biodiversity. *Monist* 85(1): 131-155.

Smyth, A.K. and Chewings, V.H., Bastin, G.N., Ferrier, S., Manion, G. and Clifford, B. (2004). Integrating historical datasets to prioritise areas for biodiversity monitoring? Australian Rangelands Society 13th Biennial Conference: Living in the outback. Alice Springs, Northern Territory.