Are Karda (*Varanus rosenbergii)* more abundant around traditional Noongar lizard traps?

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Abstract

Construction of lizard traps on granite outcrops is a traditional hunting method used by the Menang Noongar people of southern coastal southwest Australia for *Varanus rosenbergii* (also called Karda by the Noongar, or Rosenberg's Monitor by Europeans); an important protein source in pre-colonial diets. This method may have been employed to increase the abundance of this species or to aid access to this resource. To explore this question we combined Noongar traditional knowledge and western scientific techniques to investigate the abundance of lizard traps in relation to intensity of pre-colonial Noongar use and Karda abundance.. We found lizard traps were evenly distributed on granite outcrops across our study area regardless of likely past intensity of use by Noongar people. Using camera trap data and occupancy modelling we also found that Karda abundance was uniform across our study area and did not appear to be influenced by the presence of traps, indicating that their construction may have been to facilitate hunting rather than to increase their number.

KEYWORDS: Noongar, OCBIL, YODFEL, Traditional ecological knowledge, Varanus lizard

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INTRODUCTION

For tens of millennia, interdependent relationships have existed between humans and other organisms, including the human modification of habitats to aid access to food and other resources (Smith 2011; Tobler *et al*. 2017; Bliege Bird *et al*. 2013; Groesbeck *et al*. 2014; Lullfitz 2019). Habitat modification methods employed by traditional societies include construction of aquatic, marine, or terrestrial structures (e.g. fish weirs) to enhance abundance or to assist capture of resource organisms (Smith 2011). For example, 'clam gardens' constructed by First Nations people of Northwest Coastal America have been found to maximize clam productivity (Groesbeck *et al*. 2014), whereas pit traps constructed by people in pre-colonial southwest Australia were used to aid kangaroo hunting (Nind 1831) but would not have enhanced abundance.

Southwestern Australia is dominated by old, climatically buffered, infertile landscapes (OCBILs) within a mosaic of younger, often disturbed, fertile landscapes (YODFELs; e.g. coastal dunes and wetlands; Hopper 2009; Hopper *et al*. 2016). Southwest Australian examples of OCBILs include granite outcrops and quartzite uplands, which exhibit high levels of endemism and specialized organisms compared to YODFELs (Hopper 2009; Hopper *et al*. 2016). Rocky outcrops support high levels of biological diversity (Goldsbrough *et al*. 2002; Porembski 2007). Loose surface rocks are important reptile microhabitats (Croak *et al*. 2010). In Australia, an estimated 60 reptile species predominantly live on rocky outcrops of which at least 20 are found principally on granites (Wilson & Swan 2013).

Southwestern Australia has been home to fourteen groups of the Noongar nation for at least 48 000 years (Turney *et al*. 2001). Our study area falls within Menang Noongar country (Fig. 1). Archaeological and ethnographic studies indicate that Menang occupation patterns heavily utilized coastal dunes, estuarine fringes and wetland areas (all YODFELs), whereas use of granite outcrops (OCBILs) was prevalent, but less frequent and often restricted (Lullfitz 2019; Goode *et al* 2005; Applied Archaeology Australia 2012).

Varanus rosenbergii (in Noongar, Karda) plays a key role in Menang culture, featuring in dreaming stories, and its eggs and meat provided a valued protein source (Guilfoyle *et al*. 2013; Tilbrook 1983; Bindon 1997). As a Meananger elder, LK attests that eggs would be gathered from termite mounds, whereas Karda were hunted by driving them up trees or by using lizard traps.

A lizard trap consists of a rock slab propped up by smaller rocks, and does not 'trap' the animal per se (Fig. 2). These purpose-built structures mimic the natural habitat for reptiles on granite outcrops (Bindon 1997). Reptile species targeted by the Menang Knapp family include Karda, blue-tongued skink (*Tiliqua rugosa*) and carpet python (*Morelia spilota*). Previous studies suggest the role of lizard traps as habitat-enhancement or resource enrichment for reptiles (Bindon 1997; Guilfoyle *et al*. 2013; Mitchell 2016). However, there is currently a lack of quantitative studies to support this. LK describes

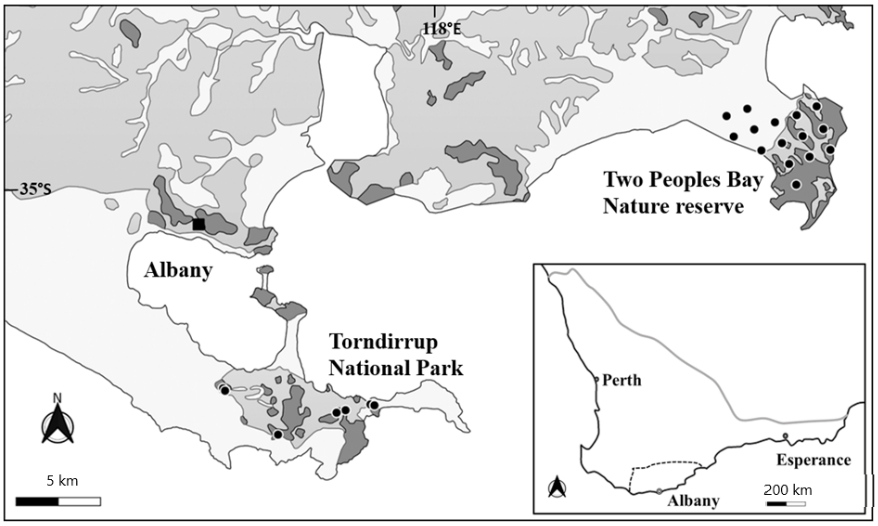

Figure 1. Study sites at Torndirrup National Park and Two Peoples Bay Nature Reserve, near the city of Albany, and soil landscape classifications. OCBILs (dark grey), YODFELs light grey), and areas which do not fall into the strict classification of OCBIL or YODFEL (medium grey). The inset map shows the region inhabited by the Noongar people in a solid grey line, Menang country in dashed line, and towns of importance. Map created using using landscape soil subsystem data from the Department of Agriculture and Food Western Australia (Purdie *et al*. 2004).

Figure 2. Examples of lizard traps: a) and b) at Two Peoples Bay Nature Reserve; c) and d) at Torndirrup National Park.

that whereas all granite outcrops were used for hunting Karda using lizard traps, outcrops closer to camps would likely contain more. LK also notes that Karda are difficult to catch in summer due to high surface temperatures, and that use of lizard traps for hunting is primarily confined to the cooler months.

We hypothesized that granite outcrops close to YODFELs (areas more heavily utilised by Menang people), including dunes, and estuarine and wetland fringes, would have a higher abundance of lizard traps than those at greater distance. Secondly, if lizard traps act as habitat enhancement, then more Karda would be detected where lizard traps were more abundant. This study aimed to investigate these hypotheses, especially whether habitat modification through lizard trap construction increases Karda abundance.

METHODS

This study was conducted in Menang country in the Two People's Bay Nature Reserve (TPBNR) and Torndirrup National Park (TNP) close to the City of Albany (Fig. 1). Landforms of the study area were categorized as YODFEL, OCBIL or neither in accordance with Lullfitz. (2019) using landscape-soil subsystem data from the Department of Agriculture and Food Western Australia (Purdie *et al*. 2004).

Lizard traps were counted on granite outcrops at 22 locations across TPBNR (15 sites) and TNP (seven sites). The TPBNR sites were pre-determined locations of the camera traps (see below) whereas TNP sites were chosen for ease of access and distribution across the landscape. No camera trap data was available at TNP. For each site, the total survey area was recorded and then the count standardized to number of traps per metre of granite surveyed. Surveys were limited to a maximum of one hectare. Surface granite features were identified as lizard traps where a prop rock was clearly present but were not included where human construction was determined to be ambiguous (e.g. natural exfoliation).

To estimate Karda utilization of habitat, camera trap data for TPBNR was acquired from the West Australian Department of Biodiversity, Conservation and Attractions for routine feral cat monitoring. Data was collected using Reconyx Hyperfire HC600 (Reconyx, Wisconsin; USA) passive infrared camera traps set 1 km apart deploying a total of 15 cameras. The data acquired for this study covered November 1, 2014 to February 28, 2015.

A 50 m transect was surveyed in each cardinal direction from each camera trap. Along each transect, average shrub height, total bare ground, granite and other rock coverage were recorded. All termite mounds and ant hills within one metre of each transect were also recorded.

A spatial occupancy model was analysed to determine the probability of Karda at various OCBIL and YODFEL sites at TPBNR. The detection of an individual on a camera confirmed that the species was present at the site. However, non-detection does not necessarily mean the species was absent (MacKenzie *et al*. 2017). Occupancy values were generated by assuming probability of detection remained constant whereas an adjacency matrix accounted for the possibility of individuals ranging across more than one camera. The spatial model of Comer *et al*. (2018) was run on WinBUGS (v14; Lunn *et al*. 2000) with a burn in of 5000 iterations and sampled for 2000 iterations.

A Pearson's correlation test was used to analyse for correlation between lizard trap abundance and distance to nearest YODFEL, and Karda occupancy values and distance to nearest YODFEL. A step-wise linear regression was utilised to identify deterministic factors for Karda occupancy. Factors in this analysis included average shrub height, number of ant hills, total bare ground, granite and other rock coverage, distance to nearest OCBIL and YODFEL. All statistical analyses were carried out using R version 3.5.1 (R Core Team 2016).

RESULTS

Of the total 22 sites in our study area, 12 included granite outcrops. Across these, the density of lizard traps was 0.01(±0.013) per m^2 of granite surveyed. At two sites none were recorded. We found no correlation between lizard traps and distance to nearest YODFEL (R^2= 0.008, p= 0.64; Fig. 3a).

Occupancy values showed Karda had a high detection probability (0.857±0.002) across all 15 sites at TPBNR. Regression results indicated distance to YODFEL explained some variation in occupancy (R^2 = 0.48, p <0.01; Fig. 3b), with a slightly higher occupancy at lesser

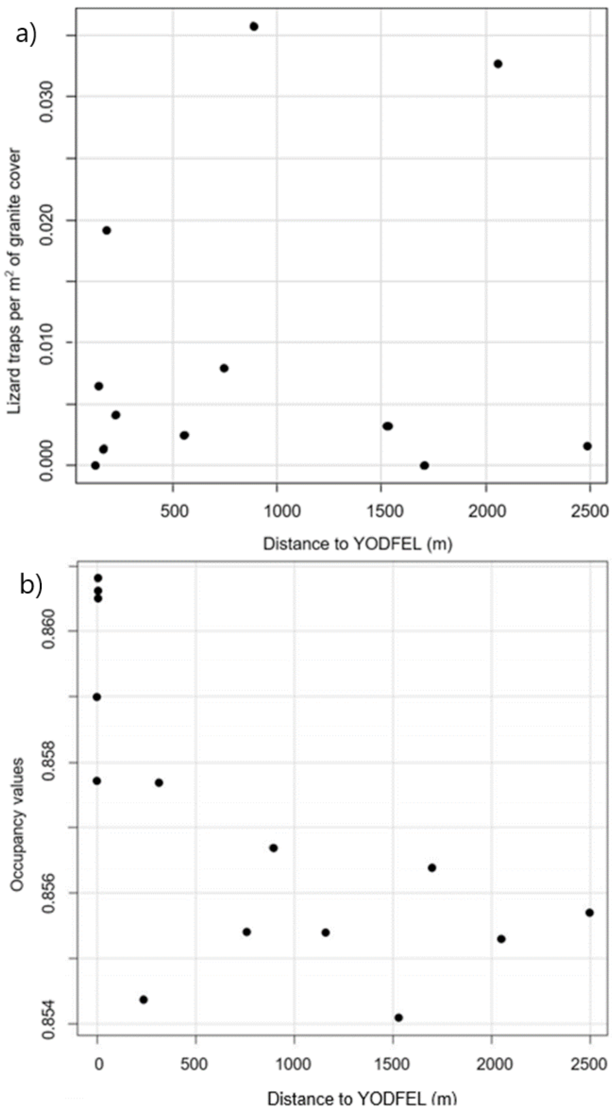

Figure 3. Scatterplots: a) count of lizard traps per square metre of granite surveyed and the direct distance to nearest YODFEL (m) for each site; and b) regression analysis between the occupancy values of karda at each site and distance to YODFEL (m).

distances. However, the overall range of occupancy values was very small (0.854 – 0.861). Karda detection rates did not differ between non-granite sites, granite sites with lizard traps, and granite sites with no lizard traps (Chi-squared = 4.768, p = 0.09, df = 2).

Occupancy values for Karda were driven by distance to nearest OCBIL, granite cover, and number of ant hills (probability of occupancy = 0.09487 + 1.872 x 10^{-6} x OCBIL - 17.879 x 10^{-6} x granite cover - 623.978 x 10^{-6} ant hill). However, occupancy range was minimal.

DISCUSSION

Our findings do not support the hypothesis that abundance of lizard traps on granites close to YODFELs heavily used by Noongar people is higher than those farther away, or that Karda are more numerous at sites where lizard traps are more abundant. These results indicate that Noongar habitat modification through lizard trap construction may not increase Karda abundance.

Although OCBILs were occupied less than YODFELs by Menang people, reptiles may have been more important than other protein sources during periods of OCBIL occupation than at other times. Given that macropod hunting (and mosaic burning for hunting) was carried out more often in YODFELs than in OBCILs (Lullfitz 2019), this could be a plausible reason for the lack of variation in lizard trap abundance with distance to YODFELs. This question warrants further investigation through collaborative research to understand Noongar pre-colonial diets, specifically in relation to ceremonial events.

Lizard traps are by nature stable once constructed. To this end, we assumed they would not be readily dismantled by people, and that constructed lizard traps would have accumulated over time. This may explain their homogenous frequency across granites surrounded by OCBILs and YODFELs. Alternatively, there may have been post-colonial removal of lizard traps from granites for ornamental or landscaping use (Shine *et al*. 1998; Goode *et al*. 2005) given the proximity of the study area to a major urban centre.

Uniform Karda occupancy across all TPBNR sites suggests that lizard trap abundance does not result in increased Karda detectability. Even though Karda occupancy was slightly higher at sites closer to YODFELs, overall variation in occupancy rates was so small (<1% difference between maximum and minimum values) that this was unlikely to have ecological significance.

Although Karda were largely hunted by Menang people in the cooler months, our camera trap data was recorded during summer (November to February). Given that Menang use of lizard traps to hunt Karda in winter is based on observations of differential Karda behaviour between seasons, this may have influenced our findings. We also note that our study area and data set are small, and that a larger study taking in all seasons is warranted to clarify a possible relationship between lizard trap and Karda abundance.

Whereas our study indicates that lizard traps may not be vital habitat for Karda, this does not discount their heritage value or possible importance for other reptile species. In addition, our finding of uniformity in lizard trap abundance irrespective of past Menang land use, indicates that they may be an animal harvesting technology tailored for human survival within old landscapes. Further cross-cultural research will enhance a shared understanding of country and the long-held land practices of the First Nations people of southwestern Australia.

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