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Intergenerational archaeology:

Exploring niche construction in southwest Australian zooarchaeology

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Abstract

Niche construction theory concerns the modification of environments by all organisms, and gives a new perspective on zooarchaeological records in southwest Australia. Aboriginal people in this region historically used fire to improve habitat and hunt animals, suggesting pre-European traditions of environmental management. Analysis of a new faunal record from the Leeuwin-Naturaliste Region, at the Wonitji Janga rockshelter, suggests post-European changes in Aboriginal hunting are the result of changed firing regimes or restrictions on traditional management techniques. These preliminary findings suggest that similar research planned for the Swan Coastal Plain, coupled with advances in ancient DNA analysis, will demonstrate past landscape modification.

Introduction

Charlie Dortch's major work, represented by his doctoral analysis of Aboriginal territoriality and congregations in southwest Australia (Dortch 2002), was largely based on regional lithic and historical records. Throughout his career he also identified many important zooarchaeological deposits across Western Australia (WA) (Dortch 1977, 1979, 1999; Dortch et al. 1984). The aim of this paper is to show how zooarchaeology can support a related research question developed in the same region: the extent of Aboriginal landscape management through burning (Hallam 1975; Merrilees 1968).

In the recent history of Aboriginal Australia, landscape burning was arguably a pervasive and transformative form of niche construction (Bowman 1998; Gammage 2011; Hallam 2002). Niche construction refers to the process by which organisms—including human societies—modify the ecological niches that they occupy (Laland and O'Brien 2011; Odling-Smee et al. 2003; Zeder 2012). Understanding past landscape management is also significant for present-day landscape management, which changed substantially with European incursion and a succession of new management regimes (Bradstock et al. 2005; Kelly 1999; Prober et al. 2013). Zooarchaeology can contribute to the identification of past land management because fire regimes influence animal habitats (Burbidge and McKenzie 1989; Gill 2002). Our research examines the southwest, and vertebrate remains excavated from cave and rockshelter deposits. Evidence from plant remains, anticipated from fine-grained pollen records and ancient (plant) deoxyribonucleic acid (aDNA) samples now being analysed, will also help to indicate plant community responses to firing (Kost 2013).

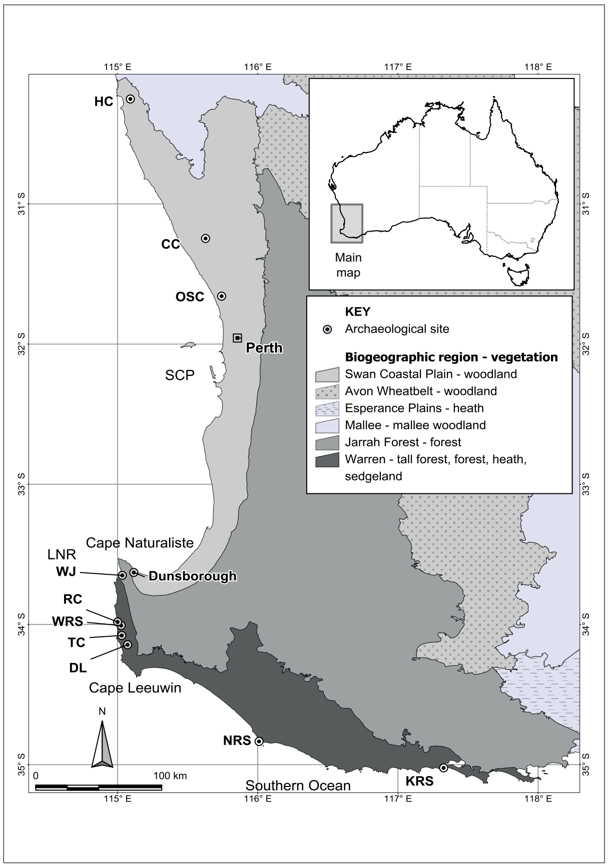

Figure 1 Southwest Australian sites and places mentioned in the text, with regions based on the Interim Biogeographic Regionalisation for Australia.

Demonstrating Niche Construction through Zooarchaeology

Niche construction theory (NCT) departs from an established theory in zooarchaeology, resource depression (Zeder 2012). The latter assumes that 'prey-ranking' decisions are made on the basis of returns on the effort invested (Stiner and Munro 2002). In Australia, for example, O'Connell and Allen (2012) suggested that resource depletion on the coasts motivated the colonisation of inland areas. In contrast, NCT assumes that humans unilaterally engineer the environments they exploit. Niche constructing behaviours are *inceptive* (modifying or relocating to a potentially more favourable environment) or *counteractive* (insulating against changing selection pressure) (Odling-Smee et al. 2003). Also known as triple inheritance theory, since it selects for environmental, cultural and genetic change (Fuentes 2013; Riede 2012), NCT explains change in terms of imperfect environmental knowledge and engineering capacity. NCT does not identify social motives, but its recognition of recursive and historical relationships between people and environment helps archaeologists to explore factors such as changes in social relationships, specialisation, regionalisation or population growth (Broughton et al. 2010; Zeder 2012).

Smith (2011, 2012) identified six cultural markers in small-scale societies for cultural niche construction associated with the cultivation, transplantation or promotion of plant and animal resources. Amundsen-Meyer (2013) demonstrated similar markers in non-agricultural societies in the Americas. Below, we propose an approach for the Australian zooarchaeological record based on southwest WA. The latter region is an ideal choice to test this research because it is environmentally resilient or 'buffered' (Hopper and Gioia 2004), was amenable to anthropogenic burning (Abbott 2003; Hallam 1975, 2002) and possesses detailed zooarchaeological records (Figure 1; Table 1). The region's ethnographic record indicates possible forms of niche construction. Noongar oral history (Kelly 1999) confirms 19th century British settlers' records of Noongar burning in late summer to flush macropods from coastal thickets (Hallam 2002). These thickets appear to have been a form of inherited property, protected by their owners from wildfire and game drives by other Noongars (Hallam 2002).

Anthropogenic fire regimes are thought to have created vegetation communities at multiple fire succession stages, resulting in a finer vegetation mosaic, increased habitat heterogeneity and prey biodiversity (Bird et al. 2008; Bowman et al. 2003). Historical evidence supports similar managed landscapes around core productive areas in southwest WA (Hallam 2002). One archaeological indicator of niche construction through burning would be evidence of changes in ecological structure and diversity between pre- and post-European periods, when the cessation of traditional land management resulted in 'wild' landscapes (Gammage 2011). A second indicator would be intensive resource use without evidence for depression of those resources over time (Smith 2011). A third indicator would be manifestation of tightly defined territories managed by hereditary caretakers who were responsible for certain landscapes or niches (Smith 2012). This report addresses the first of these indicators, leaving the other two for future work.

Given the above inferences, faunal accumulations in areas where Aboriginal influence was intensive, such as highly productive or core resource zones, should be more diverse than those in peripheral and poorly resourced areas, where Aboriginal influence may have been reduced. An example of the former is the Swan Coastal Plain (SCP; Figure 1), which featured chains of productive wetlands (Hallam 1987). The latter may be typified by poorly-watered inland areas or rugged terrain, such as the Leeuwin-Naturaliste Region (LNR; Dortch 2004). Similar contrasts may be drawn by comparing periods when Aboriginal people occupied land with periods when they were unable to access land, such as in the post-colonial period (Zeder 2012). Here, we outline an application of this approach.

The Wonitji Janga Site

As part of a project investigating faunal records through aDNA in sediments, Wonitji Janga (meaning 'spirits talking') was selected for excavation by traditional owner Wayne Webb, who recalled relatives camping in the vicinity in the 1950s. A sinkhole deposit 100 m south of Wonitji Janga was also test-excavated.

Wonitji Janga is a low rockshelter ca 10 m wide, 3 m deep and 2 m high at the drip-line (Figure 2). The site is located on the crest of the calcarenite Leeuwin Ridge, ca 200 m above sea level, at the northern end of the LNR. Here, climate and vegetation are similar to woodlands on the adjacent SCP. The site is located 10 km from productive wetlands at Dunsborough (Guilfoyle et al. 2011), and 1 km from the present day open sea coast, with rock platforms providing access to fish and shellfish.

Site (Abbreviation)	Study Area	Calibrated Age Range Years BP	References
Devils Lair (DL)	LNR	14,100–53,400	Dortch 1979; Turney et al. 2001
Tunnel Cave (TC)	LNR	1300–26,100	Dortch 2004
Witchcliffe Rockshelter (WRS)	LNR	300–800	Dortch 2004
Rainbow Cave (RC)	LNR	300–800	Dortch 2004; Lilley 1993
Wonitji Janga (WJ)	LNR	<100–1300	This paper
Nookanellup Rockshelter (NRS)	SOC	525–2902	Dortch and Kelly 1997
Katelysia Rockshelter (KRS)	SOC	1700–2000	Dortch 1999
Orchestra Shell Cave (OSC)	SCP	1700–4200	Archer 1974; Hallam 1974
Hastings Cave (HC)	SCP	6400–8500	Baynes 1979
Caladenia Cave (CC)	SCP	2900–4800	Dortch et al. 1984; Roe 1971; Thorn and Baynes 2013

Table 1 Southwest Australian zooarchaeological sites.

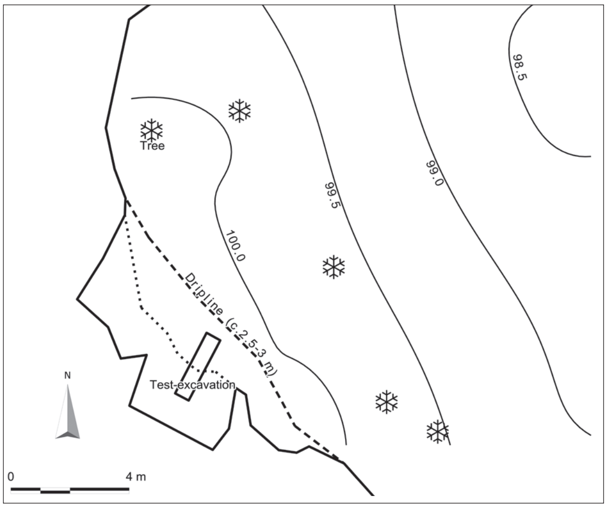

Figure 2 Wonitji Janga site plan. Solid line indicates calcarenite cliff/rockshelter wall. Dashed line indicates dripline; dotted line indicates ceiling at 1 m height; contour lines at arbitrary relative level.

Methods

In May 2013, two of us (JD and WW), along with other Wadandi people and students, excavated a 2 x 0.5 m trench in Wonitji Janga. Excavation was by stratigraphic unit and deposit was sieved through nested 5 and 2 mm screens. Stone artefacts and bone fragments were collected from the sieve. Charcoal was collected in situ and from the sieve. To minimise modern DNA contamination, the field crew wore surgical gloves, changing them every stratigraphic unit, and minimised handling of sieve residues. Faunal remains were transported to Perth for aDNA extraction and conventional identification from reference material.

Results

Wonitji Janga contains 80 cm of archaeological deposit overlying closely packed calcarenite boulders. The deposit features a series of hearths in loose grey sand associated with abundant occupation debris (Figure 3). Archaeological remains include quartz artefacts, burnt and unburnt mammal and fish bone, emu eggshell and shellfish fragments (Figure 4). The stratigraphy in this site resembles that of other late Holocene rockshelters in the southwest, such as Witchcliffe Rockshelter, Rainbow Cave and Nookanellup Rockshelter (Dortch 2004; Dortch and Kelly 1997).

The earliest occupation so far revealed at Wonitji Janga is dated to ca 1300 cal. BP, and the bulk of the deposit dates to ca 500 cal. BP (Table 2). Stratigraphic Units (SUs) 1 and 2 included a twisted metal wire artefact and rabbit bones (*Oryctolagus cuniculus*), consistent with oral history of twentieth century occupation patterns; rabbits arrived in WA in the 1890s and subsequently became a rural staple (Abbott 2008).

Throughout the deposit, bone quantity correlated with quantity of archaeological materials in the form of stone artefacts (with the exception of post-European SUs 1 and 2) and emu eggshell (Figure 4). This correlation, and the limited evidence for changes in other bone accumulating agents, suggest that variations in species abundances probably relate to human occupation patterns.

The sinkhole test-pit revealed abundant faunal remains, but no archaeological material. Preservation of unburnt organics in the upper part of the deposit suggests a recent age comparable to that of Wonitji Janga. We plan to analyse this deposit to ascertain contemporary animal habitats in non-archaeological settings (unbiased by hunters' contributions) to test for former management of the local environment. In between the sinkhole and Wonitji Janga we also identified

Laboratory Code	SU	Sample Weight (g)	Depth Below Surface (cm)	Calibrated Age, Years BP (95% Probability)
Wk 38504	3	14.9	25–29	450–540
Wk 38502	7	0.8	50–52	500–540
Wk 38501	9	0.6	39–41	570–640
Wk 38503	10	2.7	58–63	1180–1280

Table 2 Wonitji Janga radiocarbon determinations and calibrated ages. All samples are charcoal recovered in situ. All samples except Wk38504 were AMS-dated.

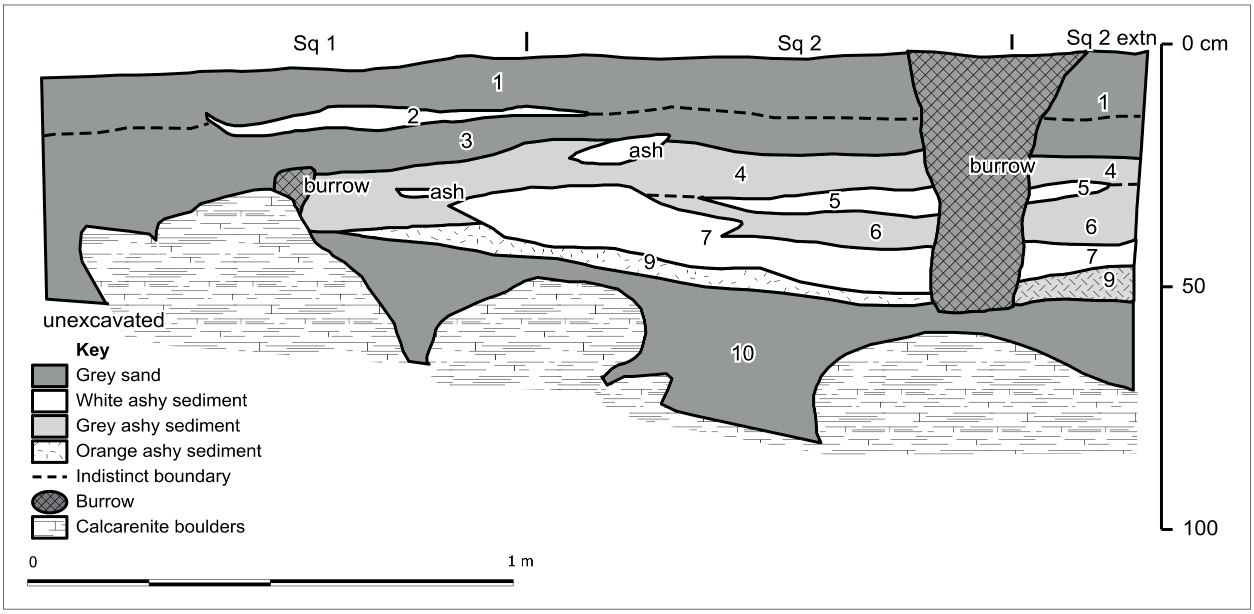

Figure 3 The East Section of Squares 1 and 2 at Wonitji Janga showing numbered stratigraphic units.

THEMED SECTION

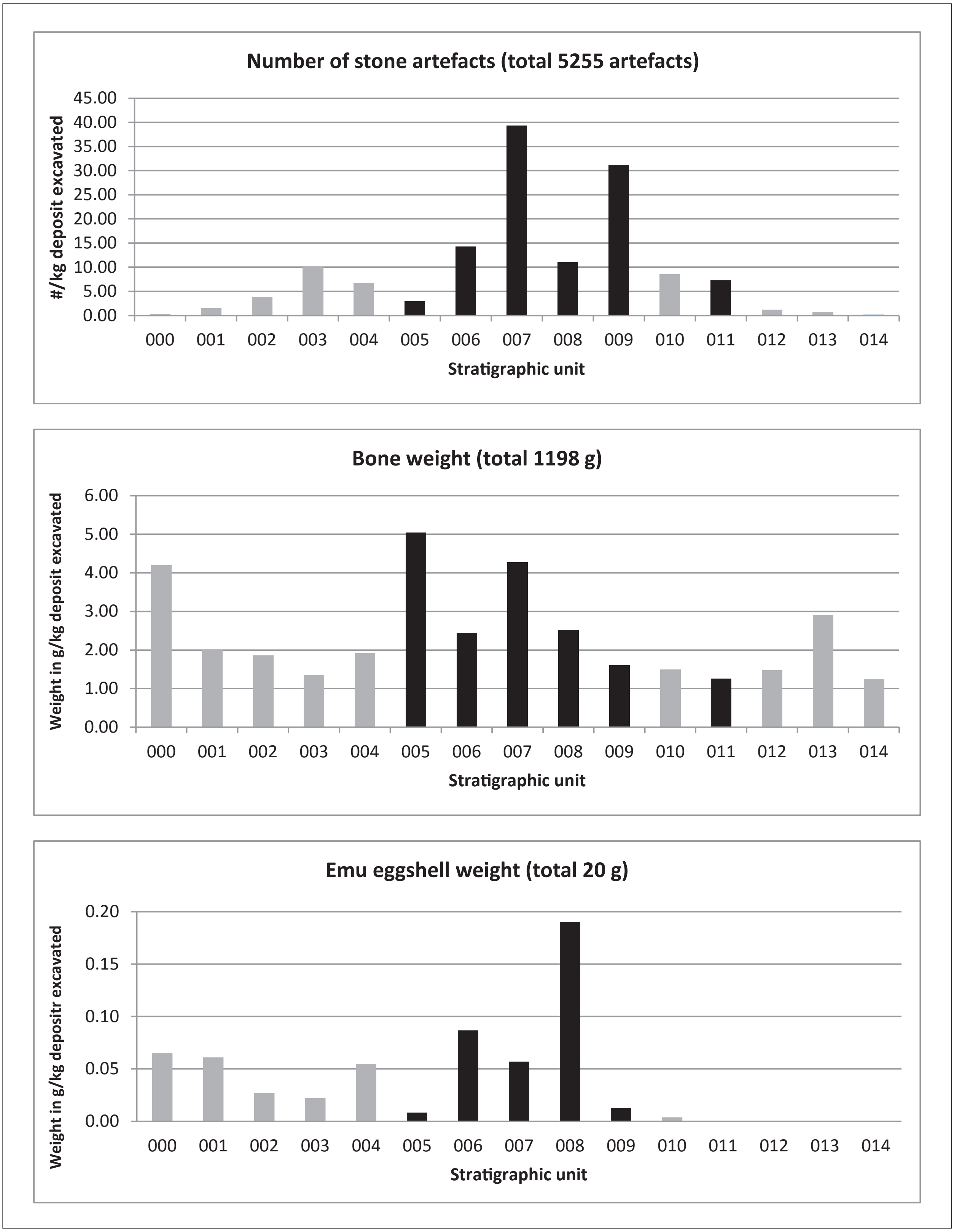

Figure 4 Stratigraphic distribution of stone artefacts, bone and emu eggshell at Woniti Janga. Black columns indicate hearths and ashy units. Unit 000 = surface scrape.

a possum tree: a mature tree notched with an axe to make toeholds providing access to arboreal nests.

Despite the small sample so far analysed, species representation at Wonitji Janga is consistent with post-European changes in Aboriginal land management. Woylies (bettongs; *Bettongia penicillata*) and quendas (bandicoots; *Isoodon obesulus*) are well represented in pre-European and post-European (20th century) deposits (SUs 1 and 2), discounting post-1940s effects from introduced predators and land-clearing as influences on the Wonitji Janga record (Table 3) (Abbott 2008). Favoured species at other LNR sites, woylies and quendas are ground-nesting, fast to reproduce, common and easy to capture (Dortch et al. 2012).

The emphasis on these species at southern LNR sites, in tall-forest or forest, is consistent with flexible, opportunistic foraging (Dortch 2004; Dortch et al. 2012).

In the post-European part of the Wonitji Janga record there is a possible decline (Fisher Exact Tests, $0.95 > p > 0.05$) in the proportions of brush-tail possum (*Trichosurus vulpecula*) and three macropods: quokka (*Setonix brachyurus*), tammar (*Macropus eugenii*) and western grey kangaroo (*M. fuliginosus*). All are species that historically involved more intensive hunting methods, such as fire drives, promotion of habitat through firing or modifying trees (Dortch et al. 2012). Declines in these species, if confirmed, would be consistent with reduced opportunity for Noongar people in the post-European period to manage resources, or alternatively, post-European changes in firing regime as suggested in pollen cores (McNicol 1999; Pickett 1997). In contrast, the pre-European population using Wonitji Janga had better access to richer resources than they would have from the southern LNR sites (Dortch et al. 2012), and may have been more likely to employ niche construction.

Discussion and Conclusion

At present ten sites in southwest Australia, falling into three areas (the SCP, LNR and the Southern Ocean coastline) provide zooarchaeological records. With the possible exceptions of Wonitji Janga, for reasons detailed above, and Rainbow Cave, where abundant pre-European kangaroo remains also suggest more planned hunting behaviour, other LNR sites suggest short-term, winter occupation of peripheral areas consistent with limited niche construction (Dortch and Wright 2010; Dortch et al. 2012).

On the Southern Ocean coastline, occupation patterns throughout the 2500 year period of use of Nookanellup Rockshelter resemble the small, winter-time occupations of LNR sites (Dortch and Kelly 1997). Katelysia Rockshelter, used in summer, suggests evidence for gatherings and group manipulation of a natural resource—estuarine fish—ca 2000 years ago (Dortch 1999). This record suggests that one aspect of the historical ethnographic pattern—summer congregations to exploit estuarine fish—is more than 2000 years old. It also shows that rockshelter sites were occupied during group foraging efforts and can reveal results of exploitation of core resource zones.

As the area with the densest historical populations of Noongar people and a drier environment prone to ignitions (Hallam 1987; Pickett 1997), the SCP may be the most likely to provide evidence of niche construction. Sites in this region may be more likely to reveal burning in summer, when regional groups tended to congregate on the SCP (Anderson 1984). Current doctoral research (by CM) will investigate sites in both productive and less productive micro-environments to distinguish modes of landscape management. Non-archaeological records will also be investigated to assess hunting bias in archaeological records, and identify variations in landscape change that cannot be attributed to climate or hunting biases (Zeder 2012).

The southwest biogeographic region is known for geological stability and an oceanically-moderated (buffered) climate (Hopper 2009), leading to a highly evolved, endemic flora (Hopper and Gioia 2004) that mainly responded to marine transgression and rainfall variations (Pickett 1997). With the coast in particular remaining in much the same position relative to rain-bearing westerlies since the Oligocene, the most stable parts (refugia) of the region are on the coastal plains and margins. The northern and interior margins of the southwest were more sensitive to changes in rainfall, thus acting as a 'pump' for species from the southwest into the arid zone and vice versa (Hopper 1979; Hopper and Gioia 2004). The northern SCP is within the pump zone—suggesting potential for identifying niche constructing behaviours as higher populations around wetlands responded to arid phases.

The view of populations being influenced by environmental stability may imply that southwest Australia, like other glacial refugia, became demographically packed and underwent niche constructing transformations earlier than other regions. However, if archaeologists are to understand human responses in a more nuanced way, additional faunal records will be needed, including non-archaeological, reference records of past environments, encouraging the use of new, high-throughput aDNA-based techniques such as bulk bone metabarcoding (BBM) (Murray et al. 2013). Discussion of the application of BBM is beyond the scope of this report, but the method is attractive for increasing sample size, as it targets non-diagnostic bone, which comprises 70–80% of the southwest zooarchaeological record.

To sum up, new theoretical approaches suggest how people managed or promoted resources over time. The Wonitji Janga record suggests that recent sites covering the modern era can reveal the effects that a lack of Aboriginal burning had on fauna. Non-archaeological reference sequences in the same region should also be explored for the same period. Pollen or other plant records may be included in these comparisons. New sites to be investigated should include archaeological sequences covering different states of hunter-gatherer aggregation and dispersal, such as caves near wetlands or lakes, and in productive woodlands and grasslands (Dortch 2002).

Stratigraphic Unit	*Oryctolagus cuniculus*	*Dasyurus geoffroi*	*Pseudocheirus peregrinus*	*Trichosurus vulpecula*	*Isoodon obesulus*	*Potorous gilberti*	*Bettongia penicillata*	*Setonix brachyurus*	*Macropus eugenii*	*Macropus fuliginosus*	Total
1	1	1	3	3	11	1	1	1	0	2	24
2	1	0	4	5	6	0	0	2	0	2	20
3 to 6 (incompletely identified)	0	3	5	6	6	1	1	10	5	7	44

Table 3 Wonitji Janga species identifications to date (number of identified specimens).

THEMED SECTION

The advent of high-throughput genetic sequencing, and its application to fragmentary archaeological remains, will make the job of processing and analysing zooarchaeological deposits considerably easier. This technology could only have been guessed at 44 years ago when Charlie Dortch began his research in the southwest, but our capacity to apply new techniques and theory today relies on his imaginative prospection and meticulous research, then and now. The development of a thriving research environment in southwest Australia demonstrates an archaeologist's successful niche construction, one that is continuing to evolve through successive generations.

Acknowledgments

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References

Abbott, I. 2003 Aboriginal fire regimes in southwest Western Australia: Evidence from historical documents. In I. Abbott and N.D. Burrows (eds), *Fire in Ecosystems of South-west Western Australia*, pp.119–146. Leiden: Backhuys.

Abbott, I. 2008 Historical perspectives of the ecology of some conspicuous vertebrate species in southwest Western Australia. *Conservation Science Western Australia* 6(3):1–214.

Amundsen-Meyer, L.M. 2013 Nature versus culture: A comparison of Blackfoot and Kayapó resource management. *Canadian Journal of Archaeology* 37(2):219–247.

Anderson, J. 1984 *Between Plateau and Plain*. Occasional Papers in Prehistory 4. Canberra: Australian National University Press.

Archer, M. 1974 Excavations in the Orchestra Shell Cave, Wanneroo, Western Australia: Part III. Fossil vertebrate remains. *Archaeology and Physical Anthropology in Oceania* 9(2):156–162.

Balme, J., D. Merrilees and J.K. Porter 1978 Late Quaternary mammal remains spanning about 30,000 years from excavations in Devils Lair, Western Australia. *Journal of the Royal Society of Western Australia* 6(2):33–65.

Baynes, A. 1979 The Analysis of a Late Quaternary Mammal Fauna from Hastings Cave, Jurien. Unpublished PhD thesis, Department of Zoology, The University of Western Australia, Crawley.

Bird, R.B., D.W. Bird, B.F. Codding, C.H. Parker and J.H. Jones 2008 The 'fire stick farming' hypothesis: Australian Aboriginal foraging strategies, biodiversity and anthropogenic fire mosaics. *Proceedings of the National Academy of Sciences* 105(39):14796–14801.

Bowman, D.M.J.S. 1998 The impact of Aboriginal landscape burning on the Australian biota. *New Phytologist* 140:385–410.

Bowman, D., I. Abbott and N. Burrows 2003 Australian landscape burning: A continental and evolutionary perspective. In I. Abbott and N.D. Burrows (eds), *Fire in Ecosystems of South-West Western Australia*, pp.107–118. Leiden: Backhuys.

Bradstock, R.A., M. Bedward, A.M. Gill and J.S. Cohn 2005 Which mosaic? A landscape ecological approach for evaluating interactions between fire regimes, habitat and animals. *Wildlife Research* 32(5):409–423.

Broughton, J.M., M.D. Cannon and E.J. Bartelink 2010 Evolutionary ecology, resource depression and Niche Construction Theory. *Journal of Archaeological Method and Theory* 17(4):371–421.

Burbidge, A.A. and N.L. McKenzie 1989 Patterns in the modern decline of Western Australia's vertebrate fauna: Causes and conservation implications. *Biological Conservation* 50(1–4):143–198.

Dortch, C.E. 1977 Early and late stone industrial phases in Western Australia. In R.V.S. Wright (ed.), *Stone Tools as Cultural Markers: Change, Evolution and Complexity*, pp.104–132. Canberra: Australian Institute of Aboriginal Studies.

Dortch, C.E. 1979 Devils Lair, an example of prolonged cave use in southwestern Australia. *World Archaeology* 10(3):258–279.

Dortch, C.E. 1999 Archaeological assessment of Aboriginal estuarine fishing on the southern ocean coast of Western Australia. In J. Hall and I. McNiven (eds), *Australian Coastal Archaeology*, pp.25–35. Research Papers in Archaeology and Natural History 31. Canberra: Department of Archaeology and Natural History, Research School of Pacific and Asian Studies, The Australian National University.

Dortch, C.E. 2002 Modelling past Aboriginal hunter-gatherer socio-economic and territorial organisation in Western Australia's lower southwest. *Archaeology in Oceania* 37(1):1–21.

Dortch, C.E., G.W. Kendrick and K. Morse 1984 Aboriginal mollusc exploitation in south Western Australia. *Archaeology in Oceania* 19:81–104.

Dortch, J. 2004 *Palaeo-Environmental Change and the Persistence of Human Occupation in South-Western Australian Forests*. BAR International Series S1288. Oxford: Archaeopress.

Dortch, J. and G. Kelly 1997 Further Test Excavations at Nookanellup Rockshelter, Point D'Entrecasteaux, Southwestern Australia. Unpublished report prepared for the Manjimup Aboriginal Corporation and the Australian Institute of Aboriginal and Torres Strait Islander Studies.

Dortch, J. and R. Wright 2010 Identifying palaeoenvironments and changes in Aboriginal subsistence from dual-patterned faunal assemblages, southwestern Australia. *Journal of Archaeological Science* 37:1053–1064.

Dortch, J., J. Balme and J. Ogilvie 2012 Aboriginal responses to late Quaternary environmental change in a Mediterranean-type region: Zooarchaeological evidence from southwestern Australia. *Quaternary International* 264:121–134.

Fuentes, A. 2013 Blurring the biological and social in human becomings. In T. Ingold and G. Palsson (eds), *Biosocial Becomings: Integrating Social and Biological Anthropology*, pp.42–58. Cambridge: Cambridge University Press.

Gammage, B. 2011 *The Biggest Estate on Earth*. Sydney: Allen and Unwin.

Gill, A.M. 2002 A review of fire regimes of the forested region of southwestern Australia with selected examples of their effects on native biota. In J. Russell-Smith, R. Craig, A.M. Gill, R. Smith and J. Williams (eds), *Australian Fire Regimes: Contemporary Patterns (April 1998–March 2000) and Changes since European Settlement*, pp.1–19. Australia State of the Environment Second Technical Paper Series (Biodiversity). Canberra: Department of the Environment and Heritage.

Guilfoyle, D.R., W. Webb, T. Webb, and M. Mitchell 2011 A structure and process for 'working beyond the site' in a commercial context: A case study from Dunsborough, southwest Western Australia. *Australian Archaeology* 73:25–32.

Hallam, S.J. 1974 Excavations in the Orchestra Shell Cave, Wanneroo, Western Australia: Part I. Ethnographic and environmental background. *Archaeology and Physical Anthropology in Oceania* 9(1):66–84.

Hallam, S.J. 1975 *Fire and Hearth*. Canberra: Australian Institute of Aboriginal Studies.

Hallam, S.J. 1987 Coastal does not equal littoral. *Australian Archaeology* 25:10–29.

Hallam, S.J. 2002 Peopled landscapes in southwestern Australia in the early 1800s: Aboriginal burning off in the light of Western Australian historical documents. *Early Days* 12(2):177–191.

Hopper, S.D. 1979 Biogeographical aspects of speciation in the southwest Australian flora. *Annual Review of Ecology and Systematics* 10(1):399–422.

Hopper, S.D. 2009 OCBIL theory: Towards an integrated understanding of the evolution, ecology and conservation of biodiversity on old, climatically buffered, infertile landscapes. *Plant and Soil* 322(1–2):49–86.

Hopper, S. and P. Gioia 2004 The southwest Australian floristic region: Evolution and conservation of a global hot spot of biodiversity. *Annual Review of Ecology, Evolution and Systematics* 35:623–650.

Kelly, G. 1999 Karla wongi fire talk: A Nyungar perspective on forest burning. *Landscape* 14:49–53.

Kost, F. 2013 Burning the bush: The development of Australia's Southwest Botanical Province. In M.I.J. Davies and F.N. M'Mbogori (eds), *Humans and the Environment: New Archaeological Perspectives for the Twenty-First Century*, pp.117–134. Oxford: Oxford University Press.

Laland, K.N. and M.J. O'Brien 2011 Cultural niche construction: An introduction. *Biological Theory* 6(3):191–202.

Lilley, I. 1993 Recent research in southwestern Western Australia: A summary of initial findings. *Australian Archaeology* 36:34–41.

McNicol, L.J. 1999 Environment at Witchcliffe Rockshelter: A Palynological Investigation of the Last 2000 Years, Southwest Western Australia. Unpublished BSc(Hons) thesis, Department of Geography and Centre for Archaeology, The University of Western Australia, Crawley.

Merrilees, D. 1968 Man the destroyer: Late Quaternary changes in the Australian marsupial fauna. *Journal of The Royal Society of Western Australia* 51:1–24.

Murray, D.C., J. Haile, J. Dortch, N.E. White, D. Haouchar, M.I. Bellgard, R.J. Allcock, G.J. Prideaux and M. Bunce 2013 Scrapheap challenge: A novel bulk-bone metabarcoding method to investigate ancient DNA in faunal assemblages. *Scientific Reports* 3:3371.

O'Connell, J.F. and J. Allen 2012 The restaurant at the end of the universe: Modelling the colonisation of Sahul. *Australian Archaeology* 74:5–17.

Odling-Smee, F.J., K.N. Laland and W. Feldman 2003 *Niche Construction*. Monographs in Population Biology 37. Princeton: Princeton University Press.

Pickett, E. 1997 The Late Pleistocene and Holocene Vegetation History of Three Lacustrine Sequences from the Swan Coastal Plain, Southwestern Australia. Unpublished PhD thesis, Department of Geography, The University of Western Australia, Crawley.

Prober, S.M., E. Yuen, M.H. O'Connor and L. Schultz 2013 *Ngadju Kala: Ngadju Fire Knowledge and Contemporary Fire Management in the Great Western Woodlands*. Floreat: CSIRO Ecosystem Sciences.

Riede, F. 2012 Theory for the a-theoretical: Niche construction theory and its implications for environmental archaeology. In R. Berge, M.E. Jasinski and K. Sognnes (eds), *N-TAG TEN Proceedings of the 10th Nordic TAG Conference at Stiklestad, Norway 2009*, pp.87–98. BAR International Series. Oxford: Archaeopress.

Roe, R. 1971 Trial excavation in a small cave, Gingin. *The Western Australian Naturalist* 57:183–184.

Smith, B.D. 2011 General patterns of niche construction and the management of 'wild' plant and animal resources by small-scale pre-industrial societies. *Philosophical Transactions of the Royal Society B: Biological Sciences* 366(1566):836–848.

Smith, B.D. 2012 A cultural niche construction theory of initial domestication. *Biological Theory* 6(3):260–271.

Stiner, M.C. and N.D. Munro 2002 Approaches to prehistoric diet breadth, demography and prey ranking systems in time and space. *Journal of Archaeological Method and Theory* 9(2):181–214.

Thorn, K.M. and A. Baynes 2013 Palaeoenvironmental investigation of Caladenia Cave fossil mammals: Consolidating Holocene climate change patterns in southwestern Australia. *Journal of The Royal Society of Western Australia* 96:71–72.

Turney, C.S.M., M.I. Bird, L.K. Fifield, R.G. Roberts, M. Smith, C.E. Dortch, R. Grun, E. Lawson, L.K. Ayliffe, G.H. Miller, J. Dortch and R.G. Cresswell 2001 Early human occupation at Devils Lair, southwestern Australia 50,000 years ago. *Quaternary Research* 55:3–13.

Zeder, M.A. 2012 The Broad Spectrum Revolution at 40: Resource diversity, intensification and an alternative to optimal foraging explanations. *Journal of Anthropological Archaeology* 31(3):241–264.