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Australian Archaeology

ISSN: 0312-2417 (Print) 2470-0363 (Online) Journal homepage: http://www.tandfonline.com/loi/raaa20

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To cite this article: Jane Balme (2014) Devils Lair: Occupation intensity and land-use, Australian Archaeology, 79:1, 179-186, DOI: 10.1080/03122417.2014.11682034

To link to this article: http://dx.doi.org/10.1080/03122417.2014.11682034

Devils Lair:

Occupation intensity and land-use

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Abstract

When Charlie Dortch first came to Perth to take a job at the Western Australian Museum, he almost immediately went into the field to excavate at the site of Devils Lair. The site has contributed much to knowledge of human occupation in Pleistocene Australia. Because of mixing in its deepest deposits, however, there has been some confusion about the timing of first occupation in the site. Devils Lair has also been used to suggest greater occupation of the southwest region of Australia during the last glacial maximum (LGM). This review of the evidence from Devils Lair and other sites in the southwest suggests that the evidence for occupation earlier than 46,000 years ago, and of more intensive occupation during the LGM, is equivocal at best.

Introduction

In the archaeological world Charlie Dortch is perhaps most associated with the site of Devils Lair. This small limestone cave in southwest Australia is an iconic archaeological site, known for its antiquity, fine stratigraphic resolution and excellent faunal preservation (Figure 1). The site was first excavated in the mid-1950s by a Chicago Natural History Museum (CNHM) team led by Lundelius (1960) and the Pleistocene fossils recovered were deposited in the Western Australian Museum (WAM) collection. In the 1960s, Duncan Merrilees, then WAM Curator of Palaeontology, identified a human tooth while looking through kangaroo teeth from those collections. This tooth, along with a fragment of baler shell lodged in the CNHM, was the first indication that people had inhabited the site. Merrilees was very keen to conduct further excavations at Devils Lair because, although Lundelius (1960) had obtained a radiocarbon date of 12,175±275 bp (14,307±820 cal. BP[1]), the deposits extended far below that charcoal sample. Merrilees (1968) had become convinced that humans had contributed to the extinction of the Australian megafauna and, in his 'Man the destroyer' paper, suggested that this had been largely through changing the vegetation via the practice of firing the landscape. He sought a site in which archaeological material and megafauna were associated, showing that their co-existence was short, and perhaps also that humans had hunted the megafauna. However, he had to wait for WAM to hire an archaeologist before he could begin new excavations.

In 1970, Charlie Dortch was hired and in the same year he and Merrilees conducted their first excavations at Devils Lair, continuing their excavations at the site over the following decade. Merrilees was not rewarded with a clear answer to his questions about the co-existence of people and megafauna, as only a few megafaunal species were identified and, apart from one *Protemnodon* sp. specimen, all derived from sediments accumulated when the cave was inaccessible to people (Balme et al. 1978). Nevertheless, over the last 45 years evidence from Devils Lair has contributed to arguments about Pleistocene technology, changes in environment and subsistence, the antiquity of Aboriginal occupation in Australia and changes in population density over time.

On this last subject, recently Williams et al. (2013) proposed that the distribution of radiocarbon dates from archaeological sites in Australia suggested that some geographic areas, including the Warren Bioregion (Thackway and Cresswell 1995) in which Devils Lair lies, may have acted as refugia during the last glacial maximum (LGM), which peaked about 23,000–18,000 years ago (Williams et al. 2009). However, they were cautious about including the Warren Bioregion as an LGM refuge area because their dataset was small (Williams et al. 2013:4618). The other problem with assessing the distribution of archaeological dates in the southwest is that most LGM dates derive from only two sites, Devils Lair and Tunnel Cave, both of which, unlike other sites in the region, are in tall, closed karri (*Eucalyptus diversicolor*) forest. The Warren Bioregion is variable, with open jarrah-marri (*E. marginata* and *Corymbia calophylla*, respectively) forest, swamps, sedge lands and marine dunes along the coastal strip and peppermint (*Agonis flexuosa*) woodlands. To what extent are Devils Lair and Tunnel Cave representative of occupation intensity in this wider region?

In this paper I review the evidence for changes in occupation intensity at Devils Lair in relationship to other sites in the region to investigate past landscape use in the extreme southwest of Australia. I begin by discussing the variable vegetation in the Warren Bioregion and how this affected Indigenous use of the area in the recent past. I then evaluate the evidence of the antiquity of occupation using archaeological dates and, where available, measures of artefact discard as proxies for occupation intensity, even though both of these approaches have limitations (see. Williams 2013 and Williams et al. 2013 for discussions of the former). The most relevant of these limitations are first, that decisions about what to date, and therefore what time periods are dated, are affected by archaeologists' questions about each site, and second, that the distribution of radiocarbon dates may just reflect decay. However, when

1 In the discussion of radiocarbon dates here, I have calibrated the 1970s age estimates using OxCal 4.2 (78), which relies on the IntCal 13 curve (Bronk Ramsey 2009).

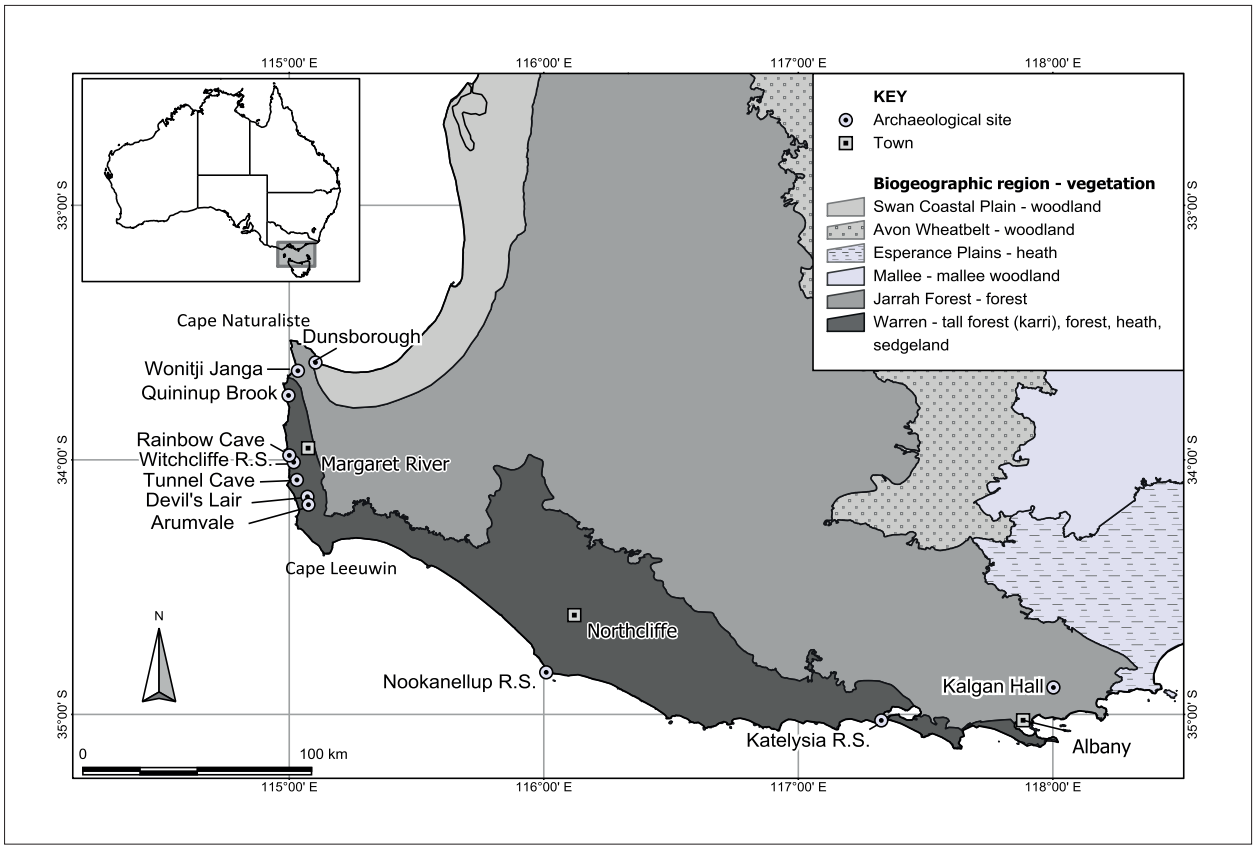

Figure 1 Southwest Australia showing sites mentioned in text and main vegetation areas.

the dates derive from many sites and are collected over a long time period by different archaeologists, the effect of the first of these is low and can certainly be examined. On the second problem, as Williams et al. (2013:4614) stated, there is little that can be done to correct for this except bear it in mind in the interpretation of the results. The main criticism of using discard rates is that they may be affected by changes in technology. However, like O'Connor and Veth (2006), I consider that sufficient numbers of sites and artefacts demonstrating a similar pattern in a region constitute a reasonable proxy for population numbers in comparable periods.

The Warren Bioregion: Historical Evidence for Indigenous Use

Dortch recognised the limitations of the Devils Lair evidence for discussing the wider regional picture and so investigated the ethnohistoric literature to obtain more information on how the local landscape was used at the time of first European settlement. He developed models for land use in the deeper past and surveyed a variety of landscape types in the region to test these models. His conclusions were that the coastlines, and particularly estuaries, were by far the most resource rich and diverse environments in the region—at least in the recent past—and it is these areas that were most attractive for human use. His work culminated in his doctoral thesis (Dortch 2000) and was summarised in Dortch (2002), a paper perhaps best known for its use of a Jackson Pollock painting to depict band movement over long periods. His view was that some areas, such as estuaries, which provided seasonally abundant resources, served as places of aggregation that facilitated the maintenance of social networks (Dortch 1997, 2002), and that between periods of seasonal abundance people dispersed around the landscape. Where they went was linked to their ability to manage the landscape through firing.

Hallam (1979) had already demonstrated the critical use of fire as a management strategy to aid in the exploitation of the area. The historical records analysed by Hallam (1979:41–43) indicated that fire was used in the coastal strip, and in open woodlands in particular, to clear undergrowth of woody bush to facilitate movement of people and game. Clearing of undergrowth further promoted new shoots that attracted game for hunting and fire was also used to drive game (Hallam 1979:28). While the edges of dense forests were burnt, jarrah-marri forests required repeated burning to keep clear (Hallam 1979:54). Ferguson (1985) and Hallam (1977) suggested that repeated burning in these southwest forests was undertaken to maintain open corridors of woodland that people used as pathways to other areas. In contrast, tall karri forests were seldom burned, as they were generally too damp and the undergrowth too dense for firing (Hallam 1979:27, 55, 70). J. Dortch's (2004:12–13) more recent review concluded that damp karri forest *can* be burnt, but its understorey regenerates faster than other forest types. However, frequent fires would destroy understorey and favour jarrah-marri forests.

Not only are the dense karri forests difficult to fire, but they are also generally poor in resources. Hallam's (1979) and Ferguson's (1985) ethnohistorical reviews suggested that these forests were little used by Aboriginal people—Hallam (1979:110) referred to them as 'empty forests'. Instead, Hallam (1977, 1979, 1987) and Ferguson (1985, 1987) suggested that people concentrated at the forest edges, in the woodlands and along rivers, lakes and swamps where resources were more abundant. The historic information is

clearly biased by the original observers' own movements and because not all plant species eaten by Aboriginal people were identified by these observers. However, J. Dortch's review (2004:13–15) of the evidence for food resources, from both historic observations and lists of potential foods, generally supported Hallam and Ferguson's conclusions about the low productivity of dense forests.

The distribution of archaeological sites, or at least those representing the mid- to late Holocene, also seems to support this interpretation. Lilley's (1993) surveys in jarrah-marri forests along the coastal strip and the transition zone between the coast and edge of the forest in the Margaret River area, found only a small number of sites, all of which were limited to the coastal strip and the transition zone. Further to the southeast, near Albany, Ferguson (1985) found a similar pattern, with the greatest concentration of sites along rivers, the coastal strip and forest edges. The occupation of Devils Lair and Tunnel Cave, both deep in karri forests, is thus anomalous in terms of regional site distribution.

The Occupation Sequence at Devils Lair

The oldest date obtained during the 1970s excavations came from Layer 31 (Figure 2) at 35,160±1800 bp (39,928±3929 cal. BP) (Balme et al. 1978:37). Just above Layer 31, Layer 30-lower produced a date of 32,480±1250 bp (37,155±2837 cal. BP). This layer was considered a watershed in the cave as, in contrast to adjacent layers, it was rich in organic material. It formed a stratigraphic division separating the layers above, which were generally thin and suggest gentle deposition, from the layers below, which had evidence of rapid water deposition. Much, but not all, of the bone from below Layer 30-lower was covered in sandy sediments cemented with calcium carbonate, suggesting redeposition of at least some of the bone (Balme et al. 1978).

The youngest date from the site, 320±85 bp (333±188 cal. BP), came from the top stratigraphic humic layer, about 5 cm below surface (bs). A date of ca 6500 bp was obtained from charcoal from Layer G, only about 10 cm below the youngest date and beneath a flowstone, which did not contain archaeological material, indicating a hiatus in deposition (Balme et al. 1978). This late Holocene date has not been able to be reproduced and more recent dating of the same stratigraphic horizon has produced a terminal Pleistocene date of 12,500±100 cal. BP (Turney et al. 2001), suggesting that the site was not occupied at all during the Holocene except perhaps in the last few hundred years. Pleistocene sediments in Devils Lair slope towards the present-day cave entrance and away from a raised area of flowstone at the rear of the cave, which has been interpreted as indicating that the early occupants entered the cave by an alternative entrance that was sealed when the flowstone formed above Layer G (Dortch and Merrilees 1973). The present entrance was probably created only a few hundred years ago.

New dates obtained by Turney et al. (2001) using a variety of new techniques, including accelerator mass spectrometry (ABA-BC and ABOX-SC) and optically stimulated luminescence (OSL), made little difference to the dates for the upper part of the deposit, including the layers representing the LGM. Not surprisingly, given the maximum age limitations of the liquid scintillation technique used in the 1970s, the deeper parts of the deposit returned older dates. The suggested date for first occupation of the site (about 45,500 cal. BP) came from an ABOX-SC sample for Layer 30 (Turney et al. 2001:7).

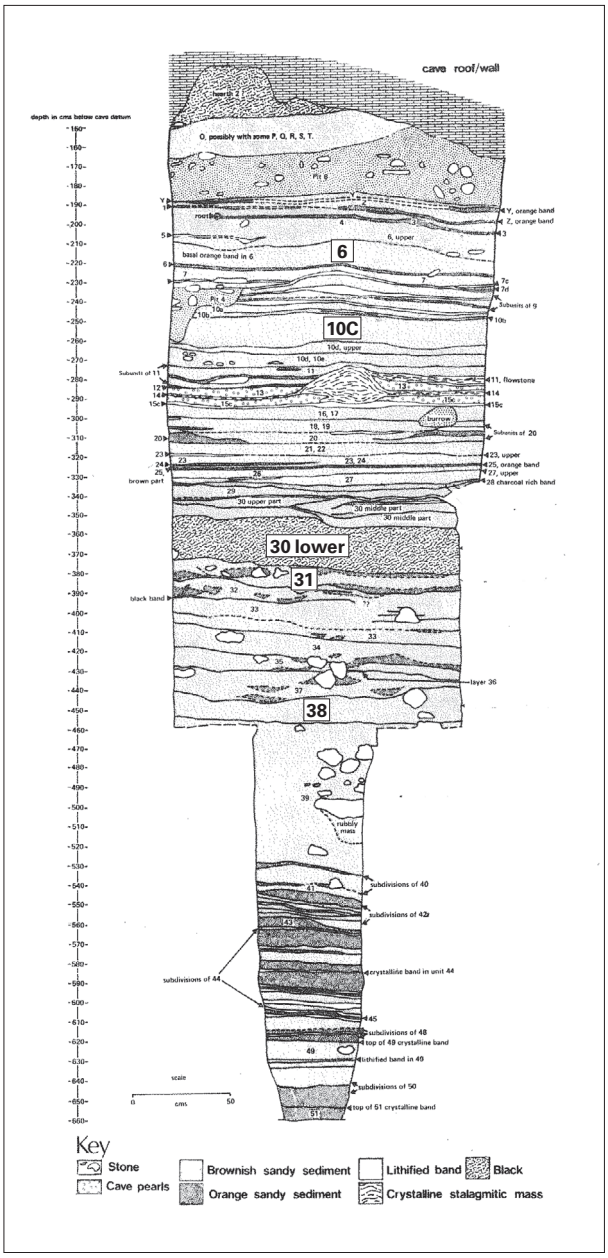

Figure 2 Devils Lair main excavation East Section (after Balme et al. 1978).

Although they did not specify whether this dated the upper part of Layer 30 or Layer 30-lower, because there are no stone artefacts in Layer 30-lower, the dated sample was probably from Layer 30-upper.

Turney et al. (2001:11) further proposed that occupation of the general Devils Lair region began earlier than this: before 48,000 cal. BP when the cave was not accessible to people. This is considerably older than other secure dates for occupation in Australia (see Allen and O'Connell 2014) and so is somewhat controversial. Their claim was that, despite the site not being accessible to people at that time, artefacts were identified in these deep sediments. Therefore, any artefacts in these layers must have been washed in from an unknown external source. The presence of remains of large extinct fauna, including *Zygomaturus* sp., in these lower layers presumably indicates that there was a large enough opening for both artefacts and animals to enter the cave. However, while sinkholes further up the system may have worked as pit traps for animals, the chances of artefacts being derived

from outside the cave by this method are low. This might explain why so few stone artefacts have been identified from these layers. Dortch (1979a:352) recorded one opaline flaked fragment and 12 calcrete artefacts from Layers 32–38. The opaline fragment measured less than 0.5 cm and was suggested to be the result of retouch or breakage from a larger piece (Dortch 1979a:351). The raw material is unusual and was described by Glover (1979) as different from the opaline material from Eocene chert artefacts found in the upper layers of Devils Lair and elsewhere in the southwest. He suggested that it was not possible to identify its origin precisely, but that it most likely derived from Bunbury basalt (Glover 1979:373). The flake does seem to be conchoidally fractured (Glover 1979:371, Plate 1), but it is not clear by what action and where the stone fragment was when it became fractured. As this fragment was destroyed during Glover's analysis, it is difficult to investigate these questions further. However, a small amount of powder from Glover's original analysis remains in The University of WA's Glover collection and so it may be possible to undertake further studies of the possible sources of the material.

Joe Dortch, Charlie's archaeologist son, identified only six artefacts from below Layer 30, of which two are quartz fragments (J. Dortch 2004:93), three are calcrete flakes and one a calcrete fragment. In none of the other layers are calcrete artefacts more abundant than those of other materials (J. Dortch 2004:98). In fact, they make up less than 1% of the total assemblage for each layer, except in Layers 5–7 (J. Dortch's Period VI) where they comprise 4% of the stone artefact assemblage. Dortch (1979a:340) described experiments of dropping limestone (calcrete and lithified aeolianite) on rubble and found it difficult to produce flake characteristics. He also described experiments on bone to argue the case for some bone fractures having been created by humans in these lower layers (Dortch 1979a:351–353). However, given the ubiquitous presence of calcrete and bone within the cave, the numerous ways in which they could have been broken, the unknown source of these objects and the undiagnostic nature of the quartz pieces, the suggestion for occupation before 45,500 years ago remains unproven. With the uppermost date for occupation now being about 12,500 cal. BP, the site represents 33,000 years of Pleistocene occupation.

Despite the long period of occupation represented, overall the numbers of archaeological materials are low, and are clustered within the sequence, suggesting intermittent occupation. The most marked clustering is around the LGM (Layers I to 10), where most of the hearths, bone and stone tools and other artefacts were recorded. Of a total of 1047 stone artefacts and 20 bone points recovered, 862 (82%) stone artefacts and 15 (75%) bone artefacts were from these layers (see J. Dortch 2004:62–63 derived from Dortch 1974, 1979b; Dortch and Dortch 1996; Dortch and Merrilees 1973). Layers 6–7, dated to about 19,000±250 bp (about 23,000 cal. BP), were especially rich, containing 290 stone artefacts (28%) and five bone points. Three bone beads, important rare evidence for symbolic behaviour, were also recovered from the LGM deposits (Dortch 1979c). This same pattern of intermittent occupation is repeated at nearby Tunnel Cave, excavated by J. Dortch in the 1990s. Tunnel Cave lies within the same limestone belt as Devils Lair and is also in karri forest. Like Devils Lair, evidence for occupation at Tunnel Cave is sparse (1548 stone artefacts represent about 26,000 years of occupation in a 6 m^3 excavation), but was most intense during the LGM (J. Dortch 2004). Although Tunnel Cave is a little younger, it has always remained accessible to people. How do these patterns compare to the wider region?

Implications for Population Intensity in the Wider Region

Williams et al. (2013) were not the first to suggest greater occupation intensity in the region during the LGM. O'Connor et al. (1993), who were concerned with broader population change in Australia from first occupation, analysed discard rates of stone artefacts for 1000-year intervals from Devils Lair, Quininup Brook, Kalgan Hall and Arumvale. They suggested that the rates increased from the sites' first occupation and peaked during the LGM, but dropped by the early Holocene (O'Connor et al. 1993:101) before increasing again in the late Holocene. In addition, Ferguson (1985:455–502) used the artefact distribution records from 12 sites in the southwest (extending to just north of Perth) to argue that an expansion of the karri forests after the LGM led to abandonment of those areas at the end of the Pleistocene. The period 6000–4000 years ago in particular, he suggested, was a time of depopulation, with numbers of people recovering after 4000 years ago. These earlier arguments were criticised for a variety of reasons (J. Dortch 2004:24–27; Dortch and McArthur 1985; Dortch and Smith 2001; Smith 1993), including the fact that 20% of the sites were first occupied in Ferguson's critical depopulation period between 6000–4000 years ago (Smith 1993), the evidence of mixing in some deposits (Dortch and McArthur 1985) and Ferguson's use of the presence of backed blades, rather than absolute dates, to estimate dates (Dortch and Smith 2001). The greater number of excavated dated sites available now provides a stronger basis that allows questions of Holocene depopulation and LGM intensive occupation to be re-examined.

Distribution of Archaeological Dates in the Region

Figure 3 shows the distribution of 123 dates for archaeological deposits in 21 sites in the southwest. The figure is based on calibrated charcoal radiocarbon dates and OSL dates for archaeological layers in Devils Lair and for 19 of the sites collated by J. Dortch (2004:44–45), as well as new dates recorded for Kalgan Hall (Dortch et al. 2013). Two more recently dated sites from the region—the DPF1 site, less than 400 m from the Dunsborough 2 site that returned a date of 10,601–10,441 cal. BP (Guilfoyle et al. 2011) and the Wonitji Janga site dating to the last 1300 years (Dortch et al. 2014)—are also included.

The overall pattern shows very few dates for the first 20,000 years of occupation, with a small peak at the LGM and the greatest increase in the late Holocene. Apart from three dates of about 23,000 years (one each from Kalgan Hall, Quininup Brook and Arumvale), all dates older than 14,000 years shown in Figure 3 are from Tunnel Cave and Devils Lair. The pattern for Tunnel Cave and Devils Lair clearly supports the conclusion that occupation at these two sites was most intense at the beginning of the LGM peak. On distribution of dates alone, if it is true that the Warren Bioregion acted as a refuge in the LGM (Williams et al. 2013), only Tunnel Cave and Devils Lair provide such evidence. However, for the reasons discussed earlier, distributions of archaeological dates are only an approximate guide to occupation intensity. Examining questions of changes in the intensity of occupation during the LGM, and the related

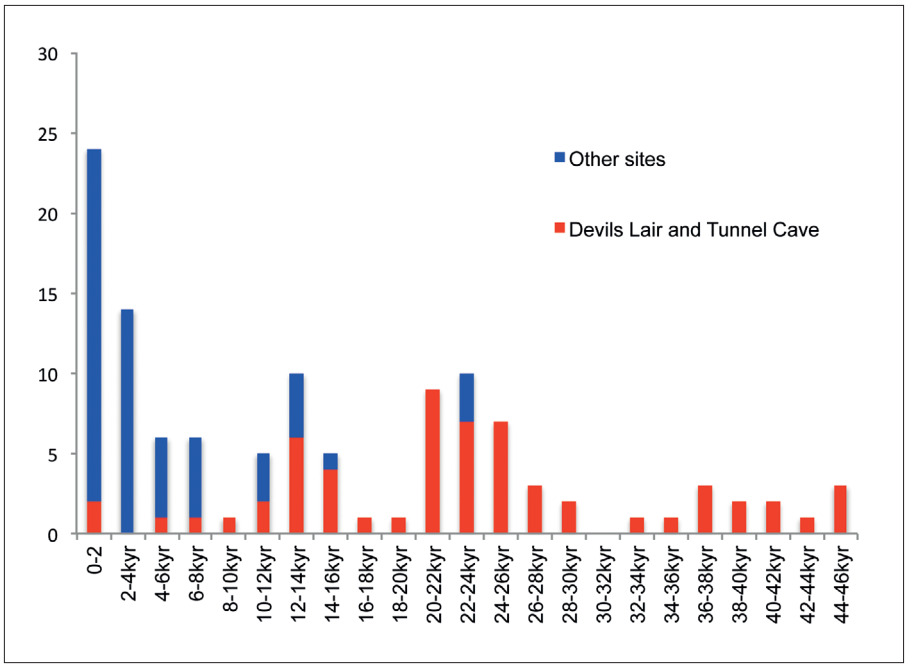

Figure 3 Frequency of calibrated radiocarbon dates and OSL dates in 2000 year time slices from archaeological sites* in the study region. *Dunsborough 1 and 2, Quininup Brook, Rainbow Cave, Witchcliffe rockshelter, Calgardup Brook, Tunnel Cave, Devils Lair, Arumvale, Malimup, Dombakup 24, Northcliffe, Nookanellup rockshelter, Yongar Bogal rockshelter, Conspicuous Cliffs, Lights Beach, Katelysia rockshelter, Herald Point and Kalgan Hall.

suggestion of depopulation at the end of the Pleistocene, requires a closer look at the regional evidence.

Artefact Discard Rates

Of the 30 dated sites represented in Figure 3, only five have dates spanning the LGM: Devils Lair, Tunnel Cave, Kalgan Hall, Quininup Brook and Arumvale. All of the scholars listed above who criticised Ferguson's (1985) and O'Connor et al.'s (1993) attempts to discuss changes in occupation intensity suggested that occupation of all of the sites was so intermittent that changes in artefact numbers cannot be used to estimate population numbers. The problem is that there is a tendency to treat intermittent occupation as continuous and sediment deposition as even to produce interpretations that are of finer resolution than is possible with the available data. When the sites are sandy with little stratigraphic differentiation, as these sites are, this is particularly problematic, as artefacts move within the deposits. In my re-analysis below I have tried to reduce assumptions about sediment deposition between dated events by simply using the radiocarbon dates (calibrated) to create the analytical units on which the rate of artefact discard for each 1000 year period is calculated. When there are few dates, the coarse resolution of this method is unsatisfying, but, in combination with observations about the clustering of artefacts within the site as an indication of occupation events, it reduces assumptions about even deposition. The graphs shown in Figures 4 and 5 are not directly comparable, as the excavations are different sizes; I discuss the effects of these differences below.

Figure 4 shows the number of artefacts discarded per 1000 years for calibrated age intervals for Devils Lair and Tunnel Cave. For Tunnel Cave I used the stratigraphic layers identified by J. Dortch (2004:77), but combining Layers 1–3, which contained few artefacts, to create one late Holocene unit with separate divisions for Layers 5, 7, 9 and 10. Devils Lair has so many overlapping radiocarbon dates that I created only four analytical units consisting of stratigraphic layers for which there was less than 3000 years difference in associated radiocarbon dates. The dates used are those reported in Turney et al. (2001) and previous radiocarbon dates summarised in J. Dortch (2004:65–66). The main observation is that both sites begin with very little occupation, and both are occupied most intensely during the LGM, after which occupation dramatically declines. Evidence for occupation of Tunnel Cave is very slim in the Holocene, while Devils Lair is not accessible after about 13,000 years until very recently. The most recent time period for Devils Lair (0–320 years) is probably an overestimate, as only one date is available.

Kalgan Hall is an open site adjacent to the Kalgan River. The area is disturbed but surrounded by jarrah-marri forest with thick undergrowth (Ferguson 1985:210). The sandy deposits were first examined in the 1970s by Ferguson (1985), who excavated two trenches. Trench 2 has the longest sequence, and, as the distribution of these dates indicates (Ferguson 1985:229), deposition is very uneven

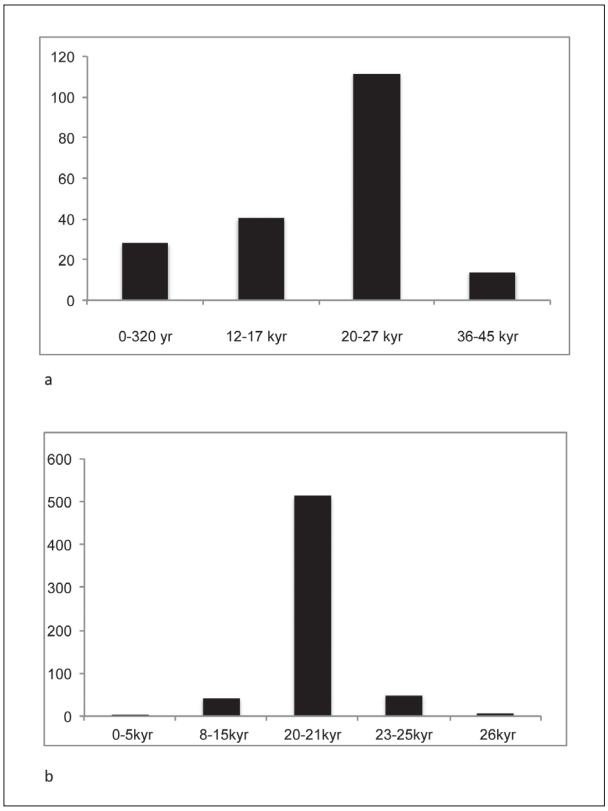

Figure 4 Rates of artefact discard per 1000 years in each of the calibrated age intervals at (a) Devils Lair and (b) Tunnel Cave.

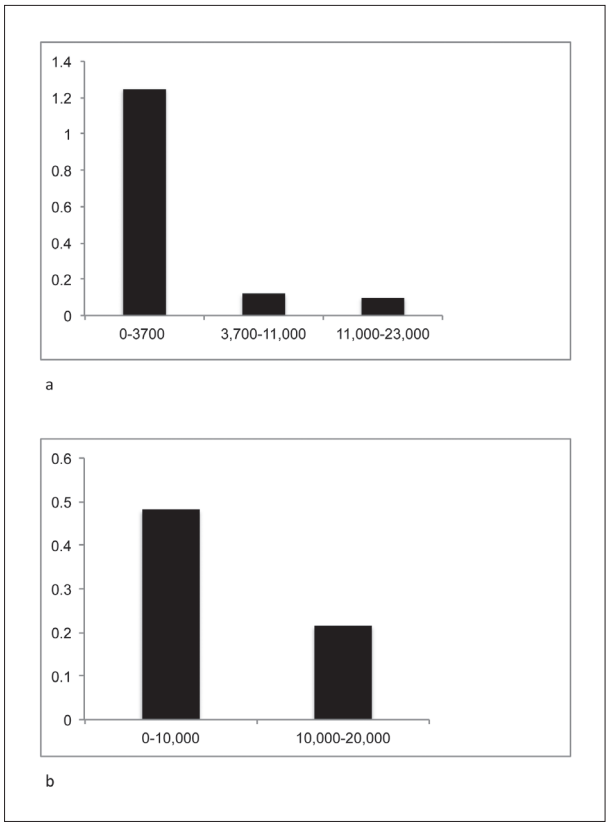

Figure 5 Rates of artefact discard per 1000 years in each of the calibrated age intervals at (a) Kalgan Hall and (b) Arumvale.

Calibrated Age	Depth Below Surface (cm)	Number of Artefacts
12,468±2231	80–90 (Trench 5)	40
12,616.5±695.5	106–116 (Trench 6)	13
23,083.5±4167	90–100 (Trench 5)	53

Table 1 Quininup Brook calibrated radiocarbon dates showing the numbers of artefacts recovered from the same 10 cm excavation unit as the dated sample.

throughout. Five dates were obtained, three of which fall in the late Holocene. The sequence has therefore been divided into three periods for Figure 5a. The overall pattern is clearly one of increasing use of the site in recent times. However, the large time periods represented by the intervals selected obscure the fact that the distribution of artefacts occurs in two pulses—one about 23,000 years ago (not represented in Trench 1) and another between ~3700–1100 years ago that is present in both trenches (Ferguson 1985:225–227). A late Holocene pulse was also identified by Ferguson (1985:217–218) in Trench 1 and by Dortch et al. (2013:28) in their recent excavations.

Quininup Brook is a site within coastal dune sands (Ferguson 1981). Most of the artefacts derived from a 30–40 cm horizon in Trench 5 between 70–100 cm bs and in Trench 6 between 96–136 cm bs (Ferguson 1981:616, 617). Three radiocarbon dates (Table 1) were obtained from charcoal from excavation units that also contained artefacts. The two excavation units associated with artefacts in Trench 5 contained more artefacts than any other at the site, except the top two units in Trench 6, which together contain 95 artefacts. These patches of artefacts must therefore be read as brief visits by people to the area and provide very slim evidence for consistent LGM occupation.

The oldest date from the site of Arumvale, also in jarrah-marri forest, is about 23,000 cal. BP (Dortch and McArthur 1985), but only two artefacts were found adjacent to the dated charcoal. As the charcoal is not clearly cultural, the sediments are homogeneous, and reversed dates are found above this date (Dortch 1986), it is possible that the artefacts are not associated with the oldest date and there is no evidence for any occupation at the LGM. It seems that this site has little to offer discussions about change over time. Nevertheless, Figure 5b shows the average discard rate of artefacts from excavation units above and below the 10,000 bp date, and confirms an overall pattern of increased Holocene occupation intensity at Kalgan Hall.

In summary, then, the best evidence for occupation of the southwest region over the LGM is from Devils Lair and Tunnel Cave, both of which have peaks in artefact discard during that period, particularly in the early part of the LGM. Kalgan Hall appears to have a brief occupation period about 23,000 years ago and perhaps also Quininup Brook, but there is little evidence that these were anything more than very low intensity. Arumvale has only very sparse evidence for occupation in the early LGM. These latter three sites, however, are exemplars of the difficulties of interpreting small samples from large sites. The differences in spatial distribution of artefacts between Ferguson's original trenches and recent excavations at Kalgan Hall (Dortch et al. 2013), where LGM artefact accumulations are restricted to only one trench, demonstrate the 'hit and miss' problem of interpreting sequences on the basis of single sites.

The discard rates between these sites are not directly comparable because of the different sizes of the excavations. Nevertheless, even taking into consideration the larger excavation dimensions (except for Kalgan Hall, which is more than twice the size of the Devils Lair trench in plan) of Tunnel Cave and Devils Lair, none of the LGM discard rates of any of the other sites come close to that of these two sites. Because almost all of the Pleistocene dates are from Devils Lair and Tunnel Cave, the evidence in Figure 2 does not support suggestions of a period of depopulation at the end of the Pleistocene. None of the patterns of artefact discard at any of the sites, apart from these two, suggest decreasing population. Instead, they suggest an increase during the Holocene from a previously low base.

Outside of the present-day karri forests there are now several sites whose initial occupation has been dated to the terminal Pleistocene or early Holocene. Occupation of three open sites near Dunsborough begins at the terminal Pleistocene/early Holocene (Dortch 1995; Ferguson 1980; Guilfoyle et al. 2011). At the Northcliffe open site occupation began around, or just before, 7645±210 cal. BP and the numbers of artefacts increased until the uppermost date of 3263±187 cal. BP (Dortch and Gardener 1976:270). All of the other cave sites, including Rainbow Cave (Lilley 1993), Witchcliffe Cave (Dortch 2004:83–84), Katelysia rockshelter (Dortch 1999), Nookanellup rockshelter (Dortch and Kelley 1997) and Wonitji Janga (Dortch et al. 2014), date to the late Holocene and, in all, the numbers of artefacts increase through time.

Thus, the overall picture of occupation intensity for the Warren Bioregion is indicated by the distribution of archaeological dates for occupation, which begin with very low numbers about 46,000 years ago, and remain relatively low, with some increase from about 14,000–15,000 years ago and then rising dramatically in the late Holocene. During the

LGM there is evidence for more intense use of both Devils Lair and Tunnel cave. The 'blip' between 14,000–12,000 years ago in the distribution of archaeological dates is largely accounted for by several dates on charcoal from a hearth-rich area of Devils Lair. Almost all the evidence of occupation in the Holocene derives from sites in open forest and woodland environments or along the coastal strip.

Interpreting the Distribution of Dates and Artefact Numbers at Tunnel Cave and Devils Lair

In their original argument about changes in the faunal record, Balme et al. (1978:63) suggested that an open woodland forest surrounded Devils Lair in the LGM, which was replaced by karri only recently. The main evidence for this was the increase in the proportion of lizard remains, from 5–10% of the MNI for each excavation unit before the LGM to between about 30–60% afterwards (Balme et al. 1978:61). At the same time the proportion of non-forest mammals to forest mammals increased and then reversed after the LGM. Further evidence for a more open woodland forest surrounding Devils Lair and Tunnel Cave during the LGM is provided by the identification of predominantly jarrah, peppermint (*Agonis* sp.) and *Banksia* sp. in charcoal samples from relevant layers in the sites by Burke (2004) and Dortch (2004:152–154). Thus the period of greater intensity of occupation at both of these sites occurred when they were surrounded by open vegetation that matches the land use pattern identified by Hallam and Ferguson in the ethnohistoric record.

There is little other local evidence from which to suggest the effect of the LGM on other areas of the Warren Bioregion; however, pollen records from the Swan Coastal Plain to the north reveal no major vegetational shifts (see review in Dortch 2004:26–30).

Discussion and Conclusion

As Williams et al. (2009) observed, the dataset for the LGM Warren Bioregion is indeed small, with only four sites providing clear evidence for occupation at that time. As only the two cave sites indicate sustained occupation for the period, it is difficult to mount an argument for the region acting as a refuge at the time. The increased use of the two cave sites during the LGM might just reflect people's greater use of woodland forest resources.

The 'hit and miss' problem of identifying use of open sites makes the existing sites difficult to interpret. At both Quininup Brook and Kalgan Hall the LGM occupation seems to represent very short-term events in a small part of both sites. As vegetation around both Devils Lair and Tunnel Cave after the LGM was not conducive to occupation during the Holocene, and there is no evidence of decreased use at other sites, there is little to support an argument for depopulation at the end of the Pleistocene. Instead, both the archaeological dates and the available artefact evidence suggest a steady increase in occupation intensity in the region from the mid-Holocene.

This review demonstrates the importance of understanding changing patterns in local vegetation in the interpretation of regional occupation patterns and the problems of using open site evidence from relatively small excavations to interpret changes over time. Much larger excavations are needed from unbounded sites before patterns can be incorporated into regional narratives. The evidence as it stands does demonstrate a remarkable continuity in subsistence behaviour in the region—in which open forests were much more important resource zones than closed forests. It may also indicate the long-term importance of fire management in the region.

Devils Lair remains one of Australia's iconic archaeological sites, since it has contributed a great deal to our knowledge of Pleistocene human behaviour. Charlie Dortch pursued that knowledge with remarkable energy and perspicacity, and without this the importance of the archaeology of the southwest may not have been recognised.

Acknowledgements

I thank Kate Morse and Sandra Bowdler for reading and providing detailed comments on a draft of this paper. Joe Dortch prepared Figure 1.

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