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Is there a relationship between contemporary high Aboriginal plant resource locations and mapped vegetation communities?

J.T. Hunter

School of Environmental and Rural Science, University of New England, Armidale, NSW 2350 AUSTRALIA

***Abstract*:** Across western New South Wales agricultural practices have led to significant changes in the distribution and abundance of many native plant species. These changes have occurred due to past clearing practices and the introduction of grazing and pest animals. It is likely that such changes have affected the distribution of plant species used by Aboriginal peoples, and that formerly rich plant resource areas may also have changed. Here an attempt is made to map contemporary high aboriginal plant resource areas in the Yantabulla area (lat 29° 55'S, long 150° 37'E) of far western New South Wales, using kriging interpolation. High aboriginal plant usage resource areas were not found to be correlated with any particular vegetation assemblage, although Lignum Shrublands comparatively had the lowest scores. Site species richness was correlated strongly with sites of high abundance of aboriginal resource use. It is hoped that by identifying contemporary high resource locations, new understandings of the landscape can be developed by traditional owners and conservation land managers.

Keywords: kriging interpolation, food, medicine, tools, ceremonial.

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Introduction

As with all human cultures Aboriginal peoples are likely to have caused vegetation modifications at various scales including encouraging mosaics and edge areas, resetting successional sequences, creating wild stands and informal 'orchards' (by favouring perennial fruit, nut and tuber bearing species) and increasing the prevalence of prey abundance in specific locations (Smith 2011). These may have been achieved passively or more directly by the use of fire (Latz 1995; Vigilante & Bowman 2004; Smith 2011). However in most current Australian landscapes, what minor or major modifications may have occurred due to Aboriginal influence over millennia, have been greatly modified by the more intensive post-settlement European farming practices. In spite of this, it is likely that the natural distribution of many species important to Aboriginal peoples will have maintained their general distribution across the landscape, as their occurrence is based on features of climate and soil (Gaikwad *et al.* 2011).

Plants used by Aboriginal peoples are culturally valuable but knowledge of high resource areas is inadequate and fragmented. This is particularly so since much traditional knowledge is now lost. Major changes in landscape management have changed patterns that may have been prevalent in the past causing redistribution, losses and increases in abundance of many plant species through large areas being cleared, changed fire regimes and more intensive primary production. In western NSW many plant communities now have extensive woody encroachment and are now dominated by native species thought to have increased in distribution since clearing and grazing were introduced (Eldridge *et al.* 2013). Such taxa include *Dodonaea viscosa* and *Eremophila sturtii* which are often termed 'woody weeds' (Porteners *et al.* 1997). Additionally, a number of dominant and characteristic species in western NSW and across the semi-arid regions of Australia (e.g. *Acacia aneura, Acacia oswaldii, Alectryon oleifolius, Atalaya hemiglauca, Casuarina pauper, Flindersia maculata, Grevillea striata, Hakea ivoryi, Hakea tephrosperma*, *Hakea leucoptera* & *Ventilago viminalis*), which appear to recruit via seed only infrequently, may not have returned to their original abundances post-clearing (Batty & Parsons 1992; Auld & Denham 2001). This is probably due to a number of these taxa having evolved in the arid and semi-arid regions of Australia (in the Cretaceous-Palaeocene when the climate was warmer, and more seasonal) (Specht & Specht 1999). Unpredictable rainfall, lack of seasonality and increasing aridity over millennia followed; these conditions are likely to be further exacerbated by predicted anthropogenic climate change further reducing the likelihood of future seeding recruitment in these species (CSIRO & Bureau of Meteorology 2015).

Adjoining properties *Naree* and *Yantabulla* in far western NSW are associated with Cuttaburra Creek, which flows into Yantabulla Swamp, and eventually into the Paroo River. *Naree* Station (15,000 ha) a former pastoral property was purchased by Bush Heritage Australia in 2012 (http://www.bushheritage.org.au/places-we-protect/new-south-wales/naree). In 2015 the southern neighbouring pastoral property of *Yantabulla* Station (16,000 ha) was purchased by South Endeavour Trust (http://www.southendeavour.com.au/). Both properties are currently managed for wildlife conservation by Bush Heritage Australia. Until the recent changes in ownership and their subsequent emphasis on conservation management, these properties were under grazing management for more than 100 years. The properties contain a range of landscapes including extensive ephemeral wetlands (billabongs, riverine lakes, terminal lakes), floodplains, dunal areas and low lying escarpments. These systems are dominated by a variety of broad vegetation assemblages including: Coolibah, Poplar Box and Blackbox Woodlands; shrublands of Mulga, Ironbwood, Lepardwood, Belah, Rosewood, Turpentine and Hop Bush; Grasslands; Canegrass and Lignum (Hunter & Hunter 2016).

The traditional owners of the lands covering these stations are the Budjiti people, and Bush Heritage Australia aims to work with, and strengthen the relationship with traditional owners and to create opportunities to involve them in identifying and protecting cultural values (http://www.bushheritage.org.au/places-we-protect/new-south-wales/naree). As we may not know the nuances of native plant species distributions and their abundances in pre-European times, investigations have to rely on current distributions and abundances. In this paper we attempt to map areas of high and low plant resources that may have been used by Aboriginal peoples at *Naree* and *Yantabulla*, to assist planning for the protection of potential culturally important areas. We use the data to test if there is congruence between defined vegetation units and areas generally high in species richness.

Methods

Naree and *Yantabulla* stations (31 990 ha in area) are 60 km south east of Hungerford and 112 km north-west of Bourke (lat 29° 55'S, long 150° 37'S) on Cuttaburra Creek within the Mulga Lands Bioregion (Thackway & Cresswell 1995). Here a total of 208 full floristic 20 x 20 m sites were surveyed for vascular plants. Sites were surveyed during June 2014 and April 2015, and all sites revisited in April 2016. All vascular plant species were scored using a modified cover abundance scale (scores: 1: <5% and uncommon; 2: <5% and common; 3: 6-20%; 4: 21-50%; 5: 51-75%; 6: 76-100%) (Westhoff & Maarel 1978). These scores were converted to the medial score for each cover category in order to redress the emphasis on low cover scores. Site scores were then divided by the lowest site score obtained for standardisation. Nomenclature follows PlantNET (http://plantnet.rbgsyd.nsw.gov.au/), accessed January 2016.

Taxon-related tables were created that included information on species score within each plot and a table of traits associated with Aboriginal usage for each species (Maiden 1889; Henshall *et al.* 1980; Cunningham *et al.* 1981; Levitt 1981; Cribb & Cribb 1982; Leiper & Houser 1984; Goddard & Kalotas 1985; Low 1985; Cribb & Cribb 1986; Low 1988; Low 1989; Low 1990; Wightman & Smith 1989; Smith & Wightman 1990; Wightman *et al.* 1991; Wightman *et al.*

1992ab; Zola & Gott 1992; Lazarides & Hince 1993; Leiper & Houser 1993; Latz 1995; Bindon 1996; Stewart & Percival 1997; Maslin *et al.* 1998; Harris *et al.* 2000; Lassack & McCarthy 2011; McKerney & White 2011; Williams 2011) (Appendix 1). Trait use of all species were weighted by their score from each plot. Kriging interpolation was used on site based plant usage scores to model the density of aboriginal plant usage across *Naree* and *Yantabulla* stations using Surfer (Vers. 14.3.691; Golden Software). Kriging is a very flexible geostatistical gridding method that produces maps from irregularly spaced data by allowing custom-fit to data by specifying the appropriate variogram model and incorporating anisotropy and underlying trends.

Hunter and Hunter (2016) used this same floristic data to produce a phytosociological classification and vegetation map within a three-tiered system based on the EcoVeg criteria (Faber-Langedoen *et al.* 2014) (Group, Alliance and Association). The Group and Alliance levels of floristic classification are used here for analysis (Table 1). The Canegrass Alliance of Hunter & Hunter (2016) has not been used as only two sites were surveyed in this assemblage which would not allow for statistical inferences to be made.

Table 1: Hierarchical floristic classification units of Group and associated Alliances within the study region (Hunter and Hunter 2016).

Floristic Group	Floristic Alliance
Mulga Complex	A. Mulga Shrubland
Shrubland Complex	B. Turpentine – Button Grass – Windmill Grass Shrubland
	C. Turpentine – Hop Bush – Kerosene Grass Shrubland
Floodplain Wetlands Complex	D. Coolibah – Black Box – Yapunyah – Lignum Woodlands
	E. Rat's-tail Couch – Love Grass Grasslands
	F. Canegrass Grassland
	G. Lignum – Glinus Shrubland
	H. Poplar Box – Black Box Woodland

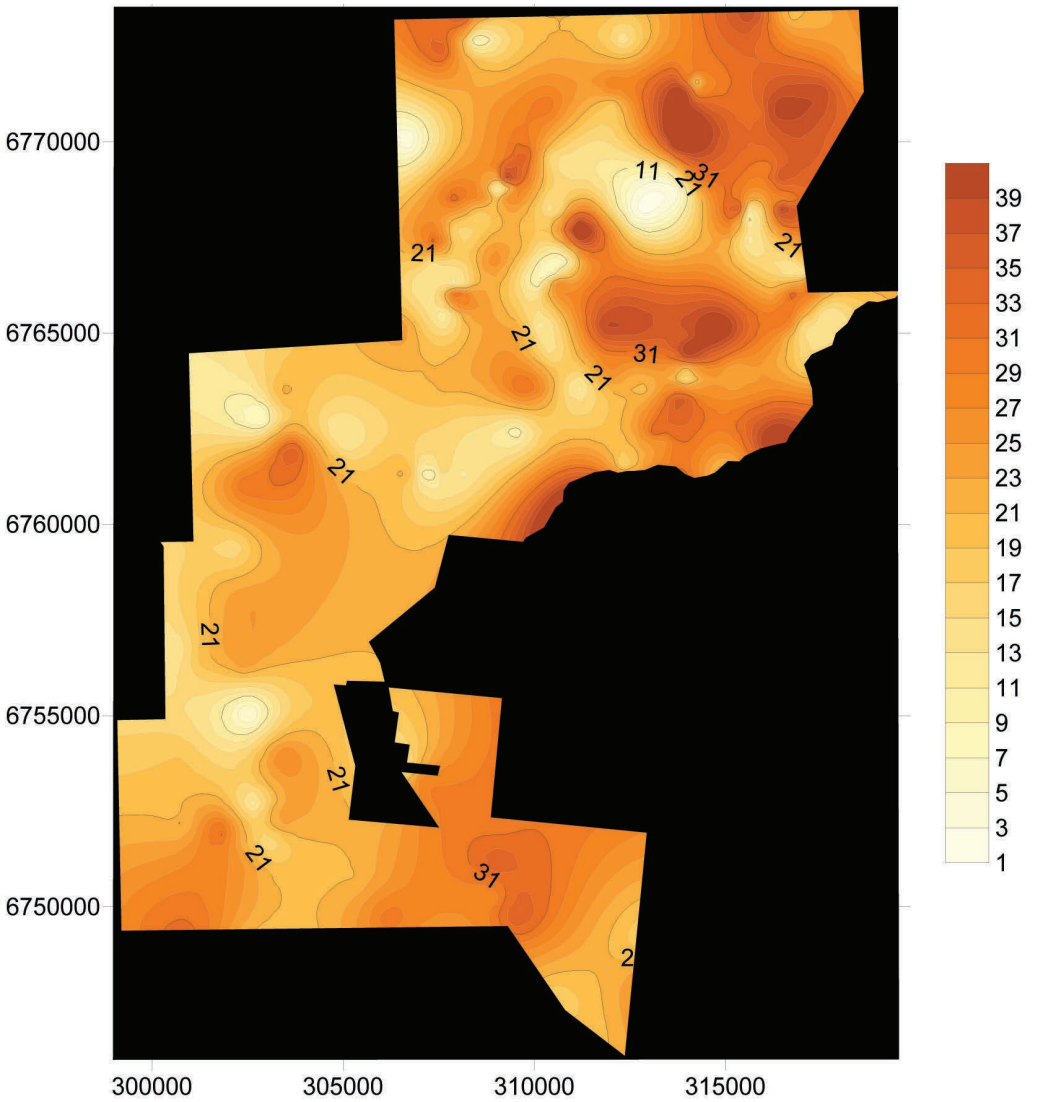

Figure 1: Modelled relative abundance of contemporary Aboriginal flora resources within *Naree* and *Yantabulla* stations. X and Y co-ordinates refer to eastings and northings within Zone 54, Datum 94.

Results

Of the 355 native vascular plant species found in the *Naree* and *Yantabulla* study area, 130 (37%) have been recorded as being used in some form by indigenous peoples (see Appendix 1). Of these 91 had been used for food, 58 medicinally, 33 for tools and only 10 ceremonially. Forbs, followed by shrubs and then grasses and trees were the most used species in the study region (Table 2).The difference between high and low plant resource locations is nearly forty-fold (Figure 1). There is no relationship between defined floristic Groups or Alliances and plant resource use scores (Figures 2 & 3). Overall, Lignum areas (G) (Figure 3) had the lowest resource use score range. A power function relationship accounted for 42% (Figure 4) of the variation between species density (richness per plot) and Aboriginal plant resource score.

Table 2: Distribution of Aboriginal usage plants from *Naree* and *Yantabulla* Stations by major plant life form categories.

Life Form	Richness
Fern	1
Forb	54
Grass	18
Hemi-parasite	5
Shrub	30
Tree	16
Vine	4

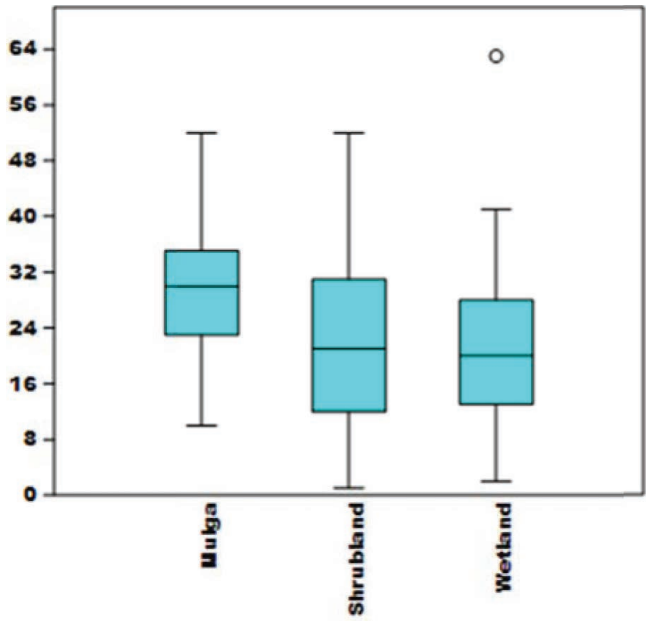

Figure 2: Comparison of relative abundance of Aboriginal flora resources within the floristic Groups of Hunter and Hunter (2016). There is no significant difference in resources between major floristic groups.

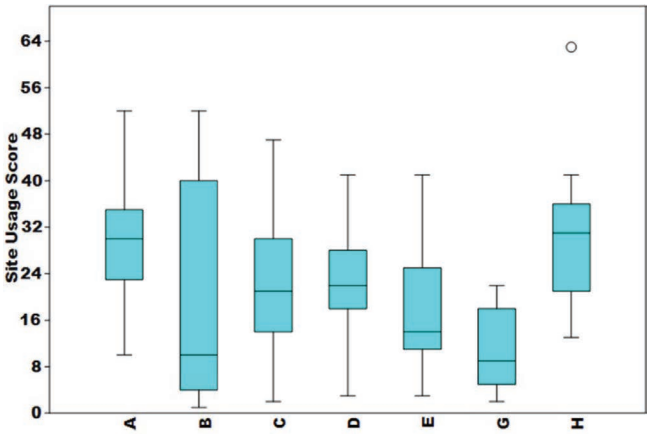

Figure 3: Comparison of relative abundance of Aboriginal flora resources within the floristic Alliances of Hunter and Hunter (2016). There is no significant difference in resources between floristic group Alliances. See Table 1 for titles of floristic Alliances.

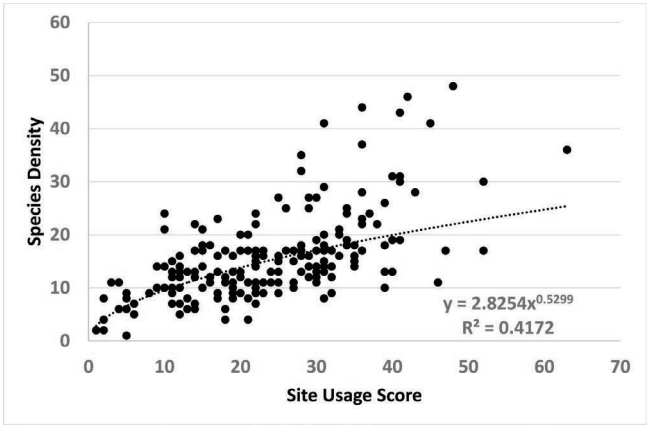

Figure 4: Power relationship between site species richness (species density) and site usage score.

Discussion

The results show that Aboriginal plant resources are heterogeneously distributed across the *Naree* and *Yantabulla* landscape in north western New South Wales. Peaks in useful plant materials are nearly 40 times greater than troughs in the landscape, but these were not found to coincide with phytosociological units defined by floristic analysis (Hunter & Hunter 2016). Thus, general vegetation mapping of plant community types cannot be used to infer high or low Aboriginal plant use abundance locations in our study region. Nor are areas of high and low Aboriginal plant usage clearly associated with major landscape features such as wetland areas, escarpment or dune systems at our scale of analysis.

High congruence between species rich locations and high Aboriginal plant use was found, indicating that enhancing and/or protecting areas of high natural plant species richness is also likely to assist in protecting areas of cultural importance within the landscape though it is acknowledged that not all Aboriginal groups used the same plants, or used them in the same ways. Furthermore, we acknowledge that

plant resources important to Aboriginal peoples are only one aspect of culturally significant areas, and that locations of high fauna food resources, or areas of spiritual importance, have not been taken into account. However, it is hoped that by identifying contemporary high resource locations new understandings of the landscape can be developed by traditional owners and conservation land managers.

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Appendix 1

Native plant species on *Naree* and *Yantabulla* stations and reported use to Aboriginal peoples (as food, medicine, tools or ceremonial).

Sources - Maiden 1889; Henshall *et al.* 1980; Cunningham *et al.* 1981; Levitt 1981; Cribb & Cribb 1982; Leiper & Houser 1984; Goddard & Kalotas 1985; Low 1985; Cribb & Cribb 1986; Low 1988; Low 1989; Low 1990; Wightman & Smith 1989; Smith & Wightman 1990; Wightman *et al.* 1991; Wightman *et al.* 1992ab; Zola & Gott 1992; Lazarides & Hince 1993; Leiper & Houser 1993; Latz 1995; Bindon 1996; Stewart & Percival 1997; Maslin *et al.* 1998; Harris *et al.* 2000; Lassack & McCarthy 2011; McKerney & White 2011; Williams 2011.

Species	Food	Medicine	Tools	Ceremonial
Abutilon leucopetalum	1			
Abutilon otocarpum	1			
Acacia aneura	1	1	1	1
Acacia brachystachya	1			
Acacia excelsa	1	1	1	
Acacia oswaldii	1		1	
Acacia ramulosa	1			
Acacia stenophylla	1			
Acacia tetragonophylla	1		1	
Acacia victoriae	1		1	
Alectryon oleifolius	1		1	
Alstonia constricta		1		
Amaranthus grandiflorus	1			
Amaranthus macrocarpus	1			
Amphipogon caricinus			1	
Amyema cambagei	1			
Amyema lucasii	1			
Amyema maidenii	1			
Atalaya hemiglauca	1			1
Atriplex elachophylla		1		
Boerhavia coccinea	1			
Boerhavia dominii	1	1		
Boerhavia repleta	1			
Brachychiton populneus	1		1	
Bulbine alata	1			
Calandrinia eremaea	1			
Callitris glaucophylla	1	1	1	
Calostemma purpureum	1		1	
Capparis mitchellii	1	1		
Casuarina pauper			1	1
Centipeda cunninghamii		1		
Centipeda minima		1		
Centipeda thespidioides		1		
Chamaesyce drummondii		1		
Chenopodium auricomum	1			
Chenopodium cristatum		1		
Chenopodium melanocarpum		1		
Citrullus lanatus	1			
Cymbopogon ambiguus		1		
Cyperus bifax		1		
Dactyloctenium radulans	1			
Dianella porracea	1		1	
Dodonaea viscosa		1	1	
Duma florulenta	1		1	
Dysphania kalpari	1	1		
Dysphania rhadinostachya	1	1		
Echinochloa inundata	1			
Einadia hastata	1			
Einadia nutans	1		1	
Enchylaena tomentosa	1	1	1	
Enteropogon acicularis			1	
Eragrostis australasica	1			
Eragrostis basedowii	1			
Eragrostis dielsii	1			
Eragrostis eriopoda	1			1
Eragrostis kennedyae	1			
Eragrostis lacunaria	1			
Eragrostis laniflora	1			
Eragrostis leptocarpa	1			
Eragrostis setifolia	1			
Eremophila bignoniiflora		1		1
Eremophila deserti	1			
Eremophila gilesii		1		
Eremophila latrobei		1		
Eremophila longifolia	1	1		1
Eremophila mitchellii	1	1	1	
Eremophila sturtii		1		
Erodium crinitum	1			
Eucalyptus coolabah	1	1	1	
Eucalyptus largiflorens	1		1	1
Eucalyptus melanophloia		1	1	
Eucalyptus populnea	1	1	1	
Flindersia maculosa	1	1	1	
Goodenia lunata			1	
Grevillea striata	1	1	1	
Hakea eryeana		1		
Hakea leucoptera	1	1		
Hakea tephrosperma	1			1
Linum marginale	1		1	
Lysiana exocarpi	1			
Lysiana subfalcata	1			
Malva parviflora		1		
Marsdenia viridiflora	1			
Marsilea drummondii	1			
Marsilea hirsuta	1			
Myoporum montanum	1	1	1	

Species	Food	Medicine	Tools	Ceremonial
Owenia acidula	1	1		
Panicum decompositum	1			
Panicum effusum	1			
Phyllanthus lacunarius		1		
Phyllanthus virgatus		1		
Pimelea microcephala	1	1		
Pluchea tetranthera		1		
Portulaca oleracea	1	1		
Pseudognaphalium luteoalbum		1		
Psydrax latifolium	1			
Pterocaulon sphacelatum		1		
Santalum acuminatum	1	1	1	
Scaevola spinescens		1		
Schoenoplectus laevis	1			
Senna artimisioides subsp. *filifolia*		1		
Senna artimisioides subsp. *x sturtii*		1		
Sida goniocarpa	1			
Sida platycalyx	1		1	
Solanum cleistogamum	1	1		
Solanum coactiliferum	1			
Solanum ellipticum	1			
Solanum esuriale	1			
Sonchus oleraceus	1	1		
Themeda avenacea	1	1		
Themeda triandra	1			
Trachymene glaucifolia	1			
Trachymene ochracea	1			
Tribulus terrestris	1			
Ventilago viminalis	1	1	1	
Wahlenbergia gracilis	1			
Zygophyllum iodocarpum	1			