Broad Scale Palaeo-Environmental Reconstructions of Southern Victoria, Australia.

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Abstract: Ethnographic narratives are often used in the creation of models of Aboriginal land use. While this is not problematic when the land use model is concerned with historically known periods, projecting more recent ethnographic phenomena back in time is highly problematic. Radical environmental changes through time have altered the way people have interacted with the environment in southern Victoria. Available archaeological data, albeit sparse and mainly limited to stone artefact assemblages is incorporated where appropriate to link archaeological signatures to the environmental reconstructions. This paper provides palaeoclimatic reconstructions of various periods over the last 30,000 years in order to better understand how humans might have utilised their landscape.

Introduction

The use of ethnographic interpretations of Aboriginal land use and behavioural patterns in the past is somewhat problematic in archaeological endeavours (Allen, 1996). While we have certain classes of data that provide examples or highlight certain aspects of Aboriginal behaviour at the point of contact with Europeans, we have less likelihood of archaeologically testing the validity or applicability of this data at receding points in time. Ethnoarchaeologically based investigations are not uncommon in hunter gatherer archaeology (Flood, 1988; Gould, 1977; McBryde, 1984a; Peterson, 1971, 1973) projecting ethnographically observed behaviour (and the basis thereof) back through time into deep antiquity is problematic.

Without the ability to utilise ethnographic data, the construction of land use models over deep time must rely on archaeological and palaeoenvironmental modelling with a logical theoretical basis. Essentially, 'archaeologists must attempt to determine independently what their data can tell them about human behaviour and what they cannot' (Trigger, 1982:5). In the absence of extensive archaeological information, palaeoenvironmental data can be utilised to re-construct broadly prevailing environmental conditions in time and space, and assist in the modelling of favourable habitation zones for human populations.

This paper focuses in particular on the West Victorian Volcanic Plains (The Basalt Plains) and upland areas of Southern Victoria, and presents a series of generalised palaeoenvironmental reconstructions at various time periods over the last 30,000 years. The focal areas of the paper are shown in Figure 1.

Human or Behavioural Ecology

The underlying premise of human or behavioural ecology is that the archaeological record is one component of a human ecosystem 'within which communities once interacted spatially, economically, and socially within the environmental matrix into which they were adaptively networked' (Butzer 1982:222). The concept of ecosystems is important here, and must be understood as the interaction between all parts of an ecological community, including the human members of that community. Human behaviour is influenced by and in turn influences the environmental universe within which all elements of the system interact. The archaeological record is a by-product of this interaction and may be seen as the 'result of political, economic and ecological forces working themselves out on the landscape' (Butzer, 1982: 222). The hunter gatherer mode of subsistence is dependent upon the biotic resources of a given area, so the 'key properties of this form of economy are ecological in nature' (Winterhalder, 2001: 15).

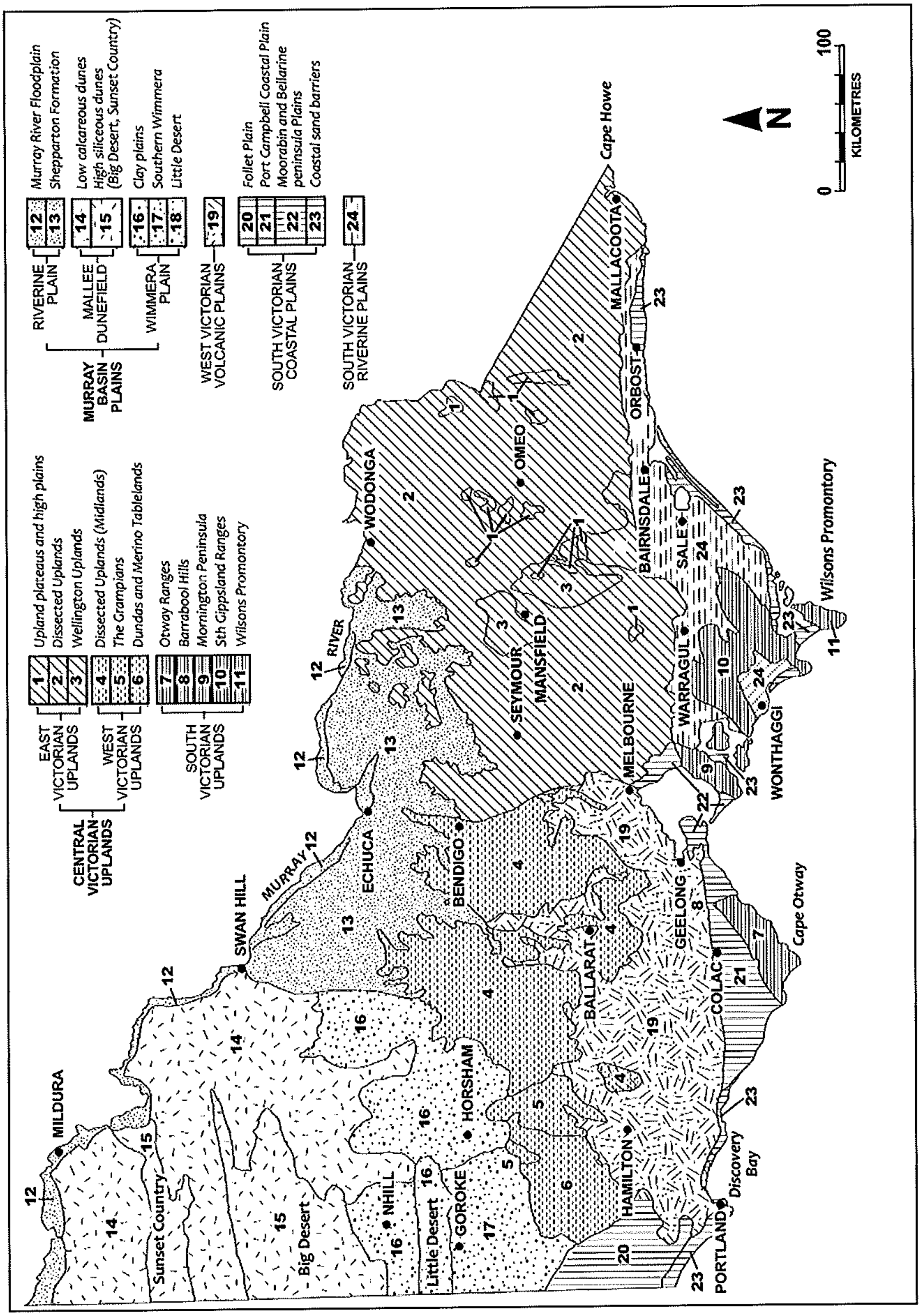

Figure 1: Victorian geomorphic divisions (Cochrane, Quick and Spencer-Jones, 1995). The areas of interest for this paper are areas numbered (2) Eastern Uplands, (4) Dissected Uplands, and (19) West Victorian Volcanic Plains.

While the political (and social) realm of behavioural prehistory is difficult to interpret from the majority of the Australian archaeological record in deep antiquity, attributes of the prevailing environmental conditions can be used to assist in the construction of models of human behaviour. In particular, the availability and distribution of resources through time and space will have had significant and predictable impacts upon Aboriginal settlement patterns and subsistence (economic) behaviour.

It is important to specifically recognise here that resource availability and distribution are not static through time, and may vary markedly through both time and space. Generalised changes in environment will have dramatically altered the resource balance through time and space, thus influencing human behaviour. While 'human groups can be expected to spread out into all habitable zones' (Butzer, 1982:223), the expansion and contraction of subsistence resources would have resulted in periodic redistribution of 'habitable zones' across the landscape. The timing, density and intensity of the utilisation of habitation zones will also vary in relation to the availability of resources. During certain periods, large portions of the Basalt Plains would have been virtually uninhabitable, while at other times resources would have been comparatively abundant in those same areas.

At the height of the Last Glacial Maximum (about 18,000 BP) for example, when climatic conditions are generally considered to have been the harshest, areas of higher altitude within the region (e.g. Mt Macedon at more than 1,000 MASL) would have been very cold, dry and windswept. Snow still occasionally falls at Mt Macedon above 1,000 metres. The low hills throughout the region (i.e. between 300 MASL and 1,000 MASL) would also have all been relatively cold, barren and windswept during the LGM climatic extremes, offering little to attract human habitation. At other times, however, areas of higher altitude have been more attractive for human habitation, or at least exploitation. For example, Flood (1980) has demonstrated the Aboriginal utilisation of parts of the Australian Alps in later prehistory, while McBryde (McBryde, 1978; McBryde, 1984a; McBryde, 1984b; McBryde and Harrison, 1981; McBryde and Watchman, 1976) has shown that the Mt William quarry (approximately 600 MASL) was also being used in recent prehistory.

The human habitation or utilization of any ecological 'niche' must be seen as part of a system of dynamic responses to long term changes or trends in resource availability, distribution or preferences primarily brought about through environmental change. While these long term changes would have been imperceptible within the span of a human lifetime, the effects of cumulative changes and the responses to those changes should theoretically be visible in the archaeological record. In the absence of archaeological and ethnographic data, however, we must turn to palaeoenvironmental data to assist in the construction of predictive models.

Prevailing Environmental Conditions

The following section introduces four generalised Aboriginal land use models, and the various sources of environmental and archaeological evidence upon which these models are based. These models are intended only as broad outlines of the environmental conditions prevalent during each of the four periods discussed in this paper. The interpretation and reconstruction of palaeoenvironmental data must also be viewed with a certain degree of caution. The data is not particularly fine grained and reconstructions offered are far from complete. As Butzer noted, 'modern functional ecosystems are essentially impractical for empirical study. Not surprisingly, past systems remain beyond [complete] reconstruction' (1982: 19).

30,000 BP

The earliest traces of the human occupation of the region indicate that Aboriginal people were utilising the Maribyrnong Valley at least 30,000 years ago (Mulvanney and Kamminga, 1999: 137)(Table 1, Pre-LGM).

Environmental reconstructions for the period prior to the Last Glacial Maximum indicate that south eastern Australia was 'cool and wet with deep water in many lakes' (Wasson and Donnelly, 1991: 26-27), followed by a rapid increase in aridity and falls in temperature, with a major climatic 'threshold passed somewhere after 25,000 BP' (Dodson, Fullagar and Head, 1992). Forests and rainforests are thought to have been more extensive than today. However the Basalt Plains characteristic of southern Victoria were relatively treeless (Dodson, Fullagar and Head, 1992:117), as was much of southern Australia (Hope, 1994:394). Archaeological evidence suggests that Aboriginal people were occupying the Maribyrnong valley 30,000 years ago (Mulvaney and Kamminga, 1999). At this time, forest conditions appear regionally restricted to the better drained and watered river valleys and hills. The relevant palaeoecological evidence from the Lancefield Swamp suggests that the Basalt Plains were treeless, despite the expanding forests elsewhere in south eastern Australia. Grasslands dominate the plains, with Poaceae (grasses) and Asteraceae (tuberous flora) dominating the grasslands taxa. Rainfall appears to have been similar to modern levels, falling mainly during the winter according to Ladd (1976).

Ladd (1976) argues that the apparent contradiction of standing open water (indicating a climate broadly similar to today) and the lack of trees at the Lancefield swamp and surrounding plains (indicating drier conditions) may be a result of more extreme seasonal variations. Ladd (1976:124) proposes that summers were long, hot and very dry prohibiting tree growth on the plains, while shorter very wet winters maintained existing standing

Table 1: Summary of the major environmental events and existing archaeological evidence by landform.

					Archaeological Evidence by Landform			Aboriginal Land Use by Landform		
Period	**Climate**	**Fauna**	**Flora**	**Water**	**Hills**	**Basalt Plains**	**Incised Valleys**	**Hills**	**Basalt Plains**	**Incised Valleys**
Pre-LGM	Wind at present day values. Long hot summers, short wet winters	Megafaunal browsers present	Mainly grasslands. No trees in pollen record at Lancefield Swamp Hills forested	Rivers permanent. Swamps and smaller creeks probably ephemeral	Unknown (?) No Dated Material	Unknown (?) No Dated Material	Occupation Indicated in alluvial sediments	Unknown (?) Possible Low Density Use	Unknown (?) Possible Low Density Use	Definite Low Density Use
LGM	Very Cold Very Dry Very Windy Snow at 1,000 MASL Silting in rivers Dune building	Megafauna becoming extinct? Limited by water and retreating food resources	Semi-arid steppe like conditions. Trees and grasslands retreat to refugia	Water balance at 50% of present day values. All but largest rivers dry. Swamps and creeks dry.	Unknown (?) No Dated Material	Unknown (?) No Dated Material	Occupation Established in alluvial sediments	Unlikely	Unlikely	Definite High Density Use
Pleistocene Holocene Transition	Rapid climate change. Sea levels rising. Cold and Dry conditions give way to Warmer and Wetter conditions	Megafauna extinct. Fully modern fauna only	Forest expands into all environments Grasslands expand Steppe-like conditions disappear.	Maximum aridity occurs at 13,000 BP. Water then becomes more plentiful, but regionally variable.	Unknown (?) No Dated Material	Unknown (?) No Dated Material	Surge in Occupation Density on alluvial floodplain after 13,300 BP. Coincides with maximum aridity and rising sea levels? Burials and artefact scatters in alluvial sediments (Wright, 1970; Mulvaney, 1970a, 1970b; Tunn, 1997).	Possible (?) Low Density Use	Possible (?) Low Density Use	Definite High Density Use
Late Holocene	Regionally variable. Hot dry summers and short wet winters. Wetter and Warmer at 6,000 BP than at present.	Fully modern fauna only	Forests contract to modern expanse. Grasslands expand.	Sea levels stable at 6,000 BP. Warmer and Wetter at 6,000 BP. From 2,000 BP to present conditions approximate modern values.	Low Density artefact scatters, isolated artefacts, and scarred trees. Other site such as Mt William and Sunbury rings in use. No dated material. Chronology by typology.	Low Density artefact scatters, scarred trees and isolated artefacts mainly located around swamps and creeks. Very low-density artefact scatters, isolated artefacts and occasional scarred trees on the plains away from water. Only one site dated to approximately 2,000 BP. All other chronologies by typology. (du Cros, 1989; 1990; 1991; 1998).	High Density artefact scatters. Scarred trees and isolated artefacts plentiful. Also hearths, burials, and quarries. Dated sites from alluvial sediments. No dated surface assemblages.	Definite Low Density Use	Definite Low Density Use	Definite High Density Use

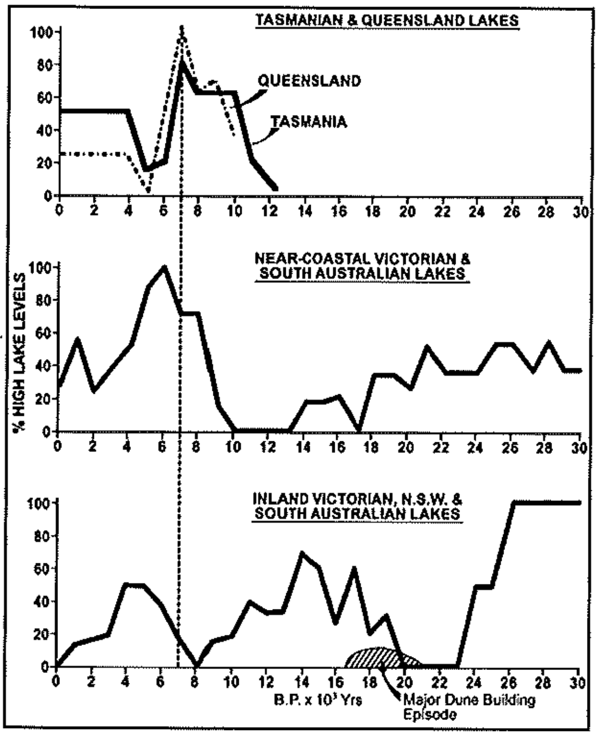

Figure 2: Lake level details over the last 30,000 years from selected Australian sites (Wasson, Fleming and Donnelly, 1991). Note the regional variations apparent in the two lower graphics from coastal and inland Victorian and South Australian sites. In the Victorian data it appears to have been much wetter near the coast at 7,000 BP and again at 1,500 BP than it was at inland sites.

water levels. The lowest excavated stratum of the Lancefield site (corresponding to Ladd's Zone 1) dates to approximately 26,000 BP. One considerable difference in the landscape of Pleistocene south eastern Australia at this time was the presence of numerous megafaunal species. The timing of the extinction of the megafauna remains elusive, as does the extent of the interaction (if any) between prehistoric Aboriginal populations and the extant megafauna (Duncan, 1998; Flannery and Gott, 1984; Roberts *et al.*, 2001; Wroe and Field, 2001).

Regional environmental and climatic variability is clearly indicated in the lake level sequences from south eastern Australia at this time. The lake level sequences from near coastal Victorian and South Australian lakes differ considerably from sequences obtained from inland Victorian, New South Wales and South Australian Lakes (see Figure 2). Evidence from coastal lakes indicates that lake levels were relatively consistent from about 30,000 BP until the LGM; while the inland lakes appear to have become rapidly dry between 26,000 BP and 23,000 BP (Wasson, Fleming and Donnelly, 1991). This data supports Ladd's (1976) view of a dry(ing) swamp at Lancefield at c. 26,000 BP, and may also go some way toward explaining why large numbers of fauna perished at the Lancefield swamp at this time. Sea levels were approximately 50-60 metres lower than today (Chappell, 1993, 2001; Chappell and Thom, 1977), making coastal resources and shorelines a considerable distance further away from the Maribyrnong valley and environs than is presently the case. In effect, Australia was a much larger continent when sea levels were lower. Later, at the height of the LGM, when sea levels were at their lowest, the Australian landmass was approximately one third larger than it is today (Mulvaney and Kamminga, 1999: 114).

Prior to the LGM, the Aboriginal inhabitants of the region would most likely have experienced conditions broadly similar to those of today. Longer, drier and hotter summers however, may have concentrated occupation areas close to standing water sources for much of the year. The use of the plains may also have been restricted by climatic conditions. The hot summers would have depleted available resources and the wet winters would have waterlogged much of the plains making seasonal utilisation of these environments difficult.

Although areas such as Lancefield Swamp contained standing water, there was little timber present, restricting the attractiveness of these environments for human habitation. There is a possibility that these swamp environments dried up during the very long hot summers, and only refilled during the winters. Only two quartzite artefacts have been found at the Lancefield Swamp site in the Pleistocene sediments, and these offer only a tentative (and inconclusive) glimpse of the human utilisation of this environment (Horton and Wright, 1981). The presence of the Asteraceae taxa on the plains raises the possibility that tuberous flora such as *Microseris scapigera* (Myrrnong) may have been a feature of Aboriginal diets from the time of the earliest known occupation of the area.

While there is a paucity of available archaeological and palaeoecological evidence, the general patterns in the available data indicate that conditions were broadly similar to those of the later Holocene period. One major localised ecological constraint upon Aboriginal populations would appear to be the lack of timber at the swamp environments. This would have greatly reduced the attractiveness of any active swamps as residential areas. However, it appears likely that the incised valleys of the region were more heavily timbered, providing adequate sources of fuel, food and shelter.

The Last Glacial Maximum (18,000BP)

The period from approximately 25,000 BP to 18,000 BP (Table 1, LGM) is characterised as one of increasing aridity, decreasing temperatures and decreasing biological productivity. Aboriginal populations residing in the region would most likely not have noticed the effects of global climate change during the course of an individual lifetime; however over the course of the millennia either side of the LGM Aboriginal settlement patterns and land use behaviour would have undergone considerable change to accommodate the scale of environmental change taking place.

At the height of the LGM temperatures fell by between 6°C and 10°C, rainfall was reduced to approximately 50% of modern values, and wind speeds increased by 150% over modern equivalents (Kershaw, 1995; Wasson and Donnelly, 1991). The combination of the three factors (colder, windier and drier) increased the rate of evaporation considerably, reducing the availability of standing fresh water. Lake levels across south eastern Australia plunged during this period of intense aridity. Vegetation patterns changed dramatically, reflecting the increased aridity and decreased temperatures. The Basalt Plains biotic communities of the region for example, which had been dominated by Poaceae and Asteraceae taxa prior to the LGM (Ladd, 1976), gave way to much sparser sedge and herb dominated steppic conditions (Flannery and Gott, 1984; Kershaw, 1995).

With the onset of the colder, drier and windier conditions forested areas declined rapidly, with the majority of tree species retreating to better-watered 'micro-habitats' (Kershaw, 1995: 661). Megafaunal browsers would also have been forced from the plains environments to the better-watered valleys in search of water, where they eventually went extinct at sometime before 18,000 BP (O'Connell and Allen, 1995). The greater wind speeds combined with heightened aridity led to a period of dune and lunette building across southern Australia (Wasson, Fleming and Donnelly, 1991). Major rivers generally became less active, depositing vast quantities of silt (from aeolian dust and frost shattered rocks) in alluvial deposits, such as those found in the Maribyrnong Valley and the Keilor Terraces which were being deposited during this period (Bowler, 1987). The majority of the fauna existing at this time would have become dependent upon the better-watered and sheltered valleys for survival once the plains and mountainous areas became less habitable.

The plains environment would most likely not have supported large populations of water dependant fauna for the several millennia either side of the LGM. Swamps and smaller creeks would have all but disappeared from the landscape. Indeed 'throughout south-eastern Australia there is little evidence for swamp or bog communities during the height of the LGM' (Kershaw, 1995: 664), and lakes across the region were virtually dry. Colder, windier and drier conditions would have also made large tracts of the higher regions of central Victoria unattractive for both human and faunal occupation. The altered climatic regime resulted in the snowline being up to 1,000 metres lower than modern levels across south-eastern Australia (Kershaw, 1995). This would have resulted in significant changes to the biotic communities at higher altitudes, particularly the retreat of forested communities to more sheltered regions.

The archaeological record contains evidence of human occupation on the better-watered and more fertile alluvial valleys at this time. The Keilor terraces at Brimbank Park have revealed a 'distinct surge in artefact density' (Tunn, 1998: 44) occurring some time after the LGM. Munro (1997; 1998) also established that the volumetric artefact density recovered from similar terraces at the Keilor Burial site (some 3 kilometres upstream from Brimbank Park) peaks at 31.34 artefacts/ m^3, and appears to correspond with the surge in density identified by Tunn.

The increase in artefact density identified by Tunn (1997, 1998) at the Green Gully, Dry Creek and Brimbank Park 1 & 2 sites appear to reflect significant changes in human behaviour. The density of artefacts found in the excavations by Mulvaney (1970a; 1970b) and Wright (1970) at approximately 18.3 metres (Reduced Level) is considerably greater than above this level (in the plough zone) or below it, in the older pre-LGM sediments, indicating a similar increase in the localised intensity of human activity (see Figure 3). The Dry Creek data was collected from the Victoria Archaeological Survey / La Trobe University excavations undertaken between 1977 and 1982, and subsequently analysed by Burke (1990) and Munro (Munro, 1997, 1998).

This pattern may correspond (at least at a gross scale) with the pattern of environmental changes in the period during and after the LGM, and the human responses that might be expected under such conditions. As aridity and cold reduce regional bio-productivity and water availability, we could expect human populations to more intensively occupy and utilise the resources of the more attractive valley environments. It is not proposed that human populations became 'tethered' to these zones of higher bio-productivity in the way that other species may become dependent upon refugia in times of environmental stress. The use of the term '*refugia*' concerning human populations is somewhat inappropriate in this context as it tends to disguise a fundamental human cognitive ability to utilise entire landscapes, the ability to schedule resources, and the resourcefulness and resilience of human populations in general. The valley environments may have been refugia for floral and faunal populations throughout this period, however, humans would still have moved in and out of these environments at will, hunting or harvesting more 'ecologically tethered' (Cosgrove, Allen and Marshall, 1990) resources. This is not to deny that humans, like other biological entities, have certain inescapable requirements for survival (i.e. water). Rather, that Aboriginal people came to utilise these zones or patches of higher productivity (Cosgrove, Allen and Marshall, 1990) more heavily in times of greater environmental stress, but were free to move in and out of these zones as necessary. Indeed, as the distribution of resources becomes more widespread during the later Holocene, Aboriginal people are consequently using more of the landscape, but certainly do not abandon the resource rich valleys.

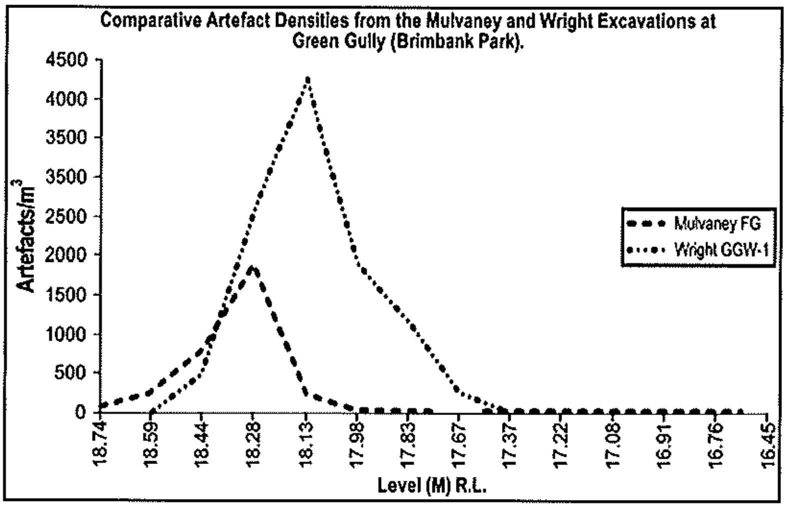

Figure 3: Comparative data from the excavations of Mulvaney (1970) and Wright (1970) at Green Gully (Brimbank Park). An identifiable surge in artefact density per m3 occurs between about 18.15m (Wright) and 18.30m (Mulvaney). These discrete excavations were located approximately 70 metres apart in the same 'Keilor' terrace landform. After Tunn (1998).

The Pleistocene-Holocene Transition

The Pleistocene-Holocene transition (Table 1, Pleistocene-Holocene Transition) is the period of climate history arbitrarily dated to approximately 10,000 BP and denotes yet another period of rapid climatic change throughout south eastern Australia, particularly between circa 12,000 BP and 9,000 BP (Kershaw, 1995: 666). While the Pleistocene-Holocene boundary marks a period of considerable environmental change, 'there is little evidence that Australia witnessed any significant cultural changes contemporary with major climatic change observed in the early Holocene' (Frankel, 1995:663).

While there may be little evidence for cultural change, the late Pleistocene-early Holocene transition shows 'the greatest change in pollen assemblages, and hence vegetation, within the last 18,000 years' (Kershaw, 1995:666). Grasslands contracted and Asteraceae levels declined, while Eucalyptus and Casuarina expanded at the expense of the contracting grasslands (Kershaw, 1995:666). The pollen record of Lancefield Swamp, for example, revealed a surge in Myrtaceae pollen in zone L2 of the excavations. Simultaneously, the pollen record shows an almost identical decline in the pollen count of the Poaceae grassland taxa (Gillespie *et al.*, 1978). This vegetal transformation is recorded in sediments that are dated typologically by the presence of geometric microliths to around 6,000 BP (Gillespie *et al.*, 1978). There is no radiocarbon evidence to elucidate the specific timing of the taxonomic changes that occurred at Lancefield Swamp. It is plausible that the vegetation changes occurred earlier than previously thought, at about 9,000 BP, which would coincide with changes observed in the pollen records of other southeast Australian sites. Conversely, the evidence collected at Lancefield may reflect a specific series of localised environmental changes not observable elsewhere.

The period between 12,000 BP and 9,000 BP is 'poorly defined' (Wasson and Donnelly, 1991: 27) in many of the southeast Australian palaeoclimatic datasets, limiting the scope of possible environmental reconstructions. Temperatures, however, appear to have been moderately higher than present values, while moisture levels at sites such as Lancefield Swamp must have equalled or exceeded the 500mm minimum required for present day tree growth to support the expanded Myrtaceae communities found in the pollen record (Gillespie *et al.*, 1978). Rising sea levels at this time caused a significant series of alterations in the physiography of southeast Australia. As sea levels rose, vast tracts of highly productive coastal plain were permanently inundated. The land bridge joining Tasmania to the mainland was severed, and what is now Port Phillip Bay became flooded.

These changes in physiography, while gradual, must have influenced Aboriginal population distribution as perhaps 'one-seventh of the land' (Blainey, 1975:10) simply disappeared. This reconfiguration of local populations probably took place over several millennia as the seas encroached until the sea levels finally stabilised at modern levels approximately 6,000 BP (Frankel, 1995:654). While there have been various theories as to how the marine transgression influenced coastal Aboriginal populations and resource availability (Bowdler, 1977), it is undoubtable that significant changes in population distribution must have occurred. Coastal residents would have lost extensive parts of their estates as the seas continued to rise. Whether these people were absorbed into existing territories, pushed into already occupied territories, or suffered a decline in population is unknown.

This population redistribution is possibly reflected in the archaeological record of the Maribyrnong valley. A comparatively sudden increase in artefact density has been described at the Green Gully (Brimbank Park) sites by John Tunn (1998:44). Tunn compared the results of his recent archaeological fieldwork at Brimbank Park to earlier excavations conducted by Mulvaney (1970a, 1970b) and Wright (1970). Tunn identified that a peak in artefact density occurs across three spatially discrete sites within the Keilor terrace at Brimbank Park, between 18.15m-18.45m (1998:44). This increase in artefact density indicates some change in behaviour at these sites (Figure 3). Artefact density alone however, may not be an accurate reflection of intensity of site usage or demographic fluctuations. It is possible that there was simply an increase in the production of stone tools, which is visible in the archaeological record as locally increased artefact discard rates. It is equally possible that the increase in artefact density was the result of a localised readjustment in population distribution caused by local environmental conditions (Bird and Frankel, 1991a). Tunn also identified a similar increase in artefact density at the Dry Creek site, some 3 kilometres away from the Green Gully (Brimbank Park) sites (1998:44).

While it is not possible to show discrete changes in the material culture of the area at this time, the evidence suggests that some form of localised change or adjustment was occurring in the way in which Aboriginal populations utilised this landscape. While it is possible that the observed increase in artefact discard could be the result of responses or readjustments to localised environmental conditions (Bird and Frankel, 1991b), an introduction of new raw materials, or a change in reduction strategies, these hypotheses remain to be tested. The terminal Pleistocene and early Holocene archaeology of the region is best described as suffering a 'general poverty of understanding' (Frankel, 1995:654) and requires a concerted effort to make up for the 'lack of earlier research' (Frankel, 1995:654).

Mid to Late Holocene

The period from approximately 6,000 BP to the ethnographic present has been extensively studied throughout south eastern Australia (See Table 1, Late Holocene). Climatic conditions during this period were generally similar to the present day, although considerable localised fluctuation in climatic conditions was common.

Palaeoclimatic evidence from the 'Maar' lakes of south western Victoria show that there was a 'marked increase in precipitation (and a continuing trend of rising temperatures) at the beginning of the Holocene, leading to maximum lake levels and temperatures in the mid-Holocene' (Wasson, Fleming and Donnelly, 1991: 3). Mean annual temperatures were between 0.5° and 2°C higher than current levels. Pollen records suggest an increase in mesic communities, indicating a 'more favourable water balance in the soil profile' (Wasson, Fleming and Donnelly, 1991: 7). Precipitation is thought to have been in the order of 20-50% greater than current levels (Wasson, Fleming and Donnelly, 1991). After mid-Holocene peaks in temperature and moisture levels, climatic conditions appear to become cooler and drier at about 2,000 BP. Temperatures decreased by 'as much as 3°C' (Wasson and Donnelly, 1991:30) in southern New South Wales and Tasmania.

The paleoclimatic record of this period, however, is not easily interpreted. There are changes indicated in the data, which show high variability (or in some cases contradictions) between the climatic conditions experienced at sites within relatively close proximity. The lake level data in Figure 2 shows climatic conditions between coastal and inland sites throughout the Holocene. Lake levels at near coastal sites appear to peak much earlier in the Holocene than those of the inland sites. While inland lake sites were relatively dry at approximately 8,000 BP (and were only at half the levels of near coastal lakes at about 4,000 BP) coastal lakes have maintained high levels from 8,000 BP. This data serves to highlight that regional or local variability in climatic conditions is the norm rather than the exception. Localised climatic amelioration or stress could also be expected to manifest in the archaeological record as specific behavioural episodes or technological responses that may or may not occur at other areas or times (Wasson and Donnelly, 1991).

Sea levels stabilised at approximately 6,000 BP, and have remained relatively stable since that time. Consequently, no coastal open sites older than about 8,000 years are likely to exist anywhere on the Victorian coastline. Older sites may exist in coastal caves, such as the late Pleistocene occupational evidence at Bridgewater cave in south western Victoria (Lourandos, 1997). Population redistributions or fluctuations caused by rising sea levels between 12,000 BP to 6,000 BP would have 'levelled' out by about 6,000 BP (Bird and Frankel, 1991a; Frankel 1988; Godfrey, 1988).

For the last 2,000 years environmental and climatic conditions appear to have remained relatively stable. Aboriginal populations would have had access to virtually all of the biotic resources known to have existed in the region over the last few thousand years. While the Basalt Plains are still relatively arid and dry for most of the year, the presence of shallow swamps on the plains would have attracted Aboriginal subsistence activities. At no time in the last 30,000 years however, have the Basalt Plains been extensively timbered. Grasslands have dominated the plains for at least the last 16,000 years (Jones, 1999), with steppe-like conditions prevailing for most of the 10,000 years before the spread of the grasslands. The incised valleys dominating the south of the region are the only landform in the region that would have consistently maintained tree cover during the last 30,000 years. Similarly, the water sources flowing through the larger incised valleys are the only ones in the region that are likely to have remained permanent through the entire 30,000-year period.

Implications

Arguably the most problematic issue when attempting to understand archaeological patterning across various landforms and through deep time is the paucity of the archaeological data itself. It is not yet clear whether the sparse archaeological signatures encountered in numerous landforms throughout the region are real, or are artefacts of (natural) post-depositional processes (i.e. geomorphological change) or more modern anthropogenic factors (i.e. soil erosion or movement through vegetation loss and grazing practices since European settlement). Given the nature of the landforms in question, it is likely that additional meaningful archaeological data from the hills and plains landforms will prove elusive. Conversely, in those places where extensive sediment traps exist, such as the alluvial valley sequences of the Maribyrnong River, the potential for significant archaeological discoveries of considerable antiquity remains high.

Conclusion

Many accounts of Aboriginal land use on the Basalt plains focus on the utilisation of biotic resources located adjacent to the many swamps and creeks that are a modern feature of this land system. The paleoclimatic and archaeological evidence tend to suggest that these environments have not always been as attractive for human habitation as they would now appear. At various points in time throughout the last 30,000 years, the plains have oscillated between highly favourable loci for human activity to decidedly unfavourable. The ethnohistorical accounts derived over the last 200 years provide a useful and analogous tool for constructing models of recent Aboriginal land use patterns. However, ethnographically based models should be limited to the ethnographically known past. Attempting to model the deeper past based on relatively recent ethnographic data cannot provide any real insight into deep antiquity. Archaeological, palaeobotanical and paleoclimatic data are the only real alternatives to provide this type of insight.

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