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AN ANALYSIS OF ROCK ART SITES IN THE RANGES NORTHWEST OF THE CUMBERLAND PLAIN

THESIS SUBMITTED IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE DEGREE OF MASTERS OF ARCHAEOLOGY AND HERITAGE MANAGEMENT

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iv. Abstract

This thesis is an archaeological analysis of rock shelters that were used by Aboriginal Australians for habitation and rock art in the ranges northwest of the Cumberland Plain, in the Sydney Basin. It considers the range of intensity of shelter site use for habitation, together with the rock art motifs, and the behaviours associated with motif production, and uses multivariate statistical analysis to identify patterns in the relationships between these variables in order to understand the behaviours associated with site use. The results are interpreted in the context of the wider environmental and social constraints that were likely to have imposed upon, and influenced the groups using the sites. The analysis reveals that most sites were infrequently used by small highly mobile groups for short durations. Rock shelters afforded an expedient means of shelter for groups traversing a rugged landscape. The energy required to traverse the land for the purpose of hunting and foraging, and for travel, and the resource availability, and risk would have restricted unnecessary movement within the landscape. Excessive movement, particularly in times of stress would have been avoided. This restriction together with the distribution, and spatial limitations of rock shelters, led to a shared space for domestic, ritual and religious activity. Rock shelters afforded a space for the dual contexts of the sacred and secular. They express and reflect the integration of the spiritual with the everyday existence of the inhabitants, and how they perceived the habitation space.

v. Declaration

I certify that this thesis does not incorporate without acknowledgment any material previously submitted for a degree or diploma in any university; and that to the best of my knowledge and belief it does not contain any material previously published or written by another person except where due reference is made in the text.

William Moon

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1 Introduction

This research was undertaken as a result of an observed trend in the morphology of rock shelters that were used by Aboriginal people for both habitation and rock art, in the ranges to the northwest of Sydney, New South Wales. Both habitation shelters and most rock art shelters share a common morphology indicating that art shelters were also likely to have been used as camps.

These observations prompted a number of questions including:

- What do rock shelters reveal about landscape use, subsistence and cultural behaviour?
- Are there patterns evident in the rock art that are associated with different types of shelter use?
- Through an analysis of the art, and the behaviours associated with its production, is it possible to identify sites that are ritually and spiritually significant, and were these sites associated with, or remote from domestic activity?

McCall (2010) conducted research of rock art sites in the Drakensburg in South Africa. He applied a method of categorising sites according to elevation zones, which showed sites from these zones had distinct differences in habitation activity, and shelter morphology. He then applied principle component analysis to the range of artefacts and rock art motifs within the sites and was able to identify three distinct site types. This included rock art sites associated with habitation and domestic activities, rock art produced for ritual purposes that was away from habitation and domestic activity, and small discrete hidden sites that did not have any evidence that they had been used for domestic activity or habitation. McCall's method, if modified and applied to suit the context of this research was considered to have a high likelihood of revealing patterns that would show differences in how sites were used, and would contribute to answering the questions. This method had not been applied in this research area before.

This research was undertaken with the objective of developing and applying suitable categories to sites on the basis of their degree of use for domestic habitation, spanning the range of use from no use, to intensive use. Sites were analysed to determine function and

purpose, taking into consideration their position in the landscape, and the archaeology of the site. As part of the analysis, site use was considered in the context of optimal foraging theory, evolutionary ecology theory, site formation associated with the settlement patterns, subsistence strategies, the influence of risk on site reuse, and the social strategies used to mitigate risk, and maintain social structure and how they would have influenced site use. From this analysis an understanding was formed for how people used the landscape and rock shelters, and how the landscape, environment and resource availability influenced and constrained behaviours associated with shelter use, including cultural behaviour.

Multivariate statistical methods were applied to the site categories and the rock art motifs with the aim of identifying patterns between the art and site, and to analyse these patterns to understand how rock art shelters were used. The rock art was also analysed to determine the importance of the content of the art, and the behaviours associated with its production in order to identify sites that were of spiritual and ritual significance. Once identified these sites were considered in terms of their relationship to the domestic use of sites to determine if the religious and the domestic occurred within a shared space, or whether they were distinctly separate from each other, and what factors influenced this use of space. Due to the absence of any ethnographic accounts of the meaning of rock art in the Sydney region, this research relies upon ethnographic accounts of important totemic figures used during rituals in the area, and accounts of the meaning and use of rock art from other parts of Australia in order to understand the purpose and likely significance of the art, and to understand the behaviours associated with its production.

1.1 Background

This study was undertaken in ranges to the northwest of Sydney and includes the Parr Conservation Area, the south-western section of the Yengo National Park, south-eastern section of the Wollemi National Park, and the north-eastern section of the Blue Mountains National Park between Bilpin and the Grose River. Refer to Figure 1.

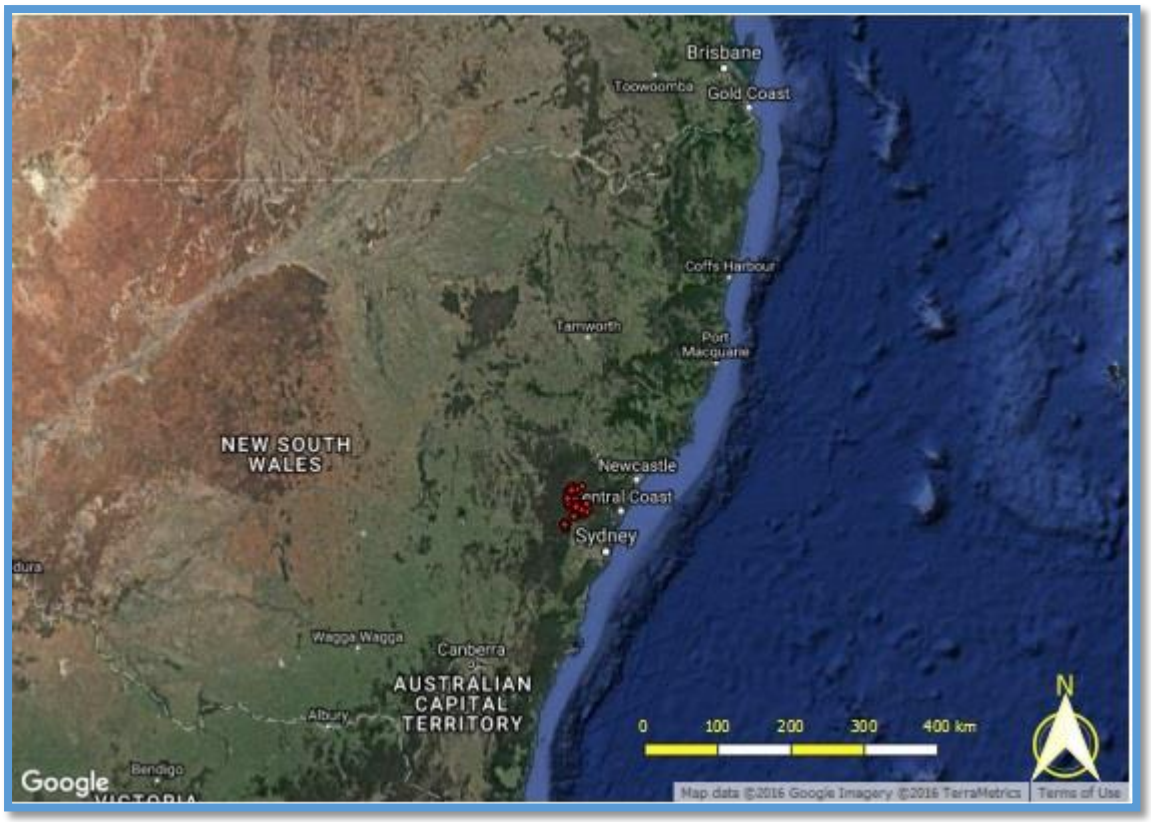

Figure 1: Map of New South Wales showing the sites in the research area in red.

This area forms a part of the greater Sydney Basin. The area will be referred to as the PYWBM throughout this thesis. This is the traditional country of the people from the Darkiñung language group (Ford 2010:391-433; Mathews 1897:1). In the southern most section of the research area near Bilpin, Ford argued that this area was part of the Darkiñung country that continued south to the Grose Valley (Ford 2010:391-433). This area may have been part of the Dharug or Gundungurra country (Kohen 1987:57-60).

The art of the area is part of the overall style used throughout the Sydney basin that is often described as Simple Figurative. Most motifs are drawn or painted in a simple silhouette of the image which is often an animal, human or anthropomorph. They are drawn with either an outline, shaded fill, or both shaded fill with outline. Humans are drawn from a frontal perspective, mammals and birds in profile, and reptiles from above (Maynard 1977:99). Normally only the minimum details are provided in order to recognise the subject. There are no intricate details included.

1.1.1 Climate

The climate is temperate with warm to hot summers and mild winters. Average daily humidity is 80% at 9.00am to 60% at 3.00pm. Table 1 shows the monthly mean rainfall and temperatures from the closest weather stations to the study area (http://www.bom.gov.au/climate/data/index.shtml). The Colo Heights station which is most central to the study area does not provide temperature records. Springwood was chosen as the next most appropriate station to provide temperature records that has an equivalent altitude.

Daily Rainfall (millimetres)												
COLO HEIGHTS (MOUNTAIN PINES)												
Station Number: 061211 · State: NSW · Opened: 1962 · Status: Open · Latitude: 33.36°S · Longitude: 150.71°E · Elevation: 320 m												
	Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Mean	121.4	143.5	122.4	86.9	64.2	73	36.6	47.8	52.6	78.6	91.8	93.1
Median	108.7	127.3	99.1	61.5	43.6	44	24.8	23.4	45.2	61.8	81.9	84.8
Highest daily	191.5	114	181.2	136.9	90	160.2	113.4	154.8	100.1	99	90.4	87.6
Daily Maximum Temperature (degrees Celsius)												
SPRINGWOOD (VALLEY HEIGHTS)												
Station Number: 063077 · State: NSW · Opened: 1883 · Status: Open · Latitude: 33.71°S · Longitude: 150.58°E · Elevation: 320 m												
	Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Mean	28.5	26.3	25	21.8	19.2	16	15.9	17.9	21.4	23.9	25.5	26.2
Highest Monthly Mean	31.1	28.5	25.5	23.3	21.2	17.2	17	19.7	24.3	26.3	28.3	28.3
Lowest Monthly Mean	25.6	24	23.6	19.7	17.6	14.6	15.1	16.1	19.6	21.1	23.6	22.1

Table 1: Showing monthly rainfall and temperatures at the two stations closest to the study area.

1.1.2 Hydrology

The PYWBM is included in the catchments of a number of major creeks and rivers. The Webbs Creek catchment is contained wholly within the study area, and the McDonald, Hawkesbury, Colo and Grose Rivers are all on its margins. The creeks and gullies adjacent to the shelter sites drain into these rivers. These creeks and rivers provide a permanent source of water, and would have been a significant source of food for the Darkiñung before colonisation. This would have included fish, eels, crayfish, and mussels (Kohen 1986:53; Barrallier 1802).

1.1.3 Geology and geomorphology

The research area includes the area immediately west of the Kurrajong and Burralow Faults near Bilpin, which is a part of the Blue Mountains Plateau. It continues north to the alluvial sands of the Mellong Swamps west of the Kurrajong Hinge. It includes the area east of the

Kurrajong Hinge across to the McDonald Valley, which is the western portion of the Hornsby Plateau. The area is primarily dissected sandstone plateau country, and was formed during the Triassic period (New South Wales National Parks and Wildlife Service 2009:10; 2001:13-14). The upper most rocks are of the Hawkesbury Sandstone group, which is up to 250 metres thick and consists primarily of sandstone and includes thin uniform mudstone layers and shale lenses. These shale lenses have been observed to be important for the development of deep shelters with level floor areas. The Hawkesbury Sandstone overlays the deeper Narrabeen Sandstone (Carter 2011:6-7; Jones and Clarke 1991). In some of the deeper valleys in the Bilpin area, and west of the Putty Road there are occupation shelters that have formed in the Narrabeen Sandstone. The majority of shelters in the PYWBM have formed in the Hawkesbury Sandstone. Some tertiary basalts occur as significant mountains in the area (New South Wales National Parks and Wildlife Service 2009:10; 2001:13-14). Some small areas of metamorphosed sandstone have been observed on ridge tops.

1.1.4 Vegetation

Plant communities in the study area have developed with relationships to the Western Slopes, Tablelands, and Coast creating a high diversity of plants species. There are more than 1000 species of plants, including 43 Eucalypt species. 43 vegetation communities occur within 11 floral groups. These groups are listed in the National Parks Management plan (New South Wales National Parks and Wildlife Service 2009:14; 2001:20-21) and those within the PYWBM include –

- Sheltered Hawkesbury sandstone dry forests
- Narrabeen sandstone dry sclerophyll woodlands
- Narrabeen series shale and sandstone dry sclerophyll forests
- Freshwater wetlands
- Dry rainforest
- Mellong sandmass woodlands
- Hawkesbury sandstone exposed woodlands
- Hawkesbury and Narrabeen sandstone wet sclerophyll forests and rainforest
- Alluvial and basalt herb and grass forests and woodlands
- Sandstone warm temperate rainforest
- Heaths

1.1.5 Fauna

349 species of animal are listed as occurring within the National Parks and Conservation Areas forming the PYWBM. This includes 49 mammal species, 211 bird species, 49 species of reptiles and 31 species of amphibians. The high number and diversity of species have been attributed to the diverse habitats and topology of the area (New South Wales National Parks and Wildlife Service 2009:16-17).

Feral animals such as pigs, wild dogs, goats, deer, and foxes have also been observed when travelling and walking in the study area.

2 Literature Review

2.1 Previous research

The following sections provide an overview of previous research that has been conducted in the area. Aspects of this research are discussed further in more detail during the analysis, discussion of the results, and the conclusions.

2.1.1 Habitation patterns and group mobility

Attenbrow (2004; 2003) undertook detailed analysis of rock shelters and open sites in the Mangrove Creek catchment, an area to the east of this study that is also within the Darkiñung language area. Her research was concerned with site use, group mobility, population changes, and technological and subsistence strategies. Although this work did not include any analysis of rock art (Attenbrow 2003:27) and its relationship to sites, it does include important arguments and conclusions in relation to site use patterns. Her work discussed the habitation patterns of sites, including patterns evident from the past 2000 years (Attenbrow 2003:22-29), a period that encompasses the time when most of the rock art that contributes to this research would have been created. This period includes the greatest spread of activity and corresponding use of a range of sites. Attenbrow (2004:220-221) proposed that the groups in the Mangrove Creek catchment were highly mobile moving between camps, and using them for short periods. Her proposal is based upon historical accounts from adjacent areas, however it does not explore the reasons that might have led to high mobility. This research explores the influences that led to high mobility of groups using the rock shelters. Attenbrow's results concerning occupation behaviour, and associated occupation site conditions including shelter morphology, are important considerations for the interpretation of site use as part of this research project.

Attenbrow (2004:217-227) developed a model to identify base, activity and transit camps based upon the artefact assemblages recovered from shelter excavation. She considered tool types and function, other artefacts such as faunal remains, charcoal and other sediments, and environmental and topographical influences including proximity to resources in her analysis of site function. Over time the assemblages revealed that some sites appeared to go through a number of changes in use, whilst others remained purely as base, transit, or activity camps. Attenbrow (2004:223) argued that the strategies for subsistence and the corresponding patterns of habitation were changing over time, with the

most significant change occurring from about the third millennium BP when there was a greater number of base camps used. Other sites such as transit and activity sites also increased in number during the second and first millennia. Attenbrow (2004:221-222) found that there was no clear delineation for when sites could be identified as a base camp, or a site related to other activities such as a transit site. This research encountered the same difficulties and for this reason it does not categorise sites as functionally specific due to the risk of misinterpretation of site use, and the corresponding relationship to the rock art.

2.1.2 The function of art and communication

McDonald (1994, 2008) conducted an analysis of the role of art in information exchange, and the function of style in social communication and identity. Her work is the most comprehensive yet undertaken on the role of rock art in the Sydney basin. Her research does not analyse the relationship of specific motif types with the degree of use of sites for domestic habitation. Also it did not investigate behaviour relating to motif production for the purpose of identifying sites of religious or ritual significance, and whether the context of these sites co exists with domestic habitation. However her work has been able to demonstrate a continuing tradition of contemporaneity of art and occupation sequences at a number of sites (McDonald 2008:226-228).

On the basis of this contemporaneity McDonald argued the case for a public versus private space for the role of art in the social context. McDonald (1994:157) argued that there is a good case for considering shelter rock art being art placed for the full spectrum of public viewing, as opposed to art produced for private purposes such as that engraved on the rock platforms. She also argued that with a strong case for contemporaneity, and more than 65% of art shelters exhibiting evidence of habitation through surface deposits, that there is a strong case for shelter art having a domestic function (McDonald 2008:218). There is scope for further exploration of this argument. This research analyses motif relationships with sites, both with and without evidence of domestic habitation, to determine if there are patterns that support the argument for art use for a domestic function, and to determine if there is shelter art that is unrelated to domestic activity. The ritual behaviours associated with rock art, and domestic habitation may have occurred in a shared space, at different times within a short timeframe. This research seeks extend the understanding of factors that led to shelter use, and contemporaneity of habitation with the art, and to validate the

argument for shelter art being for public viewing. It also seeks to understand whether the ritual and sacred were integrated within a public viewing context.

2.1.3 Religious centres of activity

Kelleher's (2002) research comprehensively studied depositional behaviour and the spatial nature of religious behaviour in the Blue Mountains National Park. Kelleher applied the concept of liminality as the basis for identifying religious behaviour in the material culture. By analysing artefacts his aim was to identify formal depositional behaviour that was evident outside of normal behaviour associated with the mundane (Kelleher 2002:10-11). He argued that the sequence of deposition of artefacts graduates in a formal manner from support camps to religious centres, from the mundane to the sacred centres of ceremony (Kelleher 2002:217-219). Kelleher argued that this progression is evident from the camps associated with intensive subsistence areas in low elevations, which include pigment art, representing the mundane, through to rock engraving sites at elevated locations which represent the sacred (Kelleher 2002:152-154).

Kelleher's research considered the patterns and relationships that are evident at a macro level in the landscape, and how larger ceremonial sites with their related support camps would be visible in the deposition. Kelleher's (2002:55-57, 268) argument that the religious ritual of Aboriginals is always physically separated according to degrees of religious significance, is tested as part of this research which determines if there is a shared space, or distinct separation of pigment art associated with ritual and religious significance, from domestic habitation. Kelleher does not explore this possibility within the pigment art of rock shelters. Also there is limited analysis of how the landscape might have restricted movement, and confined and shaped human behaviour, including that relating to shelter use for both habitation and cultural activity.

2.1.4 Shelter use

Sefton (1988) conducted a spatial analysis of artefact and site locations on the Woronora Plateau with the aim of understanding settlement patterns, and socio-cultural organisation. Sefton's results relating to shelter use are important for this research for the purpose of comparative analysis, and for validation of the interpretation of sites. She found that the majority of shelters that did not have a suitable floor morphology for habitation were not used. She also found that a critical factor in determining site use was a comfortable floor

area, rather than the length by width dimensions of the shelter. Those sites that did not have a comfortable floor area had no artefacts present (Sefton 1988:135-137), and were not used for habitation. This result is also evident in the PYWBM and an important contribution to the argument that most shelters were functionally important for use as overnight camps. Sefton (1988:164) also found that most shelters are only suitable to accommodate a small family group and, as evidenced by the presence of child hand stencils, family groups were not restricted in the locations of shelters they used (Sefton 1988:156-157). Her analysis was restricted by the same limitations as this research which relied upon an interpretation based upon the surface archaeology of sites.

2.1.5 The recording of art and important figures

There are no records available from the early period of contact with Europeans, or the 100 years following contact, of the meaning of the rock art from the Sydney Basin. Without having been inducted into the knowledge systems of the cultural group creating the art, there is no way to interpret its true meaning (Domingo et al. 2016). Not until more than 100 years after the arrival of the first fleet did detailed recording of sites commence, initially by W.D. Campbell and then Fred McCarthy (McDonald 2008:3).

The work of Mathews (1895, 1897, 1901, 2005) and Howitt (1996) in documenting ceremonies, and the accounts of ceremonies from Aboriginal elders on the east coast of Australia has been crucial for gaining a small insight into those beings and totemic figures that were of importance in the cosmology of the Aboriginal people. One of these accounts recorded by Mathews is of the Birbung of the Darkiñung tribes (Mathews 1897), which provides a direct record of the ceremonial figures used as part of the initiation ceremony. This record has been used to help understand those motifs recorded in the rock art that were significant totemic and spiritual beings.

2.2 A context for the research area

2.2.1 Linking site, activity and art

McCall (2010) applied content based spatial analysis to 14 sites in Drakensburg. The data sets used included shelter location, rock art motifs, and associated artefacts. He used Principal Component Analysis (PCA) for statistical analysis to identify relationships between the variables. This research project applies a different data set for analysis that includes

categorical data for site types, and elevations, and both quantitative and categorical data for rock art motifs. It also includes the analysis of pigment application techniques and sequences. It explores the relationships between these variables using multivariate statistical analysis methods that extend PCA to include categorical data.

McCall (2010:781) used 17 variables in his data set and was able to identify co-occurrence of the variables using PCA. He attempted to construct categories for social, religious and economic contexts and drew upon the previous work of Jordan (2003) in applying the concept that religious ritual was performed away from normal domestic activities. McCall (2010:786-789) argued that some sites had been selected for art because of their seclusion. This argument is considered in the assessment of sites as part of this research.

The set of variables used for this research is more suitably aligned with the research aims, and available archaeological evidence for the PYWBM. This includes the use of categorical variables for sites which considers all of the archaeological evidence, rather than relying solely on exact quantities of artefacts which may be misleading as unstable surfaces and fast sediment build-up in some sites would have quickly covered the artefacts (Bamforth et al. 2005:561-580).

An interesting measure carried out by McCall (2010:779) was to test an assumption that the accumulation of rock art at sites was a result of the duration of occupation. Regression tests revealed that there was not strong support for this hypothesis. A limitation of McCall's work is that the work was based on a small sample of only 14 sites within a single gorge, with a small number of these sites representing a high concentration of artefact types and quantities. McCall's research demonstrates an approach that if used on a broader scale with appropriate categories of data, has the potential to reveal relationships and patterns that may not otherwise be evident in the archaeology of rock art shelters.

2.2.2 Background to understanding rock shelter habitation use

The following sections include important considerations in the analysis of rock shelter use, including ethnographic records, subsistence strategies, resource availability, energy expenditure and consumption, foraging radii and mobility. It considers how the roles of sites change, and how artefact deposition can inform us about site use. These influences are

considered in conjunction with the behaviours associated with the production of the rock art as part of the analysis.

2.2.2.1 Ethnographic accounts of camp site use

Camp sites used by Aboriginal people in the Sydney Basin consisted of open sites utilising bark shelters, and closed sites using rock shelters. The degree to which each type of site was used in the area is not known, however early accounts of their use near Port Jackson indicate that both types of habitation were commonly used, though bark shelters were more likely to be used in the warmer months (Worgan 1788; Hunter 1793:45; Howe 1819).

Surgeon Worgan provides an account of shelter use around Port Jackson in 1788:

> It does not appear that these poor creatures have any fixed habitation, sometimes sleeping in a cavern of rock, which they make as warm as an oven by lighting a fire in the middle of it, they will take up their abode here, for one night perhaps, then in another the next night, at other times, and we believe mostly in summer, they take up their lodgings for a day of two in a miserable Wigwam, which they make of the bark of a tree (Worgan 1788).

John Hunter describes the use of bark shelters:

> In the woods, where the country is not very rocky, we sometimes met with the piece of the bark of a tree, bent in the middle, and set upon the ends, with a piece setup against that end on which the wind blows. These bark huts, (if they deserve even the name of huts) are intended, as we have lately discovered, for those who are employed in hunting the kangaroo, opossums, or in short, any other animals which are to be found in the woods (Hunter 1793:45).

During Howe's explorations from Windsor to the Hunter Valley in November 1819, a journey that crosses the PYWBM research area, he includes in his journal an account of an encounter not far from a swamp, approximately half way between Wheeny Creek and the Hunter River:

> ‘While skirting around the base of some hills with the horses’ he ‘fell in with a natives camp, in number of about 60, many of which have never seen a white man, and more had never seen a horse (Howe 1819)’.

The map in Howe’s journal shows the camp represented by nine pyramid shapes which are likely to be the representation of the A framed bark shelters used at open sites. An established site setup in this arrangement is likely to have been used as a base camp. It is unlikely that such a camp would be setup for a short stay, given the energy expenditure that would be required to establish the camp (Kelly 1995:139). Howe (1819) also describes the country as ‘very fine land with gentle hill and dale, and thinly timbered’. Given the description of the camp with the number of residents, the nature of the country, and proximity to the swamp, it is likely to have been a base camp from which the occupants would have departed from, and returned to after daily hunting and foraging excursions. This together with the ample evidence of habitation found in shelters indicates that both types of camp were used in the PYWBM.

When considering the accounts of Howe (1819), Parr (1817) and Singleton (1818) on these first expeditions which traversed a large part of this research area, there is only one recorded encounter of an open camp where bark shelters were used. The explorers followed what would have been major travelling routes through the country. This may indicate that bark shelters were mainly being used in the area as part of large open camps, of which there were very few at the time, or it may be the case that the explorers did not think it was worth mentioning the existence of isolated, or smaller numbers of bark shelters when they encountered them.

There are very few rock shelter sites in the research area that would comfortably accommodate the number of inhabitants encountered by Howe. The large majority of shelters would only suit a single family unit or a small band of people. Koettig (1976:157-161), referring to ethnographic accounts of Aboriginal use of rock shelters in Arnhem Land and Cape York, indicates there was a preference for camping in open sites, and argued that the reason for this was for communication and interaction within groups larger than single resident groups. She found that rock shelters were limited in their suitability as campsites and habitation sites and would normally only have provided for a single small group

engaged in a specific activity. She found that larger open organised sites were the most often used.

Ethnographic research by Gargett and Hayden (1991:11-32) on a Pintupi encampment in the Western Desert identified a number of important relationships within the group that influenced the living arrangements and the proximity of residences to each other. They found that family relationships were the most important both economically and socially, with son in laws required to substantially provide for their partners parents as they aged. There was a strong ethic of sharing and working in collaboration between brothers, and brothers were found to live in closer proximity to each other than any of the other relationships in the extended family. Sharing which is an important requirement for survival occurred along the primary kin lines, and this is reflected in the living arrangements and the proximity of people to each other (Gargett and Hayden 1991:28). Howitt (1996:774-775) also recorded the arrangement of camps from verbal descriptions he was provided that indicate the extended family, including the immediate relations of the husband, and the wife's parents, were closely positioned to the camp of the husband and wife for both the Kurnai, and the Wurunjerri peoples. The influence of sharing and kin relations on camp structure has also been described for other hunter gatherer populations including the Hadza of northern Tanzania (O'Connell et al. 1991), the !Kung of the Kalahari Desert in Botswana, and the Ache of Paraguay (Gould and Yellen 1987).

Bird et al. (2012:75) found that among the Martu, working in cooperation, sharing and generosity were important for gaining social influence, status and power within the wider group, behaviours that could not be maintained if families or individuals were isolated from the larger group for very long. The importance of living in close proximity was required to maintain the social structure and relationships, and for economic cooperation. For such living arrangements to exist, there is a requirement for groups to come together at larger camps that would support more than a single family unit. Rock shelter habitations would not be suitable for providing for these larger groups, together with their required social interaction.

A large part of the PYWBM is comprised of steep sided ridges with narrow gullies and rocky gorges. The gorge and gully country would be unsuitable to support large open camps such as that encountered by Howe, and the ridge tops which can provide large flat areas to camp,

would not have the water available to sustain a large group for very long. It is expected that only the broad valleys, larger creek systems with adjacent flat areas on banks, and the swamp country could sustain an open camp, and a group of the size encountered by Howe. Such conditions were also identified as key requirements for base camps on the Cumberland Plain (Kohen 1986:302-305). The environmental and geological conditions in a large part of the PYWBM would constrain camp and group size. Unfortunately there is very low visibility of open sites in the research area. Evidence of open sites such as lithic scatters would be quickly reclaimed by the bush and covered by leaf litter and sediment.

Rock shelters would have served as habitations for small groups at times when they were away from the larger camps. When considering the need for the provision of care, and responsibilities of providing for extended families, these duties could not be left unattended to for very long, so the use of shelters is likely to have been short term. Surgeon Worgan's (1788) account of shelter use indicated that a group would take up shelter in a cavern for the night, and then move on. Rock shelters may have also had greater use from those in the group that had less responsibility and greater independence such as single males, also those on extended foraging or hunting trips, and when small groups were travelling through the country.

2.2.2.2 Daily movement to resources

Strategies employed by hunters and foragers to exploit resources include moving to where resources are present, and moving the resources to where people will consume them (Binford 1980:5-10). Hunter gatherer populations will normally employ a combination of these strategies to exploit resources (Sapignoli 2014:41; Attenbrow 2003:28). Foragers that move to resources and obtain their requirements on a daily basis, have limited processing, logistical and specialised sites (Binford 1980:5-10). There is little evidence of logistical or specialised processing sites within the PYWBM, including a very low occurrence of seed grinding areas, suggesting that the population mostly moved to the resource and processed them at the source location.

2.2.2.3 Foraging and energy expenditure

Economic factors such as energy expenditure also influence the duration of site use. The distances that groups travel to forage depends upon the resource requirements and availability. Resource abundance results in small foraging areas (Moore 1981:215),

conversely limited resources would have required larger foraging areas and more frequent movement. Cordain et al. (2000:687-690) found that hunter gatherer subsistence dependence is divided between gathering, hunting, and fishing. More than 50% of subsistence is provided by animal foods. Animal foods provide a greater capture of energy to expenditure ratio than plant foods. The energy provided by foods is relative to the percentage of fat, the greater the fat, the greater the energy. Larger species have a greater energy mass and would be the preferred option when they were available. Larger game are more mobile and require long range search and pursuit and are often hunted using the 'encounter' method (Bird et al. 2005:450). Populations in the research area would have foraged in smaller radii for plant and small animal species (Bird et al. 2005:454) and in order to obtain the higher energy yielding animal foods hunters would have ranged over larger distances.

Energy expenditure influences the size of the foraging radius. Difficult terrain has an impact upon the net returns from foraging areas. If traversing the terrain for both foraging and moving to another camp expends a lot of energy, then the group should move camp after exploiting a relatively small foraging area (Kelly 1995:138). Kelly (1995:138-139) provides an extreme example where if the effort of moving through country, and foraging, expends 5020 kilojoules in an hour, then a group should move to another camp after foraging the area within 2.25 kilometres from the original camp. Energy expenditure and consumption requirements are considered for the PYWBM together with shelter availability as part of the analysis of group mobility. Also considered is how unnecessary movement can be restricted and how this influences both domestic and cultural behaviour.

2.2.2.4 The changing role of sites

Sites used previously as camps may take on another role once the group has moved to a new camp. This might include a temporary rest, shade, transit camp, or a hunting camp (Binford 1983:360-362; Schlanger 2013:99). The activities carried out at sites would not remain static. The role of a site and the activities performed there were often related to the economic potential of the site at a given time (Binford 1983:360-369). See Spertzel's (2005) analysis of the Facing Monday Creek Shelter in southeast Ohio. Activities carried out at a site may also change with adaptations correlated to seasonal changes (Binford 1983:360-369; Schlanger 2013:99). For example a south facing shelter may become more habitable during

the warmer summer months, or a gully shelter may be inhabited for longer during the eeling season and have a corresponding increase in the activities performed there.

2.2.2.5 Artefact deposition

Given the lack of logistical and specialised sites, groups would have moved to resources on a daily basis and would have occupied sites for short periods. The use and discard of tools at camp sites would have occurred at a low rate compared with logistically organised groups (Binford 1980). This would result in small accumulations of artefacts at sites and minimal visibility in the archaeology. Complex, and larger accumulations would be expected at sites used for longer periods as residential bases (Binford 1980:10-19; Nelson 1991:82-83). Cardillo and Alberti's (2013:1-12) analysis of artefact manufacture and raw material deposition, together with habitation patterns along the San Mat´ıas Gulf coast of Argentina, using Evolutionary Ecology theory, found that more 'sporadic' occupation, and the presence of lower diversity of tool types, and raw materials, is reflective of greater risk associated with low resource availability. This risk results in lower rates of re-occupation of the sites. They found that in areas of lower risk, where resources are plentiful, there was a higher rate of repeated habitation which led to greater diversity of tool types, raw materials, and discard rates (Cardillo and Alberti 2013:3-9). The assemblage revealing the association of the deposits from the different activities and occupations (Binford 1983:363-368).

A limitation with using artefacts for understanding the intensity of site use and the range of activities is that artefacts and archaeological deposit are often not visible. The floor deposits in many shelters are active, they are being built upon by the deposits from active weathering processes (Lambert 1980:31; Johnson 1974:533) within the shelters, and being moved by wind, and shifted by animal activity such as burrowing wombats, and macropods seeking shade. The rates of sedimentation build up or movement are fast in some shelters, and the evidence of previous occupation would have been quickly covered. Artefacts will only remain on the surface of a stable floor (Bamforth et al. 2005:572) and along the drip lines where there is a suitable concentration of drips imposing upon and exposing the edge of the deposit. For this reason the research relies upon a combination of archaeological evidence for the purpose of understanding site use. It does not focus on artefact quantities on the surface, rather it analyses the characteristics of artefacts to determine the types of behaviour associated with these characteristics. Artefact deposition may result from

reduction activity during the manufacture or repair of tools, or it may result from the discard of tools due to breakage (Nelson 1991:79), or loss, or the tool may no longer be required. When assessing shelters for the purpose of use as camps for multiple days, the presence of a single artefact is not considered in the assessment. Single artefacts may be the result of opportunistic behaviour (Nelson 1991:65-66) unrelated to planned or expedient behaviour that would be carried out when people camped at a site. Repeated planned activity at residential camps would be evident in multiple sequences of deposition. Raw material sourced or traded from different areas and brought to the same site for reduction, maintenance or use, represent a repeated pattern of planned activity related to the site. Evidence of reduction debris from the manufacture or repair of tools is evidence of 'downtime' (Nelson 1991:79; O'Connell et al. 1991:69-73) from other activities at the site. Debris from reduction and flaking for tool manufacture is more likely to be present at residential sites (Binford 1983:363-368; McDonald and Veth 2006:99), whilst sites with a more limited function are likely to have debris from broken tools (Kohen 1986:303-307), and there should not be debris from the reduction of primary cores, but from cores prepared to produce immediate flakes (Nelson 1991:82-83).

Signs can be found within the surface archaeology that provide an indication of the most recent use. Heat affected rocks near fire hearths are slow to recolonise with lichens in comparison to similar rocks outside of shelters, and provide a good indication of recent use. Deposits in shelters with a high percentage of charcoal inclusions, and the presence of other artefacts in the surface layer are a good indication of the most recent phases of use, when they are uniformly spread over the surface of the inhabited space.

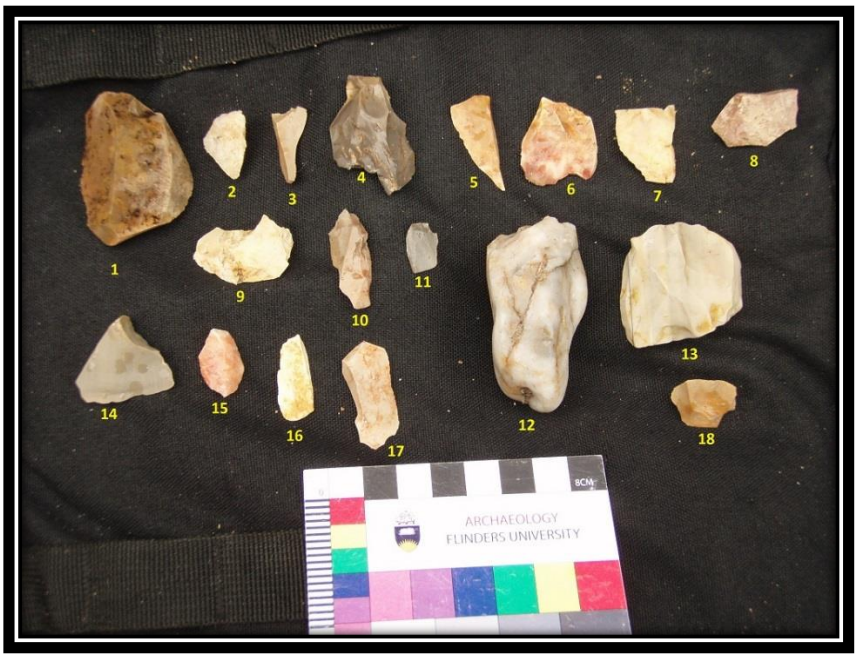

Figure 2: Artefacts including flakes, flaked pieces and cores from the Sedge Seed Shelter, showing a range of raw materials sourced from different locations.

2.2.2.6 Continuity of site use

The results of excavation work done by Attenbrow (2004:229-231) revealed that once a base camp was established, it continued to be used as a base camp over the millennia, even when new base camps had been established in the Mangrove Creek catchment, with only one example of a base camp showing evidence of less intensive use as an activity location. The results indicate a level of continuity in site use once a site was established. A site that exhibits a more complex range of artefacts representing more intense levels of use as a habitation, is likely to have maintained its use as this type of site. Attenbrow also found that in the last millennia there was the most widespread and greatest number of sites used in all topographic zones, including transit and activity locations. Those sites used less intensively as activity locations rather than residences, are likely to have maintained their role, and increased in their number throughout all topographic zones.

2.2.2.7 The Perception of Space

Galanidou (2000) conducted an analysis of the use of space in rock shelters by both foragers and horticulturists in New Guinea, South Africa and Australia. She suggests that people adapted to the space on the basis their perception of space, rather than the spatial constraints. Galanidou considers the structured arrangement within space to be according to the attitudes and beliefs of the groups utilising the space, and that this arrangement

provides a cultural signature that archaeologists can use in the broader assessment of intersite patterns, and to understand intrasite variability. Her analysis was conducted on 35 sites used by ten different linguistic and cultural groups. She assessed the location of hearths, refuse, sleeping, and activity areas.

For this research Galanidou's concept of the perception of space was extended to consider rock art, and how the location of art might represent the perception of space. Focussing on shelters as discreet units of occupied space can potentially restrict the interpretation for how a broader occupation space might have been used. The landscape that immediately surrounds the shelter might also be inhabited when the conditions are suitable, and the artefacts that remain in this zone can represent this use of a broader space.

A comparison of pigment art sites in the PYWBM with a cluster 19 art sites at an area open to the public at the King Edward River crossing in the Kimberley shows a significant difference in the positioning of art relative to the occupation shelters. 66% of King Edward River art occurs on the rocks in the vicinity of the occupation shelters, with the remaining 34% occurring within the occupation shelters. This contrasts with 3% on surrounding rocks in the PYWBM and 97% within the occupation shelters. The difference in the two landscapes might have been a factor that influenced a different perception of the available space and how it was used. The gentle open country immediately surrounding the King Edward River shelters encourages the habitation of the broader surrounding space. People would not remain confined to a shelter during times of occupation when the landscape afforded a larger space to occupy, particularly during times of favourable weather. It is suggested that the art outside of the occupation shelter is representing the perception of this broader occupied space. The steeper and more rugged country of the PYWBM does not afford a broader habitation space as in the case of the King Edward River. The differences in the presence of the art are the cultural impressions remaining of how space was perceived and used. In the PYWBM the confines of the shelter were perceived as the available space for cultural and domestic activity.

2.2.3 Background to the interpretation of the rock art

For an analysis of the art, its antiquity needs to be understood, together with its role in Aboriginal culture, and the behaviours associated with its production.

It is also important to understand what the results of existing research in the Sydney Basin can tell us about the relationship between the art and the occupation sequences in shelters and whether this indicates a relationship, and an integration or separation between the two.

2.2.3.1 Antiquity of the art

The rock art of the Sydney region is assumed to have been created within the last 5000 years (McDonald 2008:1). I argue that most dry pigment art in shelters is very young and was created during the immediate past prior to contact with Europeans, and then for a short period following contact. The maximum age for dry pigment is unlikely to exceed 400 years. This is based upon observations in the field that demonstrate the rapid deterioration of dry pigment art in shelters that are protected from the weather. Figure 3 shows the condition of a dry pigment line drawing interpreted as bovines due to the four legs and horns, from a shelter not far from the McDonald Valley, one of the first places settled for farming outside of the immediate surrounds of Sydney. The valley and tributaries were settled by 1840 (Sim 1969:145).

Figure 4 shows a drawing that has been interpreted as a horse and related to early encounters of the first explorers with the Darkiñung when travelling on horses in the area. Figure 5 and Figure 6 shows early European graffiti with a date of 1848, together with more recent graffiti, and a superimposed white fill drawing over the graffiti that was possibly drawn by Aboriginal people after the initial European visit to this shelter. From these images the condition of the dry pigments can be seen to have significantly deteriorated in a period of 168 to 197 years and is unlikely to survive another 100 years. Comparisons with other dry pigment drawing in the PYWBM indicate that most dry pigment drawings represent the immediate past including the period of 100 years leading up to, and for a short period following European contact.

Figure 3: Drawings of bovines in a shelter near McDonald Valley

Figure 4: The Horse Cave in the Mellong Swamps. A faint white hand stencil on the right provides an indication of the scale of the drawing.

Figure 5: Early European graffiti has a nearby date of 1848 drawn. A faint white fill drawing is superimposed over it.

Figure 6: Original graffiti from 1848 in the upper left showing deterioration, with more recent graffiti in the centre.

2.2.3.2 The relationship of art and totems

Aboriginal rock art is not to be understood in the Western cultural and academic view of art as simply a cultural object important for the preservation of a past way of life. To Aboriginal people they are images vital for life, from which all life is dependent upon. It is not separate from who and what they are. They are images that show how the creator made the world and they must be maintained to bring increase and renewal to all things (Mowaljarlai et al. 1988:690-693).

In order to interpret patterns within the art and what they might reveal, there is a need to consider ethnographic accounts of what art motifs meant to the artist and audience. Ethnographic accounts indicate that there is art that does not have special meanings, and there is art that has sacred meaning relating to ancestral and creation beings, and totemic spirits (Gunn 2003:54-55; Blundell and Woolagoodja 2012:473-476; Layton 1985:434-439). Some art contains sacred messages that are read by the people of that country (Mowaljarlai et al. 1988:691; Smith 2000). In totemism a person, or group, and the natural species share in the same life. The totem is the symbol of this common shared relationship. It symbolises the ancestral being or culture hero that is celebrated and respected, and for which species people are responsible through ritual practice for increase of this species, and maintenance of the normal sequence and order of nature. In return the totem brings strength, knowledge and help, and acts as a protector (Elkin 1974:227-228). The native species embody the spirit of mythic beings, and it is considered that all animals of this particular species embody the spirit. The mythic beings may be found in the shelters along the routes they travelled or created (Berndt 1974:9-14). The presence of totemic beings at a site can signify its creation by this being, and indicates ownership of the site by the group for whom the totemic relationship exists (Layton 1985:437).

For the purpose of understanding motifs likely to have represented significant totems, this research relies upon the last and only documented description of a Darkiñung initiation ceremony recorded by R. H. Mathews (1897:2-3). Mathews recorded a number of species that are likely to have represented the Darkiñung totems, including emu, wombat, possum, kangaroo, snake, echidna and lizard motifs that were carved in trees and the earth. There was also representation of a huge Dharamulan, the size corresponding to the importance of

this figure. Berndt (1974:27), Elkin (1974:281), and Mathews (1904:340-345) noted great significance of both the culture heroes Biaime, and Dharamulan.

2.2.3.3 Art renewal and increase

Renewal may involve both repainting old images, and producing new images (Sale 1992:85). It is a way of caring for the country and for the ancestral beings resident at the sites (Blundell and Woolagoodja 2012:480; Mowaljarlai et al. 1988:690-696). Ethnographic accounts from the Kimberley indicate that maintaining and renewing motifs ensured that the conditions of the seasons, and the continued reproduction of the plants and animals would be maintained. Renewal promotes the cycle of the renewal of life through the practice of increase rites (Elkin 1974:223-224). The images are seen as something that maintains all of life (O'Connor et al. 2008:29). Some accounts have recorded that the artist renewing and repainting the motifs believe that they are the spirit or ancestral being (Lommel 1997:18-19, 53; Porr and Bell 2012:198), the separation of subject and object no longer exists. The ritual act was a way to connect with the spiritual being (Berndt 1974:15), the act was the realisation of the being.

The Arunta people of central Australia also conducted ceremonies associated with totems that was for the purpose of increase of the species associated with the totem. A unique ceremony is performed for each totem (Spencer and Gillen 1927:145-147). Accounts of these ceremonies all entail the use of painted or drawn symbols applied on rock faces, the earth, and on the bodies of participants. The painting of the symbols is included as an integral part of the performance that also includes chanting, dancing, and bloodletting. On occasions the participants return to specific rocks and repaint the images as a part of the new ceremony (Spencer and Gillen 1927:145-173).

The practice of producing bi-chrome outlines of drawings, as well as re-shading fill drawings in the PYWBM is argued to have been part of this process of renewal. Outlining and re-shading the fill of drawings has been identified as an activity carried out after the initial drawing. As can be seen in Figure 7, Figure 8, Figure 9, and Figure 10 the earlier black pigments that were applied have faded significantly. The white and red pigments have been applied at a later time, sometimes extending beyond outlining to include re-shading the fill of the image. Some motifs exhibit at least three sequences of redrawing. The extent of redrawing of images in a single colour is difficult to detect with the naked eye, however it is

quite likely that the redrawing of images was not restricted to the obvious bi-chrome drawings.

Sites that exhibit renewal of the motifs include art that was significant to the cosmology of the inhabitants including culture heroes, macropods, and birds. It also includes anthropomorphs and humans with raised hands, often perceived to be in dance.

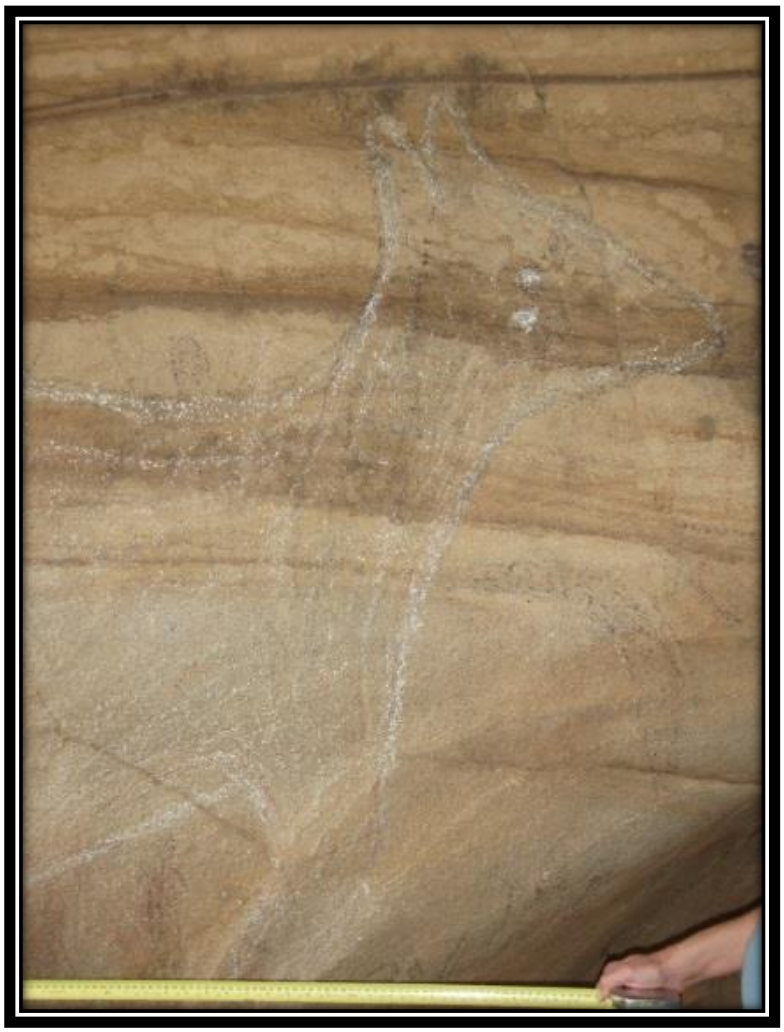

Figure 7: Kangaroo motif with white outlining and fill applied over the top of a barely visible red outline, and the original black pigment.

Figure 8: Culture hero with faint remains of the original black pigment overlain with white hand stencils, followed by the most recent white outlining and partial shading of the fill with white pigment.

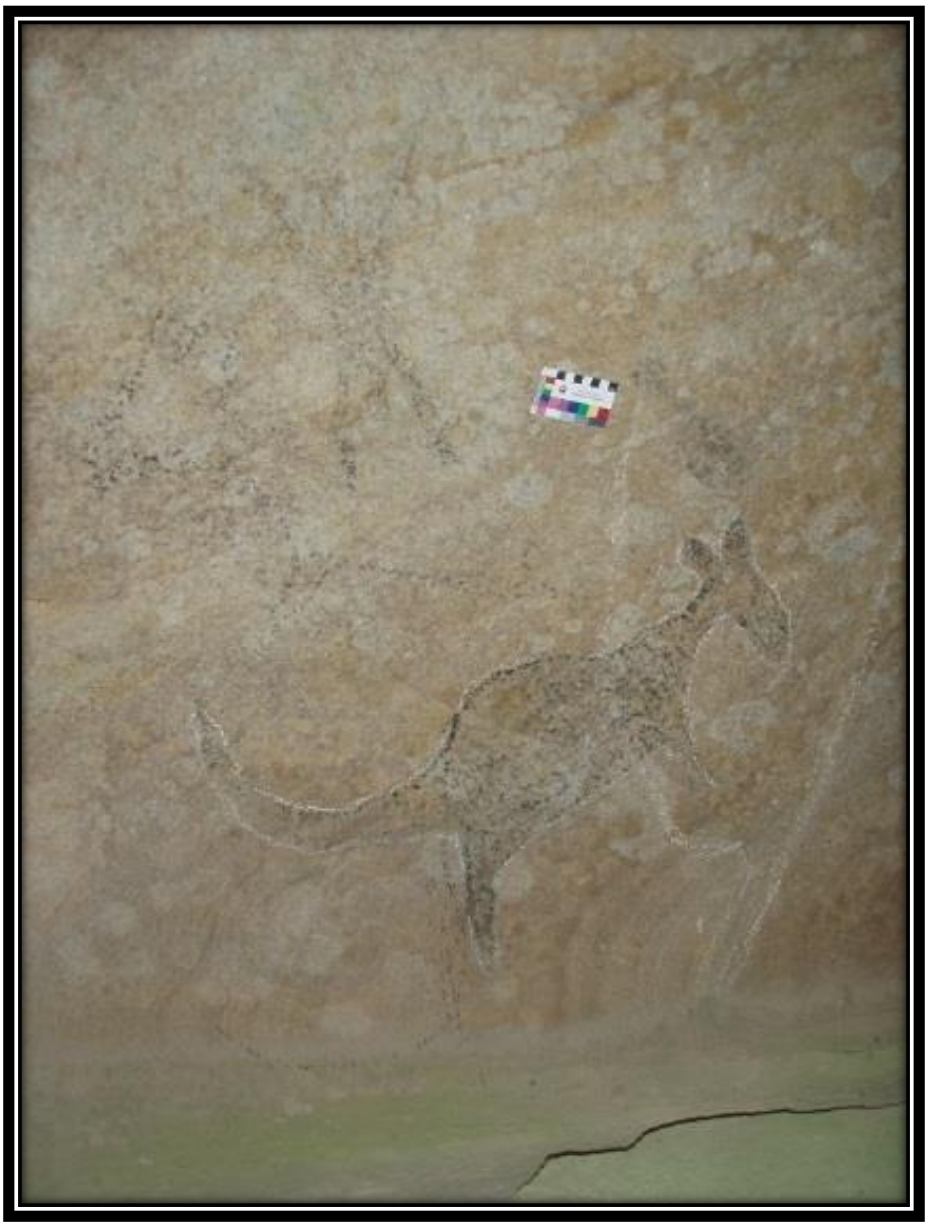

Figure 9: Kangaroo with black pigment outlining, followed by white pigment outlining, applied at a later time.

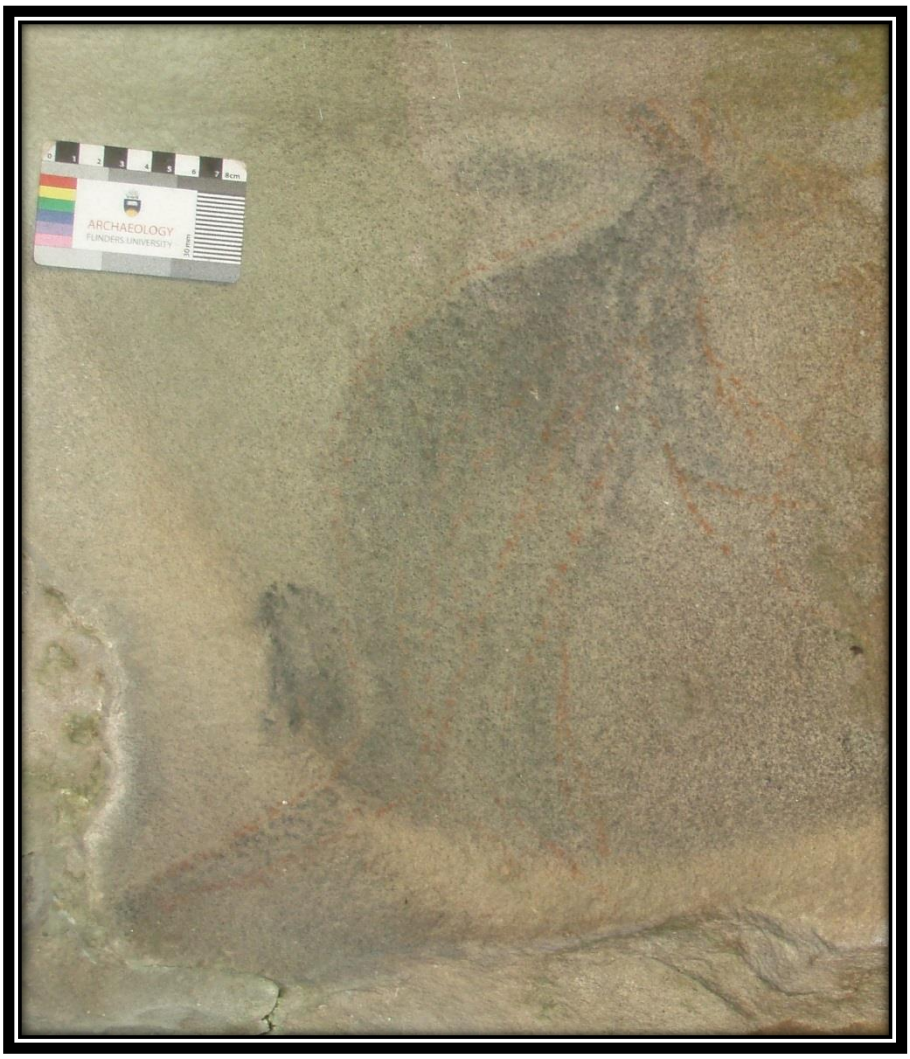

Figure 10: Kangaroo with red pigment outline and fill superimposed over the earlier black pigment.

2.2.3.4 The association of art with public viewing

McDonald (1994:157) argued that there is a good case for considering shelter rock art being art placed for the full spectrum of public viewing, as opposed to art produced for private purposes. McDonald's finding from the assessment of 214 art shelters was that 20% had no occupation deposit due to sloping rock floors (McDonald 1994:203). This morphology is unlikely to have been suitable for overnight habitation, people are unlikely to sleep on sloping rock floors. They are sites likely to have been used for short term activity that did not involve overnight camping, and may not have involved normal domestic activity. It is questionable whether these sites were designed for the full spectrum of public viewing. They may have been used by a smaller and perhaps more specific audience. An analysis of rock art from these site types may reveal a corresponding change in the motif range used.

This research considers the presence of a correlation between rock art and both habitation, and non-habitation to test McDonald's argument.

Sefton (1988:85) found that rock art was present in 83% of the rock shelters studied. This number represents a similar percentage to this research with rock art represented in 78% of shelters. Sefton also found that art was often located immediately adjacent to the living area in shelters (Sefton 1988:133-134), rather than segregated from domestic areas that might indicate a specialised purpose. Other important findings were that most shelters had a small living area of less than 10 square metres, indicating use by small groups such as family units. Use by family units was further substantiated by the presence of stencilled hands of children present in sites representing the full range of site locations and environments (Sefton 1988:156-157). These results indicate a strong association of art with habitable shelters, the domestic, and with family groups which supports McDonald's assertion for art available for public viewing. Sefton (1988:133-135) found that 9% of shelters have a no living area which closely aligns with findings from this research which was found to be 7%. As part of this research, the examination of the art at these sites looks for evidence of a difference to the art that is associated with domestic habitation sites.

2.2.3.5 Contemporaneity of rock art with shelter occupation

McDonald (1994:112-126) considered the relationship between art and occupation sequences. She acknowledged the difficulties in making a link between occupation stages at sites and the timing of the production of art. At some sites occupation sequences occur before or after the production of art, and additionally there may be multiple sequences of either occupation or art production with a single phase of the other. However, McDonald (1994:127-156) was able to demonstrate contemporaneity of the art and occupation phases for four shelters she excavated. She related the art production sequences to occupation by including a range of archaeological evidence at the sites, including carbon dating. McDonald also assessed the archaeological reports for a further 18 sites excavated in the Sydney region and was able to infer that art was created during the most intensive occupation sequences for these sites. Understanding contemporaneity of art with occupation at sites indicates that the art was not disassociated with domestic habitation.

3 Methods

3.1 Introduction

This chapter describes the methods used. The methodology aims to identify how rock shelter sites were used by assessing their characteristics, archaeological evidence, and position in the landscape, and taking into consideration inputs from a range of international research carried out relating to hunter gatherer land use. On the basis of this analysis, categories are assigned according to the differences in site use. These categories are then analysed with the art motifs present to determine if there are distinct patterns showing a correlation of the art with the shelter categories. This chapter describes the source and type of data used, the methods used, including methods that have not previously been used for archaeological research, the statistical methodology, method for the analysis and categorisation of rock shelter sites, and the methods of rock art analysis for identification of behaviours associated with the production of art.

3.2 Site Data

The site data for the rock shelters was collected over a period of more than 12 years during frequent bushwalking in the PYWBM. The location of the shelters is shown in Figure 11. Most sites were recorded on the site cards used by the National Parks and Wildlife Service and submitted for recording in the State Heritage Database.

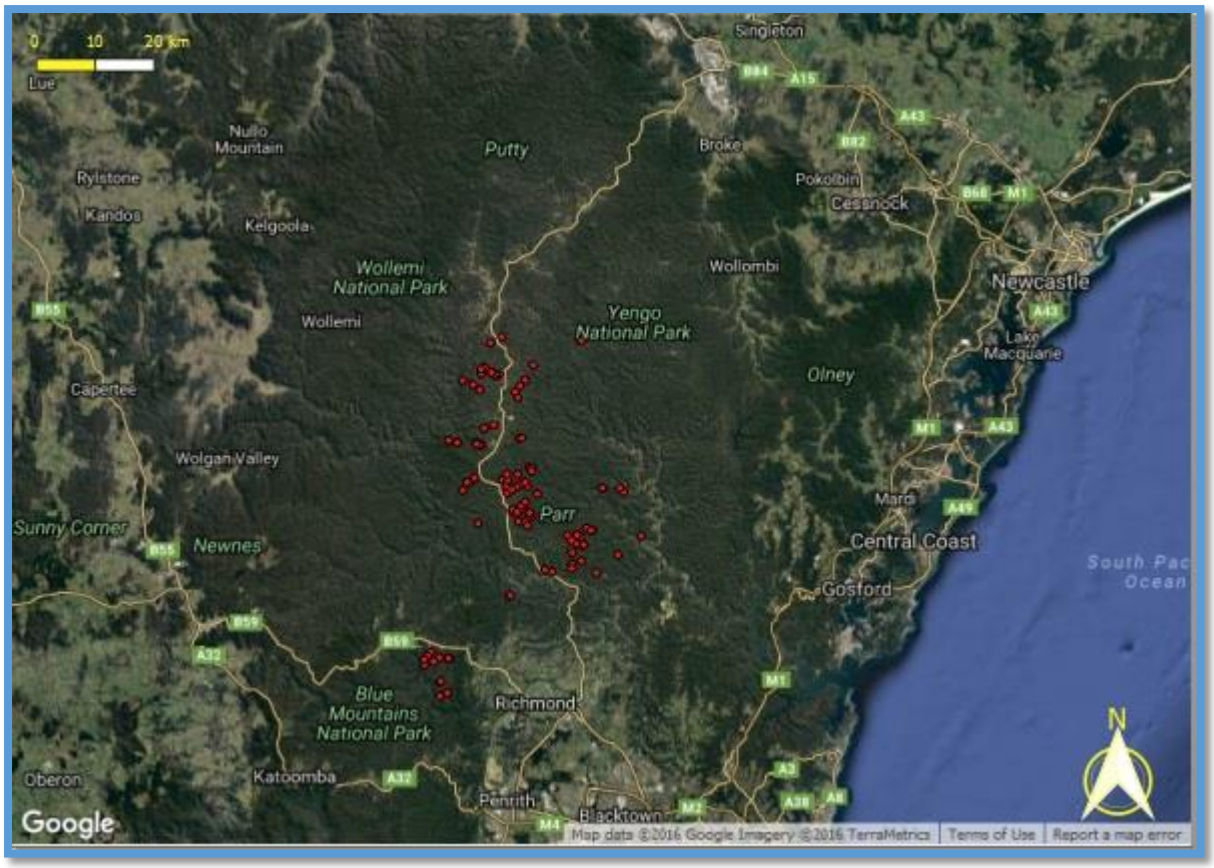

Figure 11: This image shows the site locations in red.

A small number of sites included in the analysis had been previously recorded by others. Photographic records were used to assess the characteristics of the floor morphology, artefact materials, evidence of fire hearths, ground surfaces, and the presence of archaeological deposit. They were also used for detailed analysis of the art. When the photographic records were found to be inadequate, some sites were revisited to collect the required data.

Some sites did not include rock art however they were included in the research in order to provide a holistic perspective of shelter use and to prevent any bias in the categorisation of shelters. These shelters were considered important for comparative analysis with sites that did include art. For example some of the sites that exhibited evidence of the most intensive habitation use do not have suitable surfaces for rock art. However they were important for considering in terms of their location and morphology and for using this detail for comparative purposes with art sites to determine if some art sites were also likely to have been used as habitations.

The site data considered as part of this research included –

- The dimensions of rock shelters including the length, width, height, and floor area.
- Floor composition and levelness.
- Location in terms of position relative to resources, major features, and accessibility to and from the site.
- Type and quantity of motifs per shelter.
- The presence and quantity of outlining and redrawing.
- The presence of archaeological remains including artefacts, grinding areas, fire pits, and archaeological deposit.

3.3 Methods not previously used

The research applied methods that have not been previously used. This included the use of morphology for comparative analysis to determine habitation probability. This method is described in the *Shelter site categorisation* section. It also uses observed visual and physical changes to sandstone that result from heat as an indication of the presence of fire hearths. This is described in the *Identifying fire hearths* section.

3.4 Statistical methodology

Statistical analysis is used to assess categorical variables for site habitation intensity, and site elevation zone, with the presence or absence of rock art motifs. For this purpose Multiple Correspondence Analysis (MCA) is used. The analysis also assesses the combined categorical variables for sites, with the quantities of art motifs. For this purpose Multiple Factor Analysis (MFA) is used because of its ability to analyse the different variable types together. The art motifs were assessed for the presence of correlations and relationships within the motifs and for this purpose Principal Component Analysis (PCA), MCA and MFA were used.

All methodologies were applied using the R language and environment which has been developed specifically for statistical computing (https://www.r-project.org/about.html). Version i386 3.2.1 of R was used together with the R packages FactoMineR and ggplot2. FactoMineR is a package designed to perform multivariate analysis (Husson et al. 2015:1-95) using a range of different variable types including categorical, qualitative and quantitative

variables. It sums the data with the aim of reducing the dimensionality, and provides a graphical representation of the results (Lê, Josse and Husson 2008:1-2).

MCA is a method used to analyse the categorical or qualitative information contained in a data table and presents the results visually (Husson and Josse 2014:163). It allows relationships of dependant categorical data to be analysed (Abdi and Valentin 2007:251).The objective is to understand similarities and associations between variables and their categories. The data contained in rows of the table forms a cloud of individuals (Husson and Josse 2014:163). The categorical data for each of the variables is coded by the R program, as a binary variable, as zeros and ones and in various combinations of zeros and ones. The content of the data table is changed to be completely composed of columns of binary data (Abdi and Valentin 2007:652). The data is then subjected to the algorithms used by MCA. MCA applies a numerical procedure for reciprocal averaging and dual scaling. It uses the Chi-square algorithm that is applied in Correspondence Analysis and extends its application to a larger set of variables (Greenacre and Hastie 1987:442-443). MCA converts a matrix of data and presents the result in a geometric display 'showing the rows and columns as points' (Greenacre and Hastie 1987:437). The geometric shape of the cloud is analysed to understand the shape, direction and distance between individuals (Husson and Josse 2014:164-165). Individuals represented geometrically as points will be close to each other if they respond in the same way to a significant number of questions. They will not be closely spaced if they do not respond in the same way. Individuals alone are not sufficient for interpreting the graph. An analysis of the position of the categories, which are positioned at the barycentre, or average position of individuals within the category, is necessary (Husson and Josse 2014:163-9).

PCA was applied to the quantitative variables. It was created in 1901 by Karl Pearson and further developed by Hotelling in the 1930s. PCA is a process that is based upon a linear modification of a data set into a system of coordinates (Hoffman 2010:1). The object of PCA is to decrease the dimensionality of the data set for a significant number of connected or related variables while at the same time keeping as much of the variation present as possible (Jolliffe 2002:1-7). PCA has been shown to exhibit great versatility and capacity to be used in a number of different scientific contexts (Araujo-Andrade et al. 2012:25-44). One of the strengths of PCA is that it enables categories with more than three variables to be

visualised, that would otherwise have to be seen in more than three dimensions. PCA performs an orthogonal rotation of the variables whilst maintaining the original structure of the data, and provides an easy way to visualise the information contained within the data (Monfreda 2012:49). Using the PCA function in FactoMineR provides a range of information to assist with the interpretation including lists of eigenvalues, the variance of each component, and cumulative variance (Anderson 2013:1-9).

MFA was carried out to analyse a combination of categorical and quantitative variables. It was developed by Brigitte Escofier and Jerome Pages (Abdi et al. 2013:1-2). MFA extends PCA, and MCA to accommodate the different variable and data types. MFA normalises the data by dividing all of the elements by the value of the first principal component thereby ensuring that no data group dominates because of its inertia. MFA is used when there are a range of different variables measured during the same type of observation (Abdi et al. 2013:2), such as the data sets recorded for art sites. For each data table, all the variables are first normalised, the tables are then combined into an overall table and then PCA is applied to identify the principle components (Abdi et al. 2013:2). MFA provides a graphical representation of the coordinates, contributions of individuals, correlation of variables, and coordinates for the centre of gravity of individuals belonging to categories (Pages 2004:5-6).

3.5 Shelter site categorisation

3.5.1 Shelter site assessment

For the purpose of categorising rock shelters on the basis of use, and the functions that they served, sites and their position in the landscape were analysed with consideration of ethnographic accounts (Worgan 1788; Hunter 1793; Howe 1819; Parr 1817; Singleton 1818); the economics of site use including energy requirements to access shelters and resources, taking into consideration paths of least expense (Kelly 1995; Winterhalder 1981; Nelson 1991; Binford 1983, Morgan 2008); the effect of persistent places in the landscape and how they influence movement and landscape use (Schlanger 2013); artefact deposition and complexity (Binford 1980, 1983; Cardillo and Alberti 2013; Nelson 1991, Kohen 1986:303-307); social responsibilities and group dynamics that influence camp location and behaviour (Gargett and Hayden 1991; Howitt 1996; Memmott 2007; Binford 1980; Britt Bousman 1983), and reduce risk (Hill et al. 1987); and prior research of rock shelters in the Sydney

basin (Attenbrow 1987, 2003; McDonald 1991, 2008; Sefton 1988). The analysis also considered the constraints imposed by shelter size and morphology.

Sites were positioned on 1:25000 topographic maps. The available archaeological evidence, and shelter morphology was then considered for each site in conjunction with the location in order to assign categories previously used by Attenbrow (2003) including base camps, transit camps and activity locations. It considered if logistical sites were present (Binford 1980, 1983), and categories of site according to Brush's (2006) time function dependent and space functions model. The intention was to identify, and then assess functionally specific sites with the rock art motifs for evidence of patterns that exhibit different behaviour. As a result of the analysis, the intended categorisation of functionally specific sites was changed to be based upon degrees of habitation intensity. The analysis leading to this approach is articulated in the Discussion section.

3.5.2 Shelter morphology

This research adopts the approach that the morphology of a rock shelter, and the location of the rock shelter in the landscape influence and constrain those activities that would be performed at the site. The conditions within the environment would have applied pressures upon the behaviour of the occupants (Bleed 1986:89), constraining the domestic and cultural activity.

Through a combined analysis of the shelter morphology and available archaeological evidence, four categories of shelter are used representing the range of habitation intensity, from no habitation to low, medium and highly intensively used habitations. The intensity of use considers the range of activities performed at the site together with the depth of these activities over time as represented by the presence of sequences, including episodes of stone tool reduction, grinding, and campfire use. Sites conceal archaeological evidence that would only be revealed through excavation. Without the use of excavation, the methods needed to consider a range of surface evidence together in order to assign categories on the basis of the intensity of site use.

For some sites the only obvious evidence of their use is the presence of rock art, however there are other factors evident in the site that can reveal past behaviour. This includes the condition of the site in terms of its shape, position, and general condition such as dryness,

living area, protection from prevailing winds, and absence of loose rocks that could dislodge and injure the inhabitant. As part of this study, nineteen rock shelters that did not have art, had archaeological evidence of sequences of occupation and it was found that all 19 of these shelters included a sediment area of the floor that is flat, or deep enough to be easily moulded into flat sleeping areas, and is dry. In addition, all of the shelters with rock art that show clear evidence of habitation include the same morphology. Sites that do not include this morphology do not have any evidence that they were used for habitation. Both McDonald (1994:203) and Sefton (1988:135-137) found that shelters without suitable floor living areas also did not have any evidence of use as habitations. McDonald (2008:56) found that from a sample of 214 shelter sites assessed, 20% had sloping floors and definitely had no occupation deposit. The use of suitable shelter floor morphology as an indicator of probable habitation is further validated by the results of Attenbrow's (2004:77) work in the Mangrove Creek catchment which identified eight rock shelters with art, but with no other archaeological evidence of habitation on the surface. These shelters had suitable floor living areas likely to have been used for habitation. When they were excavated all eight were found to include archaeological material. Three other sites without art that had potential to have been habitation sites were also found to contain an archaeological deposit once excavated.

Based upon these results and the observed trends in shelter preference, the use of comparative analysis of shelter characteristics provides a high probability of identifying sites used for habitation. Many of the sites categorised as low intensity sites have rock art and a morphology comparable with sites used for habitation. It is argued that these sites were selected for the conditions that they afforded for overnight habitation. If this was not the case, there would be no reason to select these sites ahead of the other adjacent and numerous overhangs and caves in the area such as the example shown in Figure 12, that do not afford the conditions for overnight habitation. This shelter has room to sit, and provides shelter from the weather, however is does not have a suitable floor area for sleeping. The preference for the use of shelters with floor areas suitable for sleeping suggests that these sites were functional, they were not solely for the production of art.

Figure 12: Shows an overhang that is a typical example of the overhangs and caves that are numerous throughout the region that do not have a level floor area, and have no evidence of habitation or use.

3.5.3 Criteria

For the purpose of this research a habitation is a site that provides shelter, and a suitable floor living area that enables sleeping overnight.

The criteria used to identify sites that would be suitable for habitation includes:

- A section of floor area that is level enough that a person would not roll off during sleep.
- A section of floor that was large enough for a least one person of 185 centimetres tall to sleep. This equates to a minimum of approximately 1.1 square metres. Attenbrow's (2004:49) criteria for potential habitation shelters defines a minimum area of 2 m x 1 m to enable two people to sleep in a curled up position. It is argued that there would be occasions when a site would only need to have accommodated one individual, as this type of site has been observed. Ethnographic accounts (Howitt 1996:559) also indicate that there were times that individuals were required to have solitary camps.
- The shelter provides protection from the rain. A minimum depth of 1 metre as applied by Attenbrow (2004:49) is considered an appropriate criteria.
- There is sufficient height for a person to at least crawl into it.

- The shelter is not in a position where inhabitants could fall out creating a risk of injury or death.

3.5.4 Site categories

The following is a description of the site categories and includes the basis for assigning the categories together with a site categorisation table that was produced for this purpose. The site categories are defined as:

- High Intensity (HI). This is based upon the presence of a combination of archaeological evidence for domestic site use. This might include the presence of archaeological deposit, fire hearths, a range of artefacts and grinding sequences, as well as a suitable floor morphology to support a sizeable group. These sites contain the most visible evidence for intensive and repeated use as camps. They exhibit the results of planned behaviour carried out in the available time when people stopped at longer term camps, such as repeated sequences of grinding, the full range of reduction debris associated with tool manufacture, exhausted tools (Nelson 1991:78-83), and repeated campfire use. They include the most complex range of tools and raw materials demonstrating the greatest re use of sites (Cardillo and Alberti 2013).

- Moderate Intensity (MI) is based upon a more limited range of visible evidence for the intensity of domestic site use, however this category includes at least some evidence of sequences of repeated use, and a floor size suitable to support more than two occupants.

- Low Intensity (LI) sites have a minimal range of archaeological evidence for habitation. In some cases the only evidence is the presence of rock art and a morphology that is comparable to sites with evidence of habitation. The habitability of these sites ranges from sites that would be comfortable to stay for multiple days, whilst others would be unsuitable for occupants to remain comfortably for more than a night. These sites are likely to have been used for short term use, perhaps as shades, or rests, and short term camps for only a small number of people. Less intensively used sites exhibit tools likely to have been required for immediate use, and include broken tools, or debris from retouch (Nelson 1991:78-83), or isolated

tools that were lost or discarded (Kohen 1986:306). They include a low complexity of artefacts and artefact raw material types (Cardillo and Alberti 2013).

- Non Habitation (NH) sites do not have a morphology suitable for providing any habitation and they do not have any archaeological evidence of domestic activity. They are normally a rock face sufficiently overhung to enable the preservation of the rock art, but without a suitable floor area to enable camping.

Table 2 was used as criteria for the purpose of assigning categories to each site. Each category shows the combinations of evidence in brackets that is required for a site to fulfil the designated category.

Site Category	A. Shelter Morphology	B. Archaeological Deposit	C. Fire Hearth	D. Stone artefact raw material	E. Stone artefacts type	F. Grinding/ Hammering areas #	G. Other artefacts (Shells, Firewood, Anvils)	H. Rock Art
High Intensity (A plus B or C; plus D, & E, or F, or G, or H)	Floor size and morphology to sleep a family unit	Floor deposit with significant representation of charcoal and/or stone artefacts in the matrix	The presence of multiple hearth locations, or intensive hearth use	Artefact raw materials from multiple source locations	Debris representing the full range of reduction sequences	Multiple grinding sequences	Other artefacts are present	Rock art present
Moderate Intensity (A plus one or more combinations of B, C, D, E, F, G & H)	Floor size and morphology to sleep more than two occupants	Floor deposit with significant representation of charcoal and/or stone artefacts in the matrix	The presence of a fire hearth	Artefacts from multiple source locations	May represent broken tools from use, and limited evidence of full reduction	Evidence of sequences of grinding	Other artefacts are present	Rock art present
Low Intensity (A plus at least one of B, C, D, E, F, G & H)	Floor size and morphology to sleep one or more occupants	Floor deposit	Evidence of campfire	Limited to one of two source locations	Limited to a small number of artefacts, mainly broken or lost tools	Evidence of grinding	Other artefacts are present	Rock art present
Non habitation	Does not support habitation	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	Rock art present

Grinding sequences are identified by means of the presence of the grinding direction placed at different angles to each other indicating that individuals were crouched in different positions to create them.

Table 2: Site categorisation table.

3.5.5 Identifying fire hearths

The use of campfires in shelters often leaves a signature in the sandstone. The author has observed through many years of camping in the bush that sandstone changes colour when subjected to intense heat. This can result from campfires and also from bushfires when extreme heat changes the pale and yellowish colour of sandstone to an orange to red colour. Research into colour changes in sandstones has revealed that heating sandstones shifts their colour towards red as the heat is increased (Torok and Hajpal 2005:7, 2004:319; Zihms et al. 2013:141). This is attributed to dehydration of iron and other ferruginous minerals in the rock. The cement structure bonding the sand grains together to form the rock also loses its properties after heating and the material becomes much more friable with the sand grains easily removed by brushing or pulling apart. Laboratory tests performed by Ranjith, et al (2012:120-125) found that heating Hawkesbury Sandstone above 600 degrees Celsius significantly weakened the cement bond. Figure 13, Figure 14 and Figure 15 demonstrate this discolouration and decomposition of the sandstone at the fire hearth location. Another observation of the effect of the concentration of intense fire within shelters is that the re-colonisation of the rock surfaces by Lichen is significantly delayed. This is demonstrated in Figure 16 and is probably a strong indication of the relatively recent use of these hearths. Bush fire effected rocks exposed to the weather are normally recolonised with Lichens and other micro flora within a few years.

Figure 13: A fire pit within a shelter showing the changed colour of the surrounding rocks and sediment to a red colour. It also shows evidence of the decomposition of the sandstone into sand as a result of changes caused by intense heat.

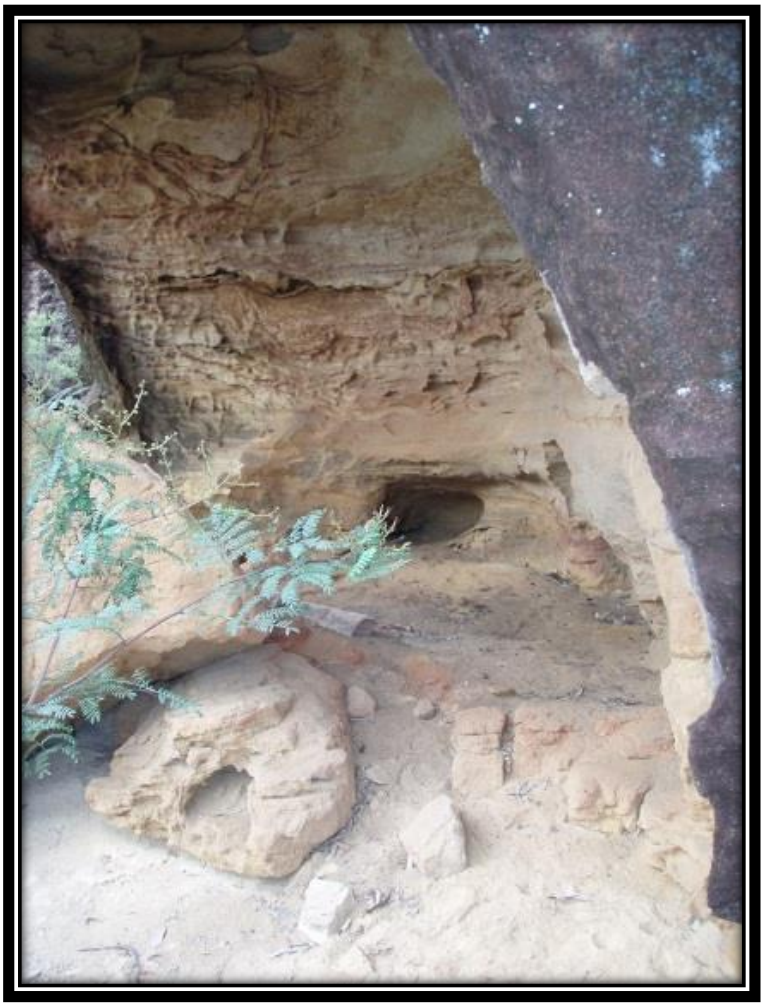

Figure 14: Rocks baked by fire within a shelter turn from yellow to deep orange and rapidly decompose into the sediment floor material.

Figure 15: Fireplace showing rocks exhibiting a changed colour together with sand grains loosened on the rock surface as a result of the structural changes to the bonding of the grains.

Figure 16: Images of campfire locations where lichens and micro flora have failed to recolonise the rock surface. The surrounding grey and brown surfaces exhibit the normal surfaces unaffected by heat.

3.5.6 Elevation zones

McCall's (2010) research in Didima Gorge used three distinct elevation zones that have unique landform characteristics for each zone. The elevation zones influenced the size of shelters and the proximity to resources. Habitation was concentrated in one specific elevation zone. In this research area there are not distinct landform characteristics coinciding with changes in elevation. However differences in elevation influence the paths

of least expense to resources and travel routes which may influence how sites were used. For this reason the four elevation zones including Stream Bank (STR), Lower Slope (LWR), Mid Slope (MID), and Upper Slope (UPR) were assessed to determine if the patterns in the art showed any correlation with the elevation zone. Landform groups including Broad Valley (BVY) and Ridge (RDG) were also considered.

3.5.7 Rock art analysis

Motif types were statistically and visually assessed, independently from site and elevation categories, for the purpose of identifying the presence or absence of inter-art correlations, and for specific behaviours. This analysis considered the following –

- Correlation and relationships between motifs.
- Those motifs of significance used during ceremony including Dharamulan, Biaime, emu (Howitt 1996:521-560), wombat, possum, kangaroo, echidna, lizards, and snakes (Mathews 1897:3-12).
- Motifs of humans were broken down into those with raised arms, and those with lowered arms to determine if this difference was expressed as part of a different pattern.
- Repetition of motifs as an indication of ritual behaviour.
- Size as an indication of significance.
- Redrawing, and outlining added after placement of the original drawing, as an indication of renewal, or refreshing of the images.

Any patterns evident within these motif variables were then considered against the site categories previously identified to determine if a relationship was evident.

3.5.8 Limitations

Without the use of excavations and dating as part of the research, the method relies upon the surface archaeology as a representation of the most recent phase of activity. Due to site disturbance from burrowing animals, and active caverning processes causing sediment build-up concealing artefacts, the categorisation of sites according to the intensity of use will be an approximate value for some sites. For this reason the method relies upon other archaeological signs as indicators of the complexity of site use, such as fireplaces, grinding sequences, complexity of stone artefacts, evidence of exposed deposit, and morphology. It also draws upon the prior research and comparative morphology to conclude likely site use.

4 Results

This section describes the results of the analysis and categorisation of rock shelter sites, the results of the multivariate statistical analysis, and results of the analysis of behaviours associated with the production of art.

4.1 Landscape use and mobility

The analysis of the use of rock shelters for the purpose of categorisation revealed that sites could not be assigned a category on the basis of specific functions. The assessment revealed that sites were used by small highly mobile groups for short periods. An assessment of the archaeological remains together with the location of sites concluded that it was not possible to confidently assign fixed categories to sites such as base, transit camps, and activity locations. Sites were assigned categories on the basis of the intensity of habitation, or occupation of the site. This categorisation spanned the full range of degrees of habitation. The discussion for how this result and approach was determined is included in the *Discussion* section. The concept for this model is that habitation intensity represented the full range of site use, from no use as a habitation, through to high intensity use associated with group domestic habitation. On this basis the sites were analysed with the associated art to identify if the patterns revealed a relationship with sites used for purposes remote from domestic habitation, through to sites used primarily for domestic habitation. This analysis differed from that used by McCall, requiring a greater use of categorical data.

4.2 Site categories

From the 128 sites used in the research, 100 sites included rock art. The sites were categorised as shown in Table 3. For the purpose of the analysis the art sites were further reduced to remove those sites where the art could not be interpreted. Total population sampling was used for the analysis. Motifs with a low frequency of occurrence did not provide a meaningful result and created too much congestion of information in the charts. As a result motifs that occurred in less than 4 sites were removed from the data used for statistical analysis. The final number of sites used in the analysis was 81, see Table 3. The total number of motif types used is shown in Table 4.

Site Category	Total Sites	Total Sites Containing Rock Art	Reduced Sites for Analysis
HI	8	3	3
MI	26	17	9
LI	87	73	64
NH	7	7	5
Total	128	100	81

Table 3: Total sites used in the study, including reduced site numbers for art analysis

Motif	Frequency
Anthropomorph	94
Culture Hero	11
Echidna	18
Macropod	49
Snake	8
Lizard	7
Human Raised Arms	114
Human Lowered Arms	18
Koala	13
Bird	14
Other Stencil	21
Hand Stencil	183
Eel	46
Pattern	15
Lines	46

Table 4: Motif frequency from 81 sites used in analysis.

4.3 Statistical analysis

4.3.1 Statistical Methods Applied

The site and art motif data was assembled into CSV files for reading by the R statistics program. Scripts were run in the FactoMineR package. PCA was applied to quantitative variables, MFA to combined quantitative and categorical variables, and MCA to categorical variables. MFA was used to consider the presence of correlations between art motifs and site categories on the basis of quantities. It seeks to understand if the numbers of motifs

changed in correlation with site categories, and site elevation zones. MCA was used to determine if there was a correlation with site categories on the basis of the presence or absence of motifs.

For considering the interrelationships between motifs, if a motif type increases or decreases independent of other motifs, there must be some level of independence of expression, or meaning of this motif. However such independence may still be expressed while maintaining a relationship with other motifs. For example, if a motif showed independence in quantities, but commonly occurred with another motif type, there is a possible relationship. However if there is independence in both quantity and presence they are unlikely to be related. If there is a correlation in quantities, but a limited correlation in presence, then it is possible the result is being influenced by a specific site. For example a site with larger quantities of motifs may create a correlation result between two motifs due to the correlated increase in quantity, but this may not be evident in any other sites that the motifs occur. For these reasons both PCA and MCA are used to test for correlation in quantities, and correlation in the presence of motifs at sites. Both methods are used to validate the interpretation.

Table 5 and Table 6 show the legends used in the results for the motifs and site categories.

Legend	Motif
ANTH	Anthropomorph
EC	Echidna
MPD	Macropod
S	Snake
HR	Human Raised Arms
HL	Human Lowered Arms
KA	Koala
B	Bird
L	Lines
OS	Other Stencil
HS	Hand Stencil
FE	Eel
PTN	Pattern
CH	Culture Hero
_+	Present
_0	Absent
OTL	Outlined or Redrawn Motif

Table 5: Legends used in the analysis for motifs

Legend	Site Habitation Category
HI	High Intensity
MI	Moderate Intensity
LI	Low Intensity
NH	No Habitation
Legend	**Elevation Zone**
UPR	Upper Slope
MID	Mid Slope
LWR	Lower Slope
STR	Stream Bank
RDG	Ridge
BVY	Broad Valley

Table 6: Legends used in the analysis for site categories

4.4 Results for the site to art motif relationship

The results are shown in the following figures 17, 18 and 19 and tables 7 and 8.

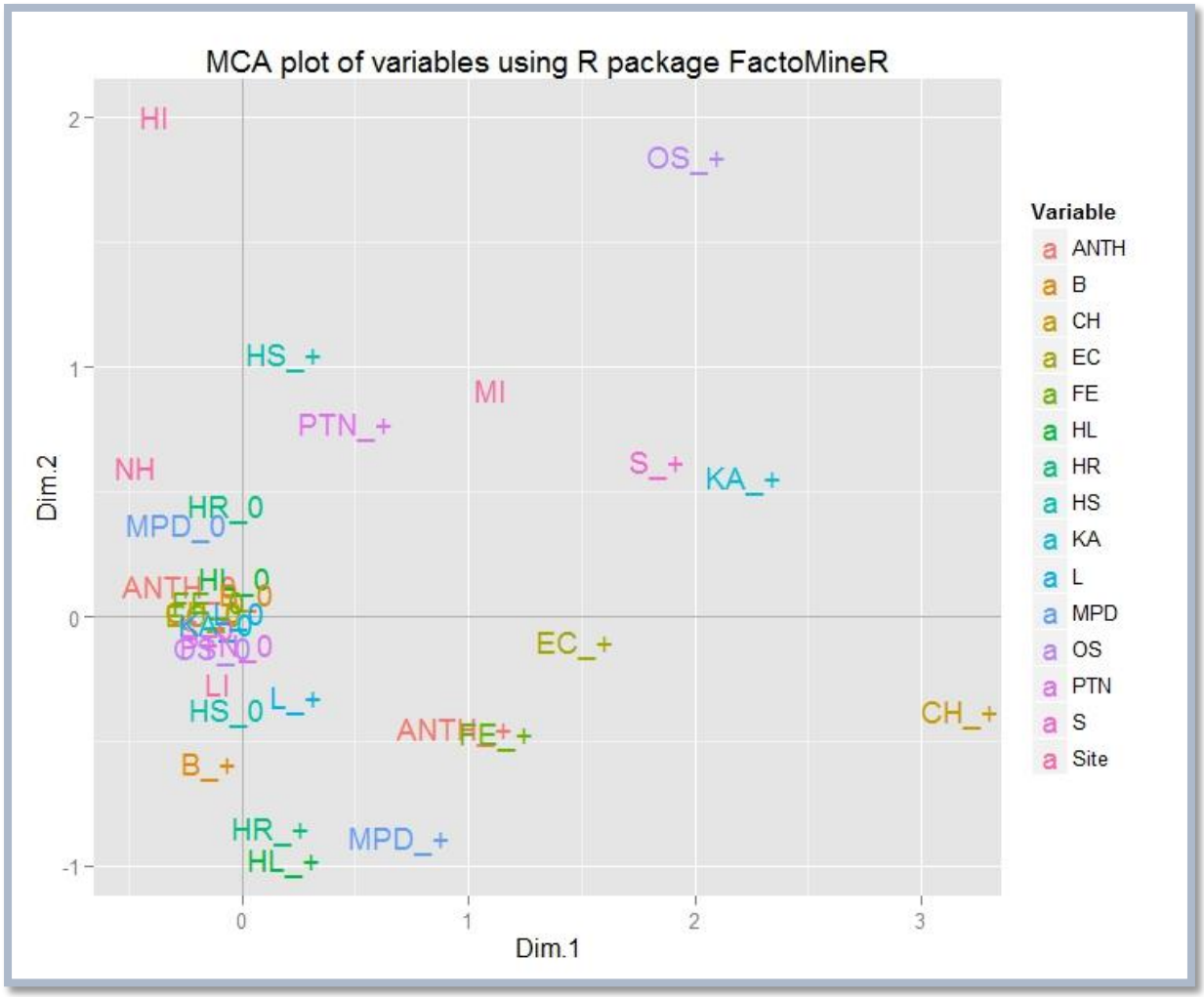

Figure 17: MCA variable plot of art motif to site type relationship

Dimension 1		
Quantitative		
	correlation	p.value
CH	0.9141122	1.04E-32
ANTH	0.8923063	5.16E-29
OS	0.7975719	5.07E-19
HS	0.7786808	1.16E-17
MPD	0.7668756	7.04E-17
S	0.6685837	9.07E-12
Categorical		
	Estimate	p.value
MI_MI	1.403305	8.68E-05
LI_0	1.007867	4.01E-04
LI_LI	-1.007867	4.01E-04
MI_0	-1.403305	8.68E-05
Dimension 2		
Quantitative		
	correlation	p.value
FE	0.6703289	7.66E-12
PTN	0.5877335	8.00E-09
S	0.5174272	7.56E-07
L	-0.22688	4.17E-02
Categorical		
	Estimate	p.value
LI_LI	1.1665316	5.03E-11
MI_0	0.9989274	4.03E-05
NH_0	0.9045155	5.66E-03
HI_0	1.1209101	7.21E-03
HI_HI	-1.1209101	7.21E-03
NH_NH	-0.9045155	5.66E-03
MI_MI	-0.9989274	4.03E-05
LI_0	-1.1665316	5.03E-11

Table 7: MCA results showing the contribution of each variable on each dimension

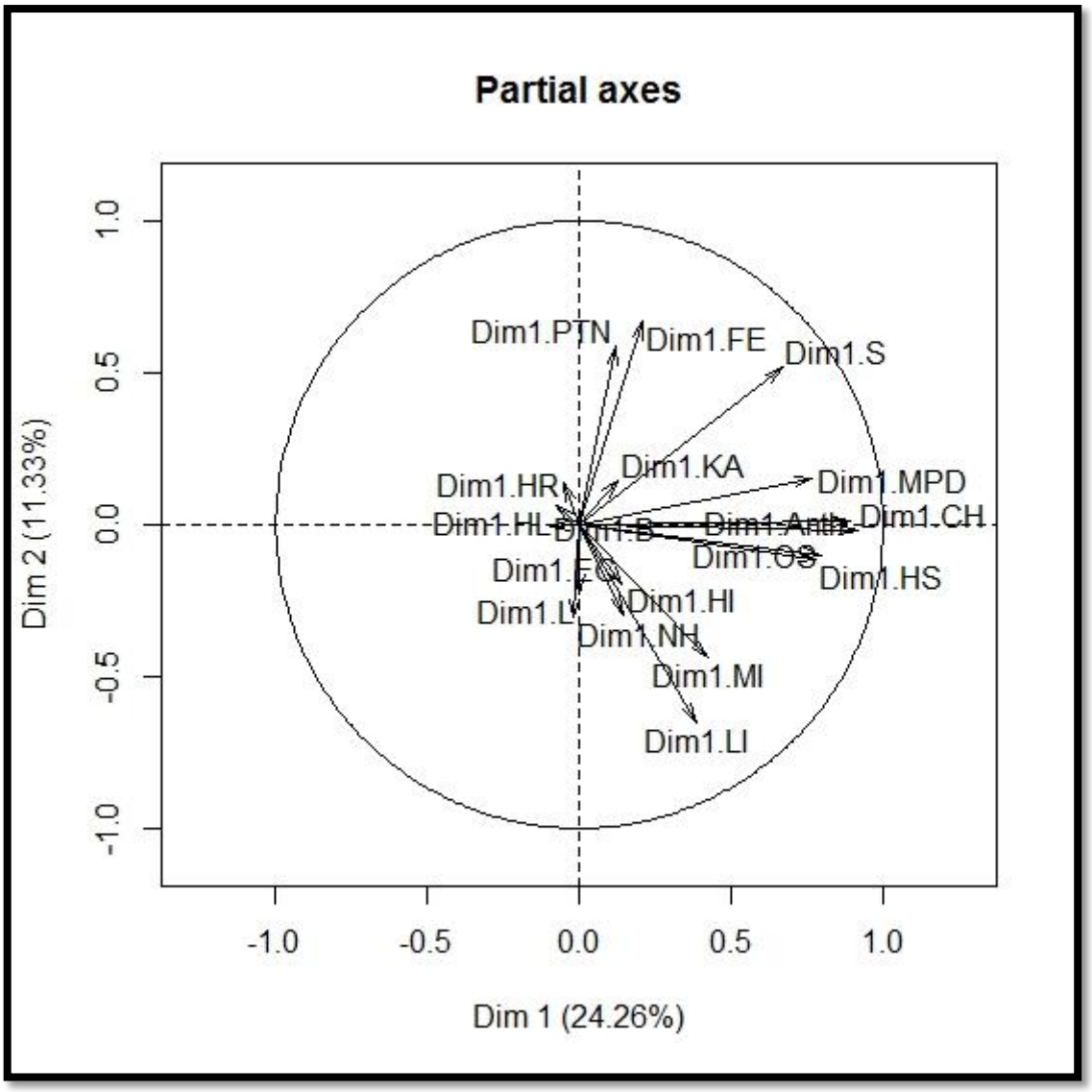

Figure 18: MFA partial axis diagram for art motif to site relationship

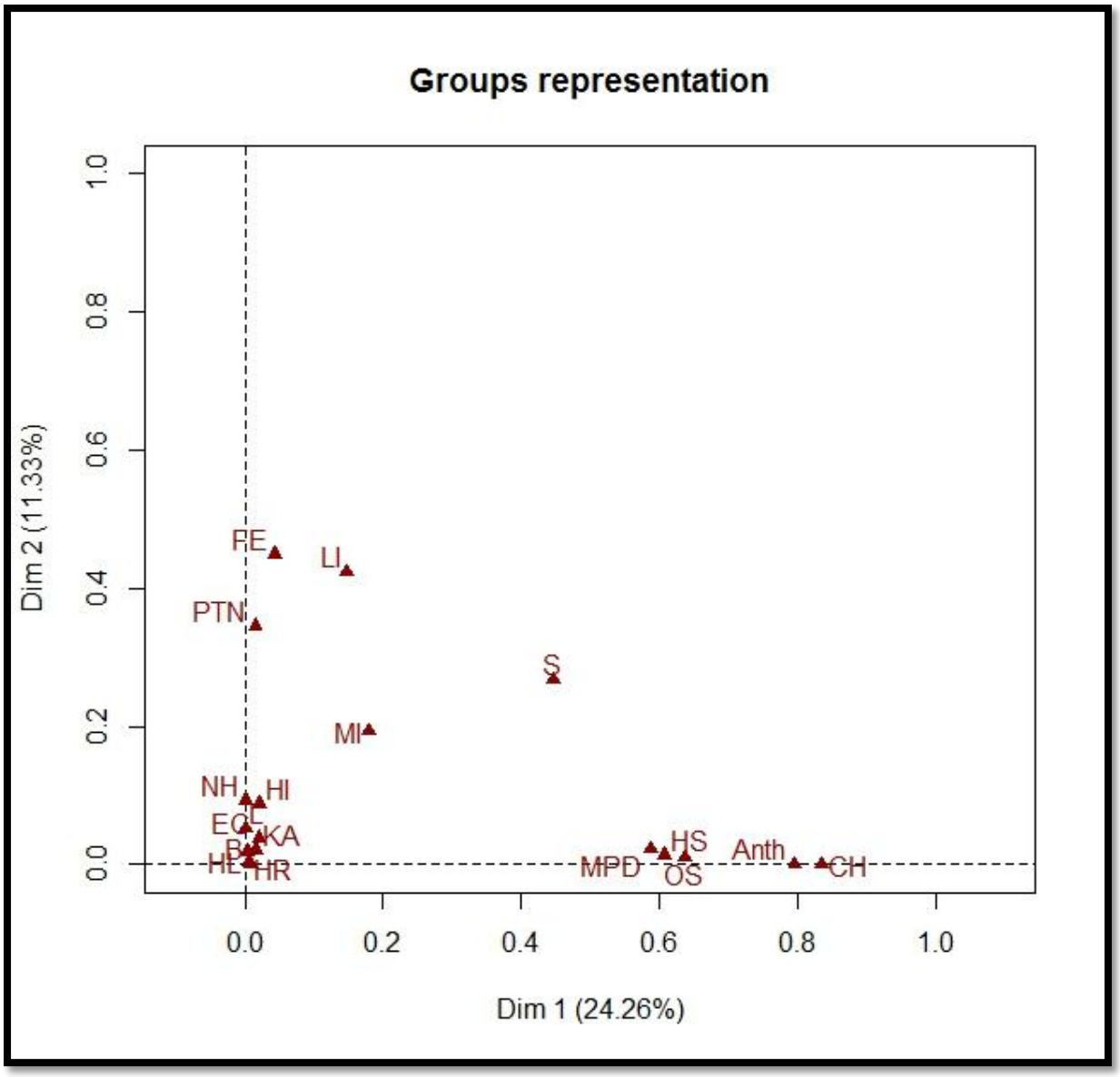

Figure 19: MFA groups representation, art to site relationship

	Dim.1	Dim.2	Dim.3	Dim.4	Dim.5
Dim1.Anth	0.892306	0.010392	-0.2905	0.084164	-0.0636
Dim1.CH	0.914112	-0.01976	-0.24371	0.096205	-0.05409
Dim1.EC	0.139458	-0.19548	-0.12688	0.32243	0.360502
Dim1.MPD	0.766876	0.150635	-0.3722	0.058262	-0.11046
Dim1.S	0.668584	0.517427	0.255375	0.204056	-0.18628
Dim1.HR	-0.05204	0.137973	-0.39396	-0.02094	-0.13671
Dim1.HL	-0.07654	0.063833	-0.28077	-0.18039	-0.0282
Dim1.KA	0.122696	0.145651	0.006112	0.113353	-0.43442
Dim1.B	-0.09465	-0.01008	-0.29536	0.079567	0.204337
Dim1.OS	0.797572	-0.1017	0.107801	-0.42503	0.09042
Dim1.HS	0.778681	-0.11527	-0.00189	-0.36815	0.069286
Dim1.FE	0.208791	0.670329	0.452206	0.209061	0.143064
Dim1.PTN	0.120735	0.587734	0.551759	-0.0287	0.280033
Dim1.L	-0.0001	-0.22688	0.101428	0.327743	0.26614
Dim1.LI	0.384054	-0.6503	0.518869	0.169279	-0.10695
Dim1.MI	0.422097	-0.43956	0.118512	0.503296	0.340842
Dim1.HI	0.144878	-0.2964	0.39162	-0.68113	0.15439
Dim1.NH	-0.01962	-0.30479	0.401334	0.186208	-0.6962

Table 8: Correlation of art motifs with site category shown for each dimension

Figure 17 and Table 7 show the results using MCA. Figure 18, Figure 19 and Table 8 show the results for MFA. The figures for both methods indicate that there is no correlation between site category and motif type when considering both motif quantities, and the presence or absence of motifs. The results shown in the correlation tables validate this interpretation. The motifs showing the strongest correlation on the first dimension have a negative correlation with NH sites, and no correlation for LI, MI and HI sites.

4.4.1 Average motif quantity per site category

An analysis of motif quantities for each category revealed that motif quantities increase in correlation with increased evidence of habitation.

Site Category	Average Number of Motifs Per Site
NH	4
LI	11
MI	17
HI	19

Table 9: Showing average motif quantities per site for each site category

4.5 Art to elevation zone relationship

The results of the analysis of the art to elevation zone relationship are shown in the following figures 20, 21 and 22, and table 10.

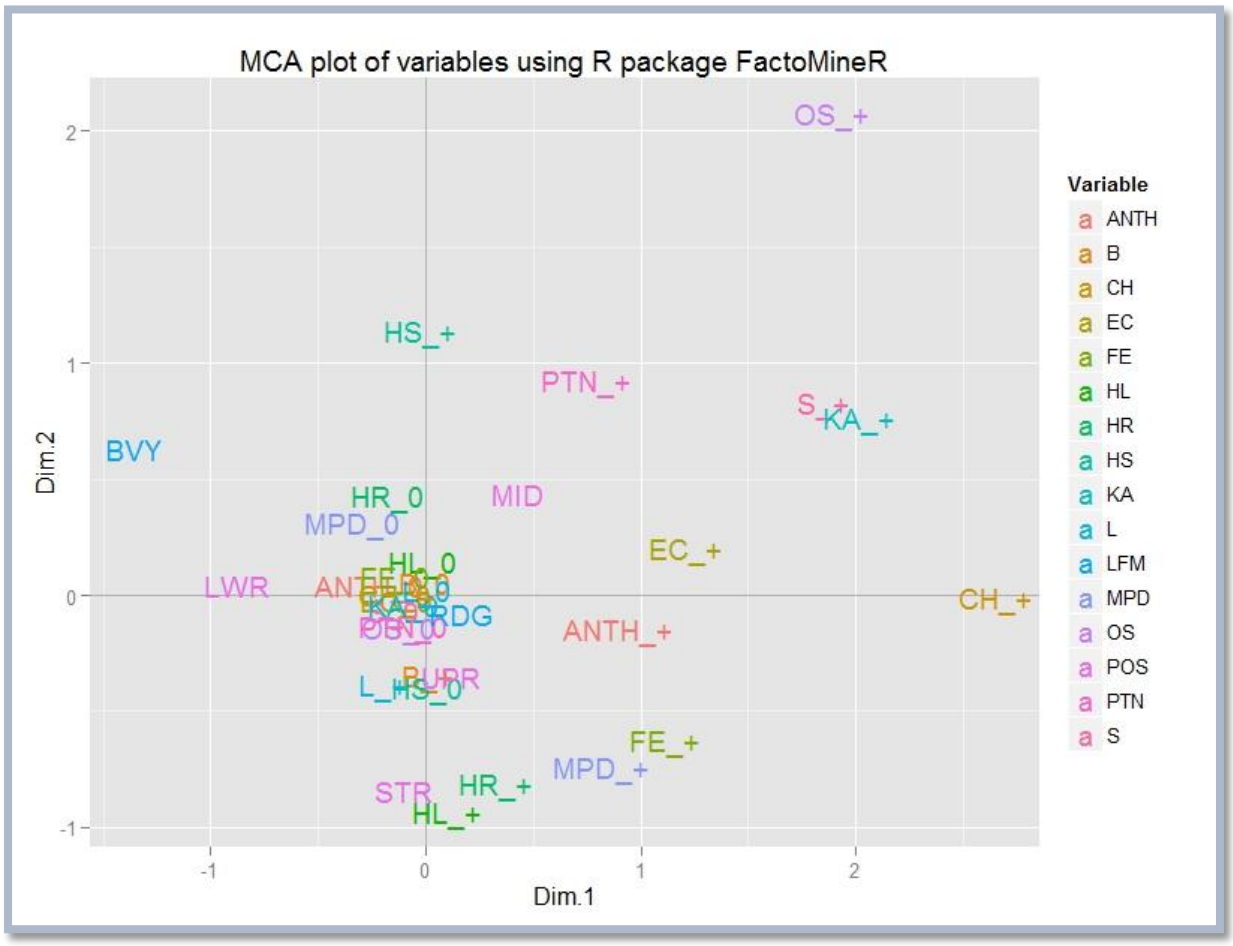

Figure 20: MCA plot of art motif to elevation zone relationship

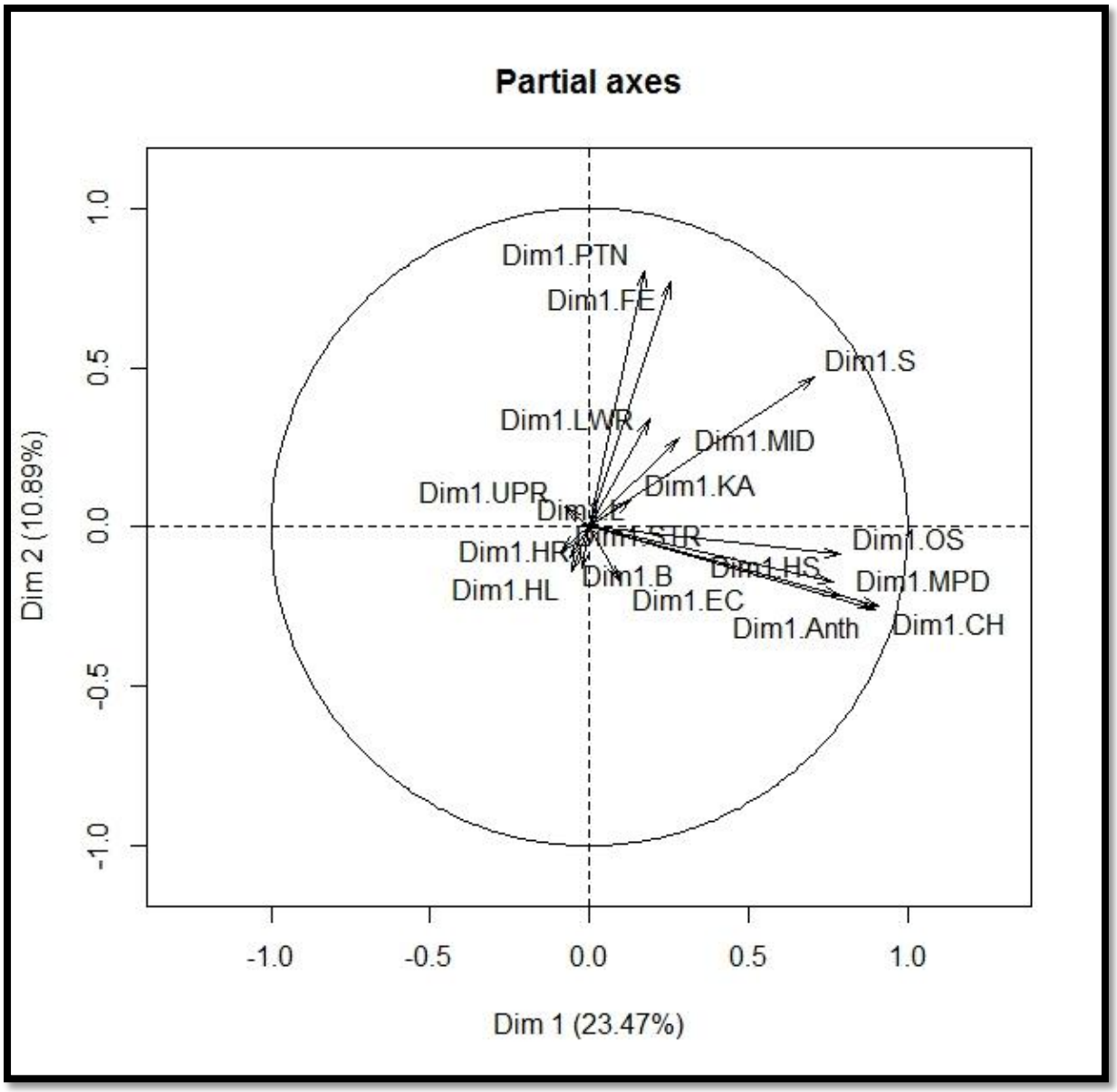

Figure 21: MFA partial axis of art motif to elevation zone relationship

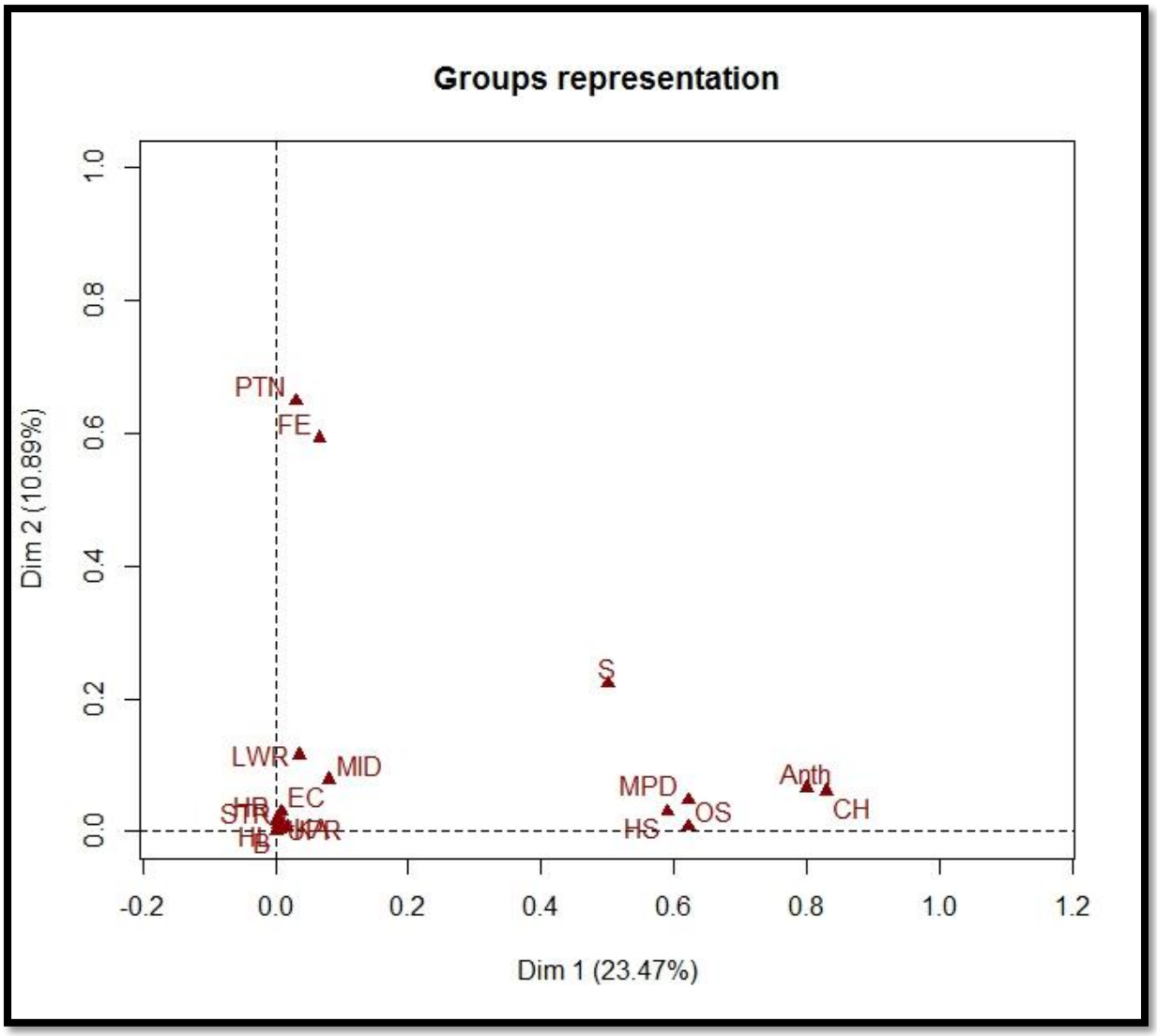

Figure 22: MFA group representation of art motif to elevation zone relationship

$coord

	Dim.1	Dim.2	Dim.3	Dim.4	Dim.5
Dim1.Anth	0.89476682	-0.256909002	-0.01880508	0.04734602	0.014586844
Dim1.CH	0.91065310	-0.246004116	-0.01343601	0.02765202	-0.018921306
Dim1.EC	0.09427954	-0.173242752	0.19015969	0.56377842	0.317589576
Dim1.MPD	0.78814410	-0.217145966	-0.08226371	0.04800958	-0.029871881
Dim1.S	0.70755524	0.471947184	-0.22604872	0.10570662	-0.082048180
Dim1.HR	-0.02020599	-0.127026339	-0.05216613	-0.17759382	0.038458203
Dim1.HL	-0.05294634	-0.138847234	0.06005583	-0.05058386	-0.099310835
Dim1.KA	0.13118898	0.081324267	-0.41283844	-0.10312477	0.221690906
Dim1.B	-0.05898531	-0.096368652	0.35457155	-0.06077144	0.368421363
Dim1.OS	0.78888986	-0.087545705	0.08845178	-0.06438445	-0.045280847
Dim1.HS	0.76859126	-0.173816125	-0.03648675	-0.09287086	-0.006704968
Dim1.FE	0.25713807	0.770105673	-0.02593016	0.23648894	-0.198878723
Dim1.PTN	0.17461074	0.804972742	0.03377918	0.11903757	-0.107027194
Dim1.L	-0.02478340	0.006657439	0.29474433	-0.20912781	-0.079786996
Dim1.LWR	0.18856356	0.340024830	0.05436410	-0.19220866	0.825755981
Dim1.MID	0.28396324	0.278999820	0.75229659	-0.38663947	0.181976782
Dim1.UPR	-0.07544413	0.060822990	-0.80281688	-0.27180868	0.356572655
Dim1.STR	-0.08851203	-0.075271510	0.05641528	0.77650378	0.313575886

Table 10: Correlation table showing the relationship between motifs and elevation

Figure 20, Figure 21, and Figure 22 shows that there is no correlation between the elevation zones and the art motifs. This is supported by the correlation results shown in Table 10. A motif type has a likelihood of occurring in any elevation zone. BVY and RDG were removed from the analysis because there was no indication in the initial results that indicated these landforms influenced the site use in the elevation zones.

4.6 The Interrelationship of art motifs

The analysis for correlation between motifs was carried out using PCA, MFA and MCA. The results are shown in the following figures 23 and 24, and table 11.

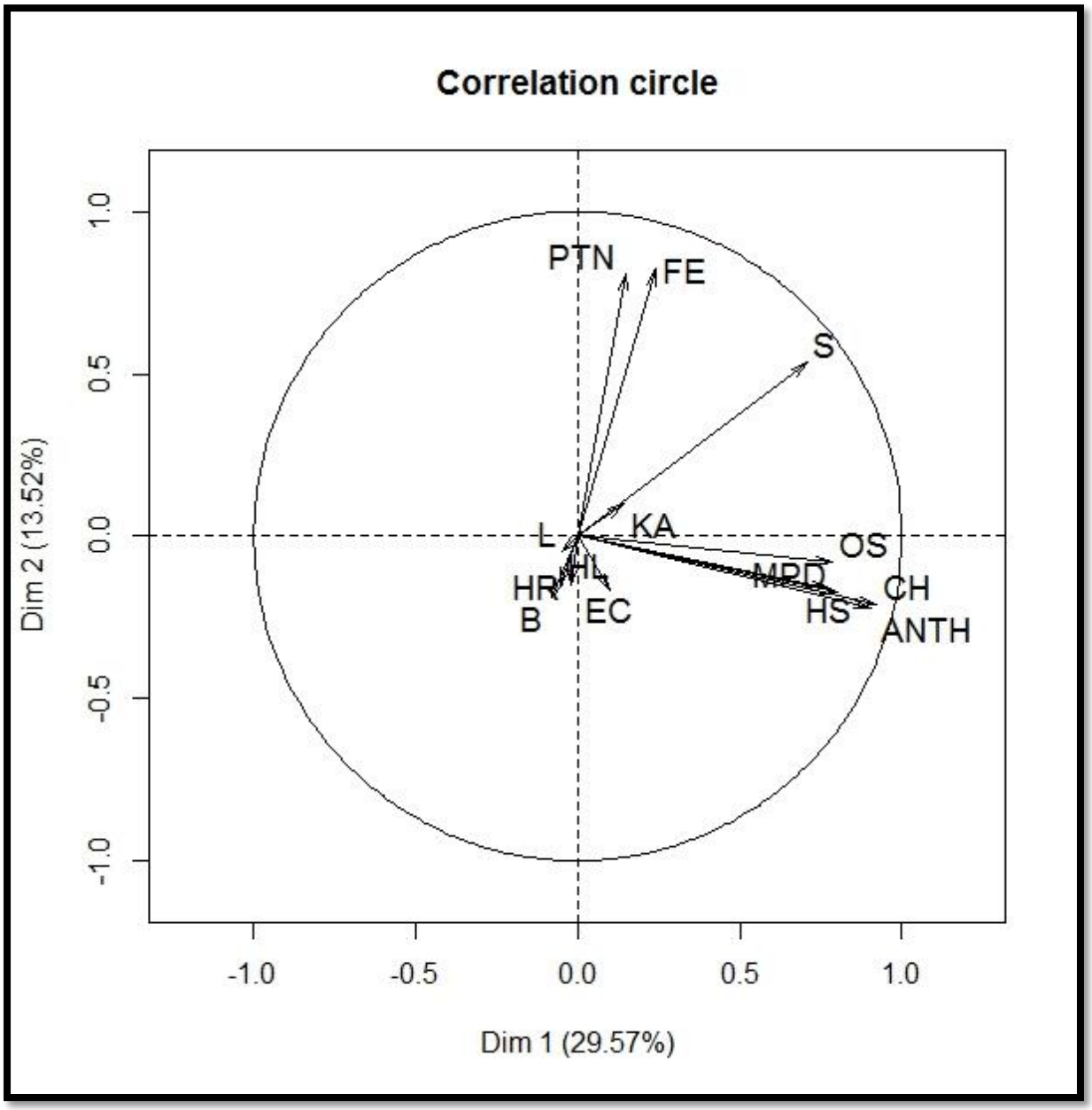

Figure 23: PCA correlation circle for motif relationships

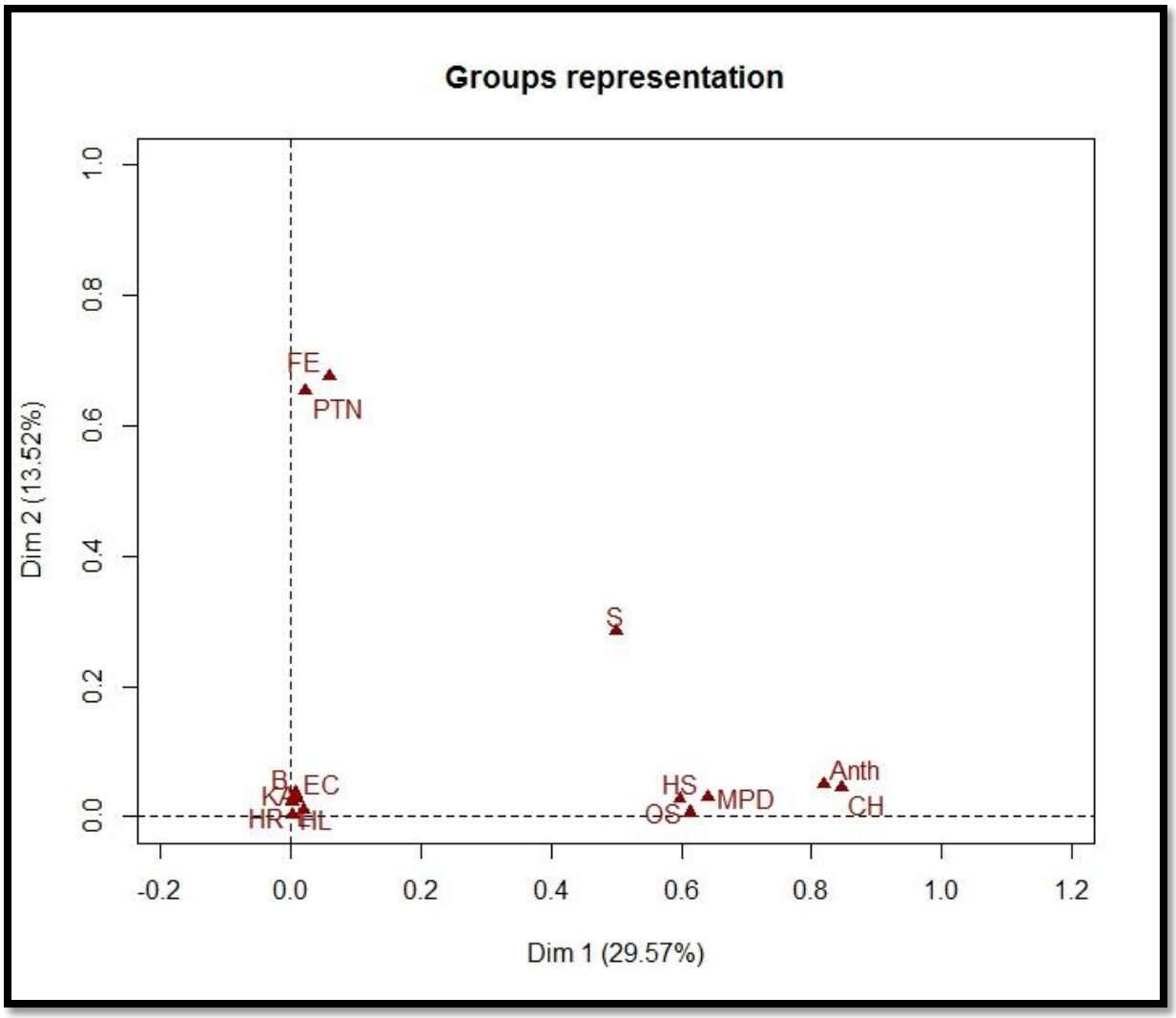

Figure 24: MFA showing motif relationships

```
$coord
                Dim.1       Dim.2       Dim.3       Dim.4        Dim.5
Dim1.Anth   0.90453149 -0.22257192  0.047196125  0.03609706  0.0310236822
Dim1.CH     0.91944970 -0.21146207  0.006064024 -0.03537023  0.0253750613
Dim1.EC     0.09966039 -0.16648736  0.270881149  0.53379797  0.0114752066
Dim1.MPD    0.80087735 -0.17274165  0.257372198 -0.08710882 -0.0003543801
Dim1.S      0.70683140  0.53399262  0.142293610 -0.03133764  0.2562986667
Dim1.HR    -0.02237432 -0.15280662  0.665638538 -0.28942831 -0.1459575048
Dim1.HL    -0.05553416 -0.14763747  0.529463447 -0.32498279 -0.1383590409
Dim1.KA     0.14092134  0.09938804  0.040371097 -0.16001070  0.9002388596
Dim1.B     -0.08267994 -0.18931392  0.185545216  0.70369103  0.1739218385
Dim1.OS     0.78367472 -0.08176910 -0.242266698  0.03649211 -0.2017839542
Dim1.HS     0.77283690 -0.16318007 -0.263895617  0.02737494 -0.1821020961
Dim1.FE     0.24345125  0.82218300  0.203323490  0.06223144 -0.0708689900
Dim1.PTN    0.14820901  0.80852978 -0.017502733  0.11100811 -0.2559506324
Dim1.L     -0.04474040 -0.04848439 -0.422130202 -0.30029314  0.0623502604
```

Table 11: Correlation table showing the relationship between motifs

The PCA and MFA results shown in Figure 23 and Figure 24 show that for the first dimension, or principal component, anthropomorphs and culture heroes are the most strongly correlated, followed by macropods, other stencils and hand stencils. This is further confirmed by the correlation Table 11.

On the second dimension eels and patterns are most aligned with this principal component. For these motifs there is no correlation with those motifs aligned with the first dimension.

On the third dimension the most strongly aligned are humans with raised and lowered arms. These motifs have no correlation with the other motifs.

The results indicate that there are correlations evident in motifs on both the first, second and third dimensions. Some motifs have no correlations and appear to be expressing something independent from all other motifs.

An analysis of the correlations between eels and patterns shown on the second dimension reveals that the results have been heavily influenced by an individual site that has high quantities of motifs. When quantities are no longer considered, and the analysis is performed using MCA, no correlation is found. Refer to Figure 25. The correlation in changes in quantities needs to be evident in a number of sites before it could be argued as a consistent relationship. When isolated to an individual site, or small number of sites, the correlated increase may relate to an overall increase in drawing activity at the level of individual sites.

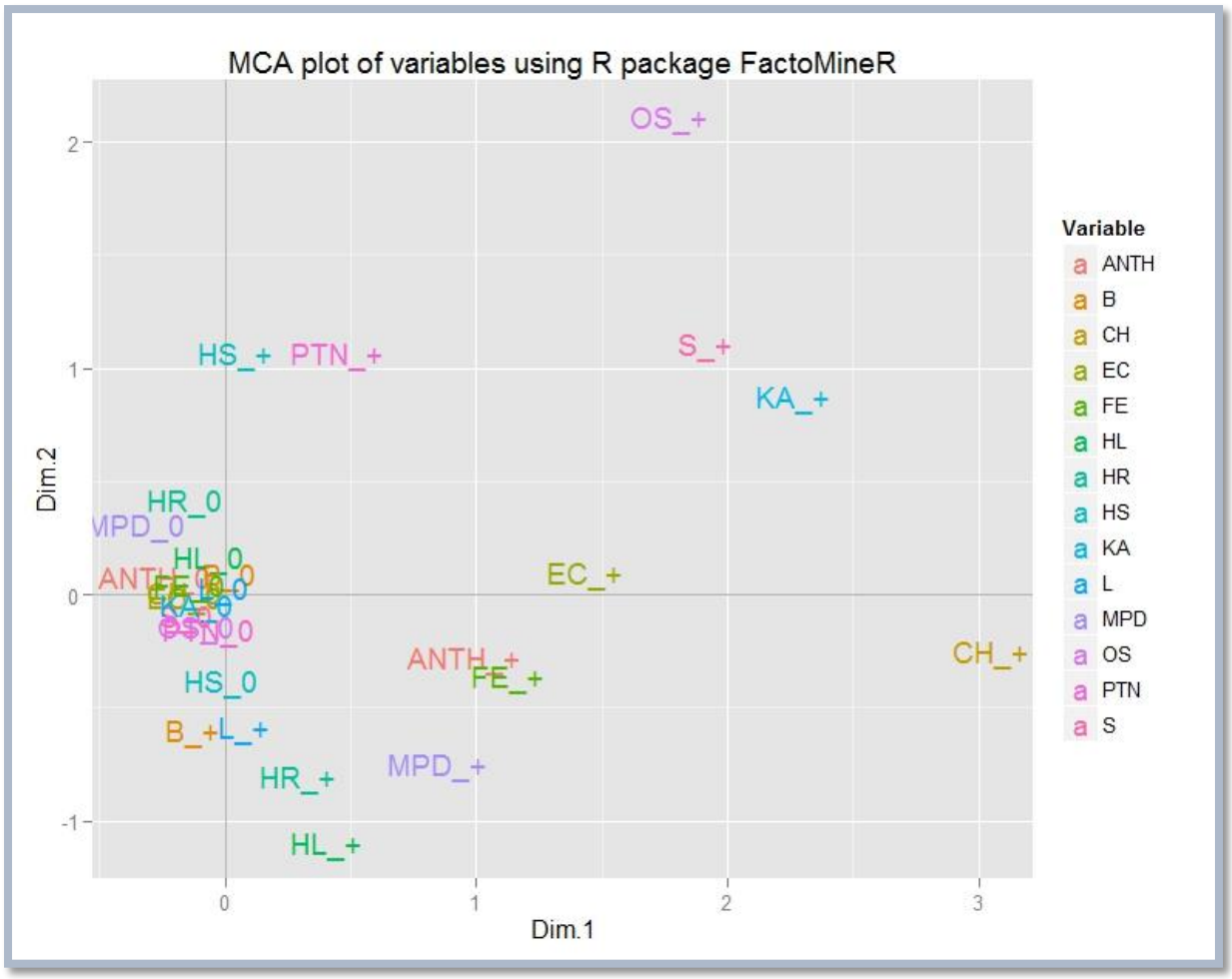

Figure 25: MCA results for presence and absence of motifs

4.6.1 Repetition

The combined analysis using MCA and PCA prompted a closer analysis of quantities of motifs at individual sites to determine if site specific behaviours were influencing results and what this might mean. Some sites exhibit higher concentrations of individual motifs. At one site, there are 43 instances of anthropomorphs. The average occurrence for the other 17 sites with this motif is three instances, refer to Figure 26. Eels occur in nine sites. One site, the Upper Double Cave includes 30 Eels. The average occurrence for the other eight sites is two. The Koala Cave has ten instances of the koala motif. In the remaining three shelters where this motif occurs there is an occurrence of one per shelter. The Echidna Cave includes seven instances of the echidna motif, with an average for the remaining six shelters of 1.5. The repetition of motif form may be indicative of ritual behaviour (Rappaport 1999; Conkey 1985:304-305), or some kind of benefit accumulating through repetition (Ross and Davidson 2006:318-319).

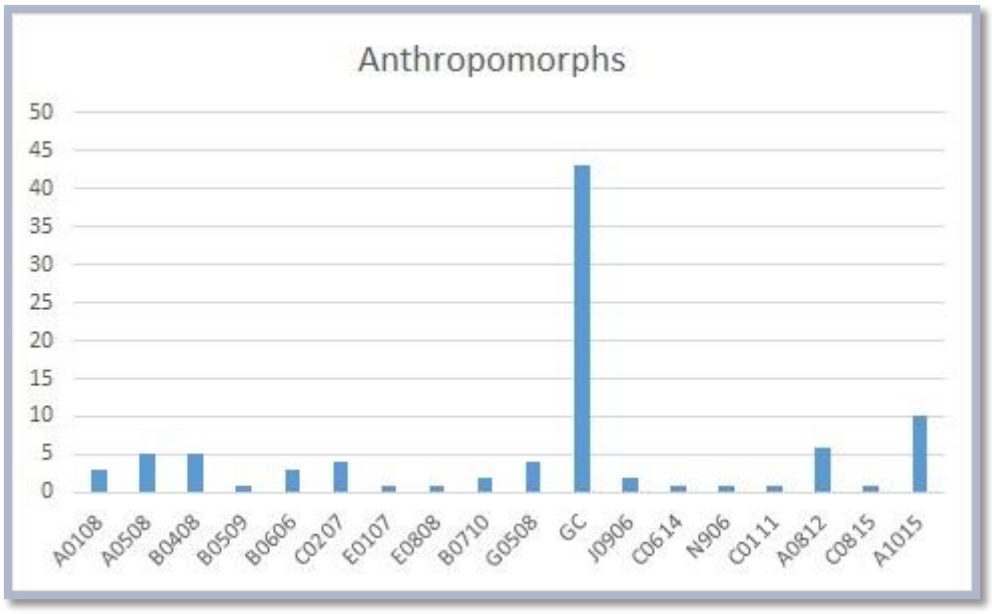

Figure 26: Graph showing the quantity of anthropomorphs per site

Hand stencilling also exhibits patterns that are indicative of ritual behaviour. Whilst they may be very different rituals to those associated with totemism. Figure 27 shows the quantities of stencils for each site.

Those sites with the highest incidence of repetition do not show a uniform correlation to a specific site category. From the six sites that exhibit repetition of motifs, three sites are categorised LI, and three sites are MI. From the three sites that include the highest numbers and repetition of stencilling, one site is LI, one MI, and one HI. The results suggest that the contexts associated with the ritual and domestic behaviours changed within individual sites.

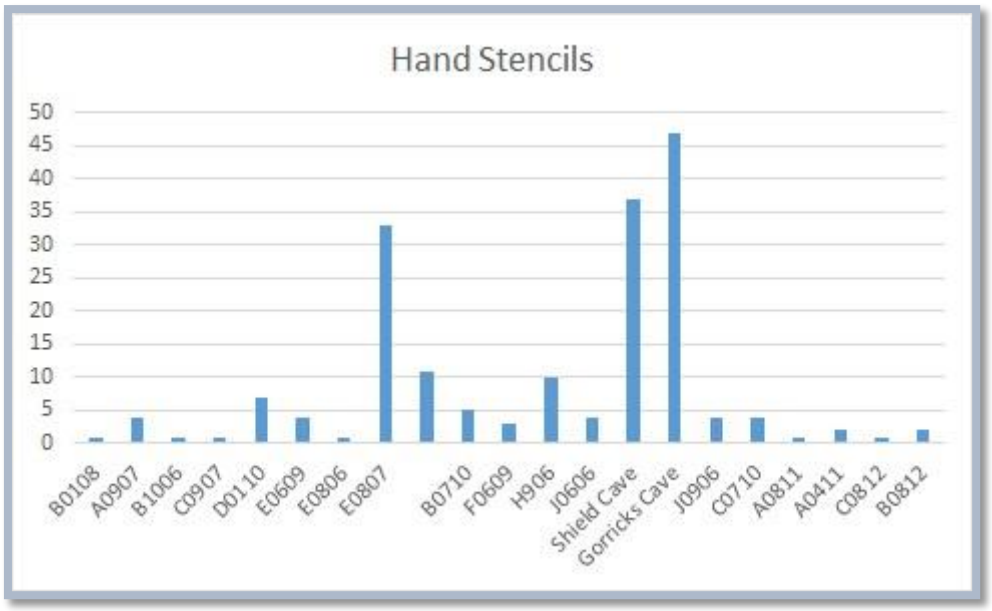

Figure 27: Graph showing Hand Stencil frequency per site

4.6.2 The relationship between renewed or redrawn art

PCA, MFA and MCA were also applied to refreshed and redrawn motifs. The results are shown in the following figures 28 and 29, and tables 12 and 13.

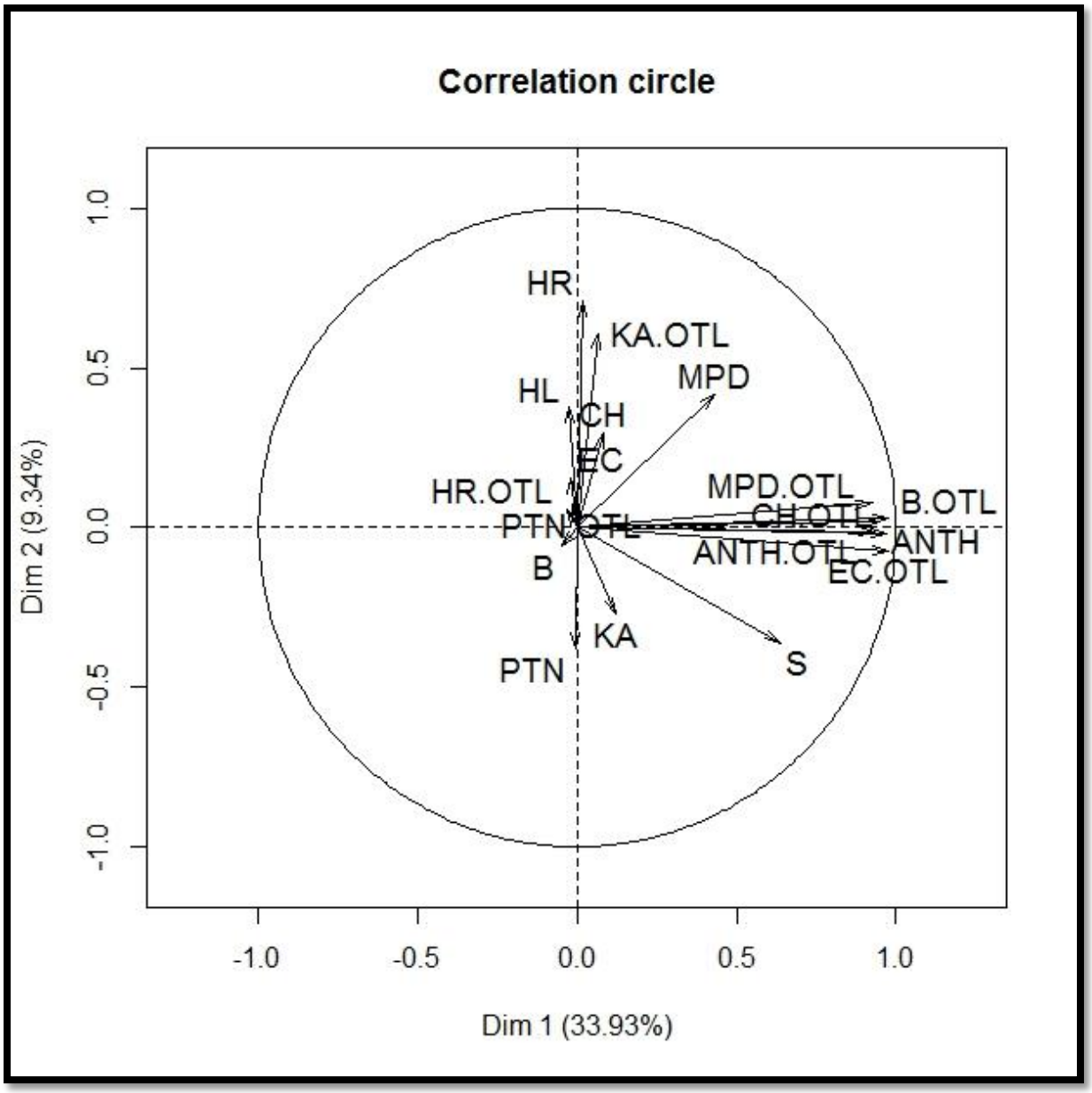

Figure 28: MFA correlation circle results for outlined and redrawn motifs

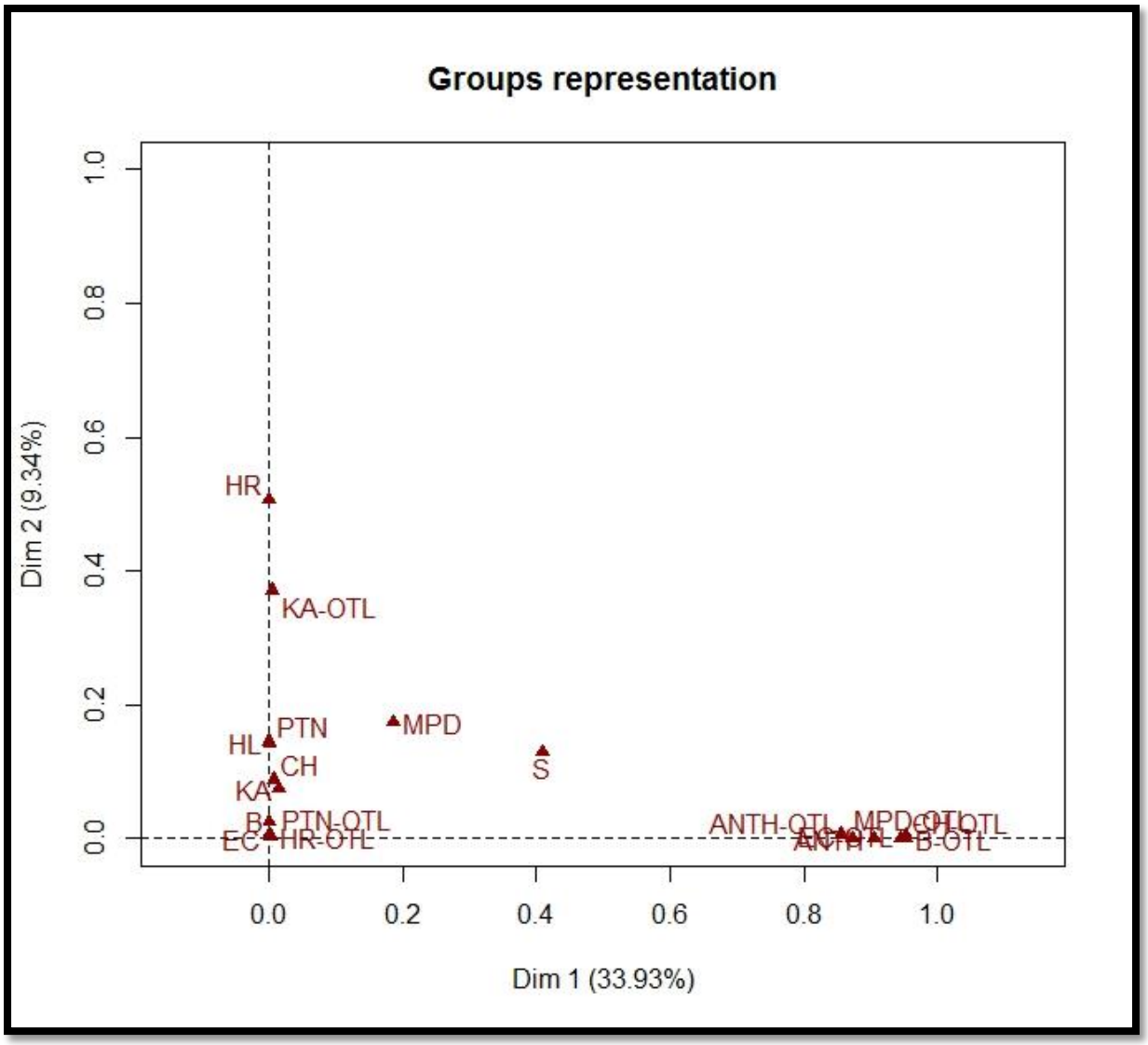

Figure 29: MFA group representation for outlined and redrawn motifs

```
$coord
                  Dim.1       Dim.2        Dim.3       Dim.4        Dim.5
Dim1.ANTH      0.956983005 -0.02880712  0.026767606  0.18079987 -0.042620274
Dim1.ANTH-OTL  0.942239084 -0.08016553 -0.001105607  0.09741741 -0.024195985
Dim1.CH        0.095908558  0.36010709 -0.156251758  0.77690815 -0.178317798
Dim1.CH-OTL    0.975625999 -0.08620032 -0.004702617  0.04738933 -0.024821217
Dim1.EC       -0.014929531  0.08610420  0.619649026 -0.16546679 -0.171775390
Dim1.EC-OTL    0.977580579 -0.13916201 -0.004450485 -0.04651245  0.003017149
Dim1.MPD       0.442097834  0.47509836 -0.152155992 -0.11573874  0.081894814
Dim1.MPD-OTL   0.922037197  0.03421843  0.036654520 -0.15908194  0.017462336
Dim1.HR        0.033151964  0.79807387  0.003462177  0.14248618 -0.039713382
Dim1.HR-OTL   -0.027772330 -0.02871974 -0.226481308 -0.09526818  0.599689418
Dim1.KA        0.086169039 -0.16495978 -0.090095369 -0.03534372  0.212103900
Dim1.KA-OTL    0.076628354  0.66452021  0.209272045 -0.46917072  0.033484500
Dim1.B        -0.040049918 -0.16114502  0.681204548  0.25411013  0.060235482
Dim1.B-OTL     0.978863365 -0.02807908  0.030075206 -0.12326089  0.008498159
Dim1.PTN      -0.060818953 -0.10446673 -0.388254702 -0.29424642 -0.678185960
Dim1.PTN-OTL  -0.008563793  0.10298223 -0.189665031  0.01727728  0.343392332
```

Table 12: Correlation table for outlined and redrawn motifs

```
> dimdesc(arc.pca2)
$Dim.1
$Dim.1$quanti
          correlation      p.value
B.OTL       0.9788634 3.222085e-56
EC.OTL      0.9775806 3.223406e-55
CH.OTL      0.9756260 8.436158e-54
ANTH        0.9569830 3.287213e-44
ANTH.OTL    0.9422391 2.814609e-39
MPD.OTL     0.9220372 2.655879e-34
MPD         0.4420978 3.595248e-05


$Dim.2
$Dim.2$quanti
        correlation      p.value
HR        0.7980739 4.642004e-19
KA.OTL    0.6645202 1.341045e-11
MPD       0.4750984 7.407617e-06
CH        0.3601071 9.595845e-04


$Dim.3
$Dim.3$quanti
        correlation      p.value
B         0.6812045 2.589547e-12
EC        0.6196490 6.931049e-10
HR.OTL   -0.2264813 4.203727e-02
PTN      -0.3882547 3.415367e-04
```

Table 13: Redrawn and outlined motif correlation using the dimdesc function in FactoMineR, grouping the closely correlated motifs of the first dimension ($Dim.1).

The PCA and MFA results from Figure 28 and Figure 29 show a correlation of redrawn motifs for anthropomorphs, culture heroes, macropods, echidnas and birds, and anthropomorphs that have not been redrawn. This interpretation is supported by the correlation results in Table 12 and Table 13. MFA was used in this assessment to enhance the visibility of the trends. With the exception of anthropomorphs, the other motifs show a lack of correlation with their redrawn counterparts. Humans, koalas and patterns, both with and without redrawing are uncorrelated with the other motifs. Humans have maintained their distinct lack of correlation with other motifs when redrawn, whilst culture heroes, anthropomorphs, macropods, echidnas and birds have all moved into closer correlation with each other. An analysis was carried out to understand why some previously uncorrelated motifs had become closely correlated when redrawing had occurred, and why motifs were uncorrelated with their redrawn counterparts. Figure 30 shows redrawn motifs quantity per site. Site 57, has a concentration of redrawn motifs strongly contributing to the results. This site appears to have included behaviour dedicated to the process of renewal of the motifs, including motifs that were significant in the spiritual and totemic beliefs of the Darkiñung. Other sites of renewal are limited to a small number of motifs. From the sites identified as exhibiting renewal or redrawing, 12 sites (75%) are in the LI category, and 3 Sites (25%) in the MI Category. The most significant site for renewal is an MI site that represents 51% of the total quantity of renewed art.

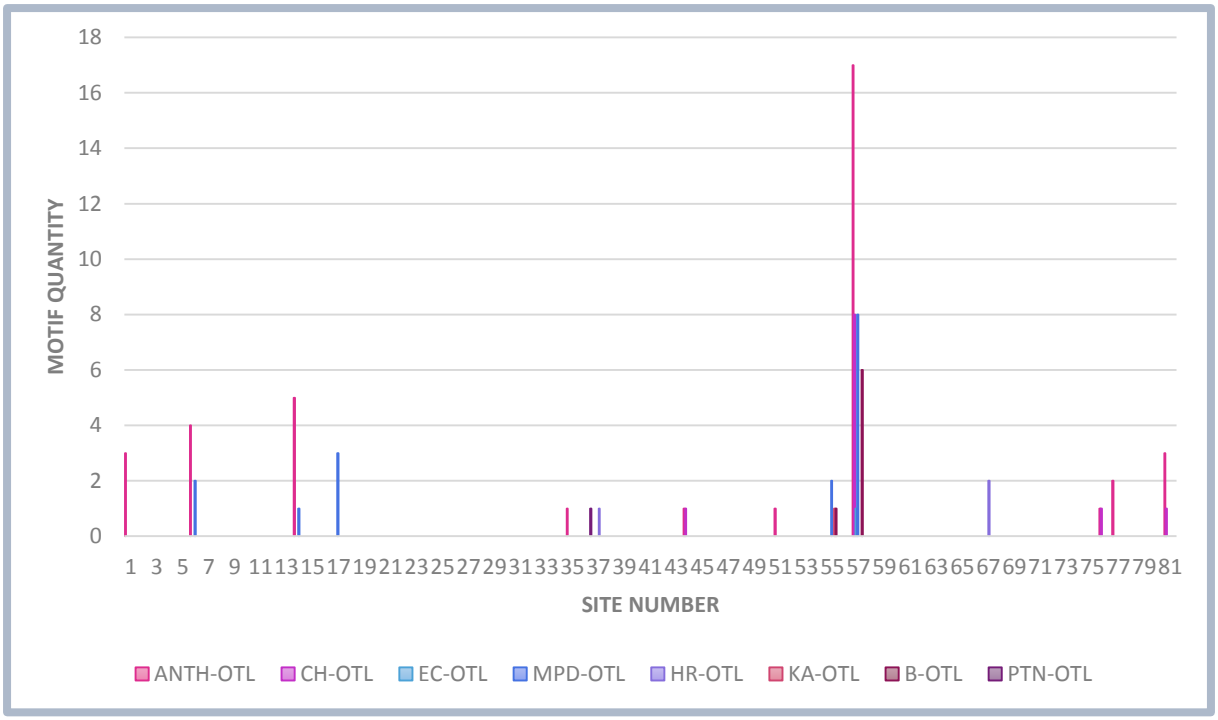

Figure 30: Graph showing the quantity of outlined and refreshed images at each site

4.7 Summary

The method for site categorisation was based upon the evidence of intensity of domestic site use. The objective of this model was to understand the range of sites used, from those used intensively for domestic habitation purposes through to those showing little or no evidence of domestic habitation. This would then be used to test the proposition that space was divided into areas dedicated to specific social practices such as spiritual, ritual, or domestic activity (McCall 2010:777; Kelleher 2002:3-4; Rappaport 1999:33).

The site categories were analysed with motif types using MCA and MFA to determine if a relationship existed. The result from using both statistical methods was that there was no pattern of relationship between any of the motifs and site categories. A group of motifs including anthropomorphs, culture heroes, macropods and hand and other stencils exhibited a negative correlation with non-habitation sites. Motifs were likely to occur in sites that were low, moderate and highly intensively used. There was no evidence of a correlation with any motif type from one end of the habitation spectrum to the other. There was no evidence of specific art motifs being spatially remote or distinct from habitation and domestic sites.

Elevation zones were also assessed to determine the presence of specific patterns within the motif types using both MFA and MCA. The objective was to determine if proximity to resources, and travel ways, influenced the presence of specific motifs. For example if eel motifs were strongly correlated with stream bank and lower slope sites, it might be arguable that because these sites are close to the place that the eel lives, or is harvested, the paths of least expense or proximity to the resource might explain an increased presence in the rock art. However no correlation between elevation and motif type was revealed. This could be argued to be evidence that the motifs were not representative of their being a nearby resource that was being celebrated, but a presence relating to their totemic importance. This is further validated by the presence of engraved motifs such as eels on ridge-top rock platforms, far removed from their habitat.

Interrelationships between the motif types was considered using PCA, MFA and MCA. The analysis considered relationships through both quantities, and the presence or absence of motifs. The result indicates that culture heroes will normally only be present if anthropomorphs are present, indicating a possible connection in the meaning expressed. Though anthropomorphs will often be present without culture heroes. A similar correlation appeared evident for eels and patterns.

An analysis of the sites data indicates that the correlation between motifs is largely influenced by specific sites with higher volumes of a set of motifs that would normally not occur together in many other sites. Specific sites are having a strong influence on the PCA correlation results. This was validated using MCA which tests for the presence and absence of motifs at sites. It was found that when quantities are no longer considered, there is no evidence of the correlation indicated in the PCA results. Behaviour at specific sites is responsible for the PCA correlation results. For motifs such as humans, there is an apparent independence of meaning being expressed from all other motifs.

An analysis of motif quantities indicates that some sites show more intensive and repetitive application of motifs suggesting ritual may be associated with the motifs and site use. It has been argued that the presence of repeated sequences of action (Rappaport 1999:221-389; Drennan 1983:31; Ross and Davidson 2006; Conkey 1985:304-319) are evidence of ritual behaviour. If we consider the example of the Upper Double Cave, there are 30 repetitions of the same eel motif, with little or no variation within these motifs. Multiple reproduction of a

motif is likely to have brought some kind of benefit to the artist (Ross and Davidson 2006:319) or group.

When outlined and redrawn motifs were assessed, there was found to be a significant correlation evident between macropods, birds, culture heroes and anthropomorphs, together with anthropomorphs that have not been redrawn. Further analysis of this result revealed that one site is heavily influencing this result, and this site may have included a dedication to the practice of renewal, or refreshing the art. Human motifs remain uncorrelated with other motifs after redrawing.

When sites showing signs of ritual and renewal are assessed against the site categories there is no evidence of this activity being performed spatially remote from domestic habitation suggesting changing contexts were occurring within the same space.

5 Discussion

The first section of this discussion describes how people used rock shelters. This analysis led to the adoption of the model of assigning categories of site on the basis of the intensity of habitation use. This model has been described in the Methods chapter. The original intention was to assign categories on the basis of site function, however this proved inconclusive for the reasons articulated in this discussion. The second section discusses how the behaviours associated with the production of rock art were integrated with the domestic use of shelters, and how the constraints that influenced domestic site use also influenced the cultural use of the sites.

5.1 How people used rock shelters

5.1.1 Rock shelters were only suitable for small groups for short periods

Social responsibilities included sharing resources and information for the purpose of risk reduction and survival (Hill et al. 1987:1-31; Britt Bousman 1993; Binford 1980), and for maintaining social status and influence (Bird, et al. 2012:64-78). These responsibilities were associated with both kin relationships, and relationships within the wider group. This influenced the arrangement of camps including camp size, and the proximity of occupants to each other (Gargett and Hayden 1991; Howitt 1996; Memmott 2007:112-129). The small size and physical constraints of rock shelters mean that they could not accommodate large groups, or provide for the social requirements of large groups. Rock shelters are likely to have only been for short temporary use when small numbers of people were away from the larger open camps.

There are no historical accounts of bark shelters being used in the steep ridge country of the PYWBM and only one account in the more gentle country north of the study area. Due to impacts of disease and colonisation it is not clear to what degree bark shelters would have been used in the area prior to the arrival of Europeans. The large camp recorded by Howe (1819) would have enabled the maintenance of the kinship relations, and maintenance of the social responsibilities of members of the wider group (Gargett and Hayden 1991; Memmott 2007:112-129). It would have also enabled resource sharing and reduced risk to the group (Hill et al. 1987:1-31). The large number of shelters with minimal artefact numbers and complexity indicates infrequent use of most sites, and it is likely that resources were not plentiful in much of the area (Cardillo and Alberti's 2013:1-12), meaning sharing

resources and information amongst the wider group would have been an important strategy for reducing risk (Hill et al. 1987) and for helping to ensure a consistent supply of resources. It is not surprising that Howe encountered a large open camp in the gentler country of the broad shallow valleys with their more resource rich swamps. Kohen's (1986:302-305) research of sites on the Cumberland Plain revealed that the major camps were clustered on the flat areas, and on terraces and rises around the lagoons and major waterways, providing ready access to water and the associated resources. The more rugged steep ridge and gully country that forms most of the PYWBM is unlikely to have supported large camps. Rock shelters are likely to have been an important source of shelter for small mobile groups when they were away from the larger camps. The location and availability of rock shelters in this country would have significantly influenced patterns of movement. Shelters were 'persistent places' that created a focus for habitation (Schlanger 2013:92-97). Where shelter density is low, the available shelters would exhibit increased intensity of use, and lower intensity in areas of high availability.

5.1.2 Factors influencing group mobility

The ruggedness of the terrain influenced the paths of least expense to resources and shelter. The foraging radii, the distance people travelled out each day from their camp to forage (Morgan 2008:148) would have been more restricted in the rugged country, with fewer options for movement out from the camp to forage. Risk and energy expenditure would have influenced and restricted these choices. Foraging radii may peak at between 8 and 10 kilometres (Kelly 1995, Morgan 2008), though this is expected to have been much less in the rugged ridge country. From years of experience walking in this country, a person of reasonable fitness starts to become fatigued after traversing about 4 kilometres on the ridge sides, and along the gullies. Unnecessary movement would be avoided in this terrain due to energy expenditure, the closest available shelter would have been the preferred choice.

Resource availability would have also influenced movement. Low resource availability also requires larger foraging radii which then acts as a driver for more frequent movement (Moore 1981:215). 68% of the sites in the PYWBM are categorised as Low Intensity due to the low numbers and complexity of artefacts and raw materials, and a further 20% of sites are Moderate Intensity that show a relatively low complexity in the artefacts present,

indicating low rates of repeated habitation. This indicates that resources were not plentiful in the area (Cardillo and Alberti's 2013:1-12).

In many parts of the research area habitable shelters are often found within one to two kilometres of each other. For example there is a ten square kilometre area of the Mellong Swamp country that includes 11 habitable shelters that all include archaeological evidence of use. A five kilometre section of the Left Arm Ridge provides ready access to eight shelters on the side of the ridge. With the ready availability of shelters, parties moving out to hunt and forage would have reached a point where the next shelter was in closer proximity and the cost benefit of moving to the new shelter, and the opportunity to exploit a new foraging area would have outweighed returning to the original shelter. There would also be a point where the resources available within range of the original site became exhausted and it would no longer be viable to journey the increasing distances to resources, and then return to the site (Kelly 1995:130-145).

High seasonal yields of a specific food type might cause a group to remain in a location for a longer period. For hunting parties pursuing larger prey the desire to move camp would be more amplified by the greater distance travelled. There will be little motivation to return to the previous shelter when a number of other suitable sites may have been passed during the pursuit, or be within range of the kill site. Frequent movement may also have been made as part of the strategy to conserve resources in the foraging area, rather than fully deplete the resource (Winterhalder 1981:18). Refer to Kohen's (1986:330-331) estimates of sustainable Kangaroo harvest for the Cumberland Plain, which suggests from 1 to 4 kangaroos maybe killed by a single hunter in a year. More than this is unsustainable. Kangaroo numbers are expected to have been lower in the PYWBM than on the broad grassed areas of the Cumberland Plain.

Rock shelter frequency would have created a natural impetus for small family sized groups to move frequently as foraging radii expanded and quickly breached the adjacent radii associated with other shelters. High energy expenditure from traversing the rugged terrain, and low resource availability would discourage returning increasing distances to the original shelter. These restrictions would have also influenced and constrained cultural behaviour. Other factors influencing movement would have included trading, socialising with the wider group at open camps, responsibilities relating to kin relationships, and group ritual and

religious activity (Kelly 1995:153-158). Due to the confinement of shelters these activities would all require moving away from the shelter.

Binford (1980:5-10) argues that for foragers that are extremely mobile there is very low visibility of archaeological evidence for sites being used as residences, plus there is a lack of evidence of specialisation and logistical behaviour. This is validated by the high number of low intensity sites identified, plus the absence of any evidence of specialised and logistical behaviour. There is no evidence at any of the sites of storage, caching, or processing associated with groups that maintain 'centres of settlement' (Morgan 2008:247-258).

The rock shelters would have afforded an expedient source of shelter. Bark shelters would offer the versatility for locating campsites in areas of choice when suitable rock shelters were not present, however, apart from the one recording of a large camp by Howe, there are no other accounts of their use recorded by Howe, Parr or Singleton during their crossings of this country. Setting up an open camp would require a resource intensive period to clear the area, obtain the construction materials by cutting the bark from a tree, and then erecting the structure. People would have adapted to the conditions taking into consideration the best outcome from the investment of their time and energy (Nelson 1991:60). Use of the available rock shelters in many cases, would have been the most energy efficient and expedient means of shelter for a small group.

The morphology of most rock shelters indicates that they were chosen for overnight stays, not just as temporary shelter for several hours, as could be afforded by the vast array of overhangs throughout the country. They are spacious enough to provide shelter and comfort. They were not solely landmarks chosen for their unique features, inherent meaning, or location in the landscape. They also had a functional requirement.

5.1.3 Limited evidence of functionally specific sites

The strategic position of sites was considered in conjunction with the archaeological remains, shelter size, and paths of least expense to resources to determine if sites would fit into a model of base, logistical, and transit camps, and other activity and specialised sites (Binford 1980, 1983; Brush 2006; Burns and Raber 2010). Sites were considered in terms of their position in the landscape to determine if they were strategically positioned to fulfil a specific purpose. For example a main mountain range spanning the country and bridging key

localities such as major valleys and river systems would be likely to have been used as a transit route and shelters positioned at key intersections along such ridges would be a suitable location for a transit camp. A site positioned within the swamp country from which foragers could easily radiate out from in all directions to resources and then return, at least expense (Kelly 1995) compared with other areas, would be considered to be strategically positioned as a base camp. A site that was mid slope and required traversing difficult terrain to access would be a short term site such as an activity site. When the strategic position of sites was considered together with the available archaeological material, sites could not be clearly defined on the basis of a functional purpose. Some sites that would have been candidates for a particular function such as a base, or transit camp did not exhibit the associated archaeological evidence. Whilst it has been argued that sites used for longer periods as residential bases exhibit more complex, and larger accumulations of artefacts (Binford 1980:10-19; Nelson 1991:82-83), it was found that some sites that had evidence of the most intensive use were not strategically positioned for use as a base camp. For example one site on the Coloul Range showing evidence of high intensity use does not appear to offer any strategic benefit for use as a base camp due to very rugged terrain needing to be traversed to and from the site, except in one direction from the ridge top leading to the site. It is in an area where there appears to be few suitable shelters along the main ridge, a ridge likely to have been a transit route. The site would have had concentrated use mainly due to a lack of suitable alternative shelters. In other areas where there is a larger range of available sites to choose from, there would be less intensive use of each of the available sites. In the case of the Coloul Range site the intensive use, and complex range of artefacts are not related to its use as a base residence, but more to do with the constraints imposed by the landscape concentrating more frequent short term habitation, rather than longer term use as a base. Similar problems were encountered with other sites. It was concluded that the method of identifying and categorising sites as functionally specific would not produce a reliable result. It is argued that a site may undergo intensive use due to the constraints of the landscape, but may not have been used as a residential base due to its position.

The analysis revealed that the most energy efficient strategy would have been for people to regularly move from one habitation to the next as it came into closer proximity, as the

current foraging radii widened. Sites were unlikely to have been dedicated to a specific functional use, and were likely to have changed in their role according to the needs of the group. The lack of functionally specific sites aligns with Binford's (1980:5-10) assertion, that for highly mobile populations functionally specific sites would not be observed.

On the basis of the low complexity and volume of artefacts and raw materials present at most sites, they were subject to infrequent use (Cardillo and Alberti 2013), though the degree of site use remained consistent throughout the last millennia (Attenbrow 2004:77). Once a site began to be used at a specific frequency and intensity it continued to be used this way. Shelters were 'persistent places' that influenced the pattern of use of the wider landscape (Schlanger 2013:92).

5.1.4 Habitation intensity

Some sites show clear evidence of repeated occupation, some appear to have been used sporadically, and others show a complete absence of evidence of occupation and domestic activities. Some are morphologically unable to support overnight habitation. However all types of site can potentially include rock art.

The lack of evidence for clearly defining sites on the basis of specific functions meant that sites were categorised on the basis of the degrees of intensity of habitation, with the aim of identifying patterns of change in the rock art that correlate with changes in the degree of domestic activity evident at sites.

5.2 The integration of the sacred and domestic

The results of the analysis indicate the coexistence of art associated with ritual, and religious beliefs with sites that were used for domestic habitation. There is evidence of the sacred and the mundane existing within the same space. The coexistence of archaeological remains for both ritual, and domestic behaviour has been identified at different hunter gatherer sites around the world, in a number of different contexts. In caves in Israel, evidence has been found for the co-existence of domestic habitation with ritual behaviour associated with the dead, and with burials (Grossman and Munroe 2007). Rock shelters in Alabama and Illinois reveal the coexistence of domestic habitation activity and ritual burials for both people and dogs during the Middle Archaic period (Walker 2010). Äikäs et al. (2009) found that it was not possible to separate ritual offerings from subsistence activity at Sámi sacrificial sites in northern Finland. The world view of the hunter gatherer being integrated

with their everyday existence. Berndt (1974:11) describes there being in one sense a 'continuum' existing from the spiritual world into the everyday for Aboriginal people, but he also acknowledges that this definition is not completely adequate. This is probably due to the existence of both dedicated and integrated religious and ritual practices. Spencer and Gillen (1927:224-225) recorded an Arunta ceremony that continued for five months. During this time there was a daily succession of ceremonies, sometimes up to five or six a day, with never a day missed. With such frequency and regularity of ceremony, it is unlikely that this could occur without a close integration with daily domestic life, due to logistic considerations and spatial constraints. The archaeological record for this type of behaviour is likely to exhibit a close relationship between domestic and ritual behaviour. Mulk and Bayliss-Smith (2007:98-99) point out that for many pre modern hunter gatherer societies the rituals that connected people with the spirit worlds were part of the everyday life of all members of the community. Rituals often took place within their dwellings. Modern religious practitioners also perform daily rituals of prayer and meditation within their domestic household, often with a small space dedicated to this practice. Their cosmology is integrated with their lives. Äikäs et al. (2009:111) argue that ritual actions may not be performed spatially remote, in specific contexts, or at special times and provide an example of the hunter who enters into a ritual performance with the animal spirit as a part of the hunt. The results of the research indicate that ritual associated with the art was not performed spatially remote from domestic activity, however specific contexts would have been required for both. Whilst there is ample evidence and argument for the integration of spiritual and religious behaviours with the domestic life, religious ritual by nature often involves a dedicated performance of actions that would not otherwise be required to satisfy domestic requirements, and it is performed at a different time.

Based upon their time spent with the Ngarinyin people of the Kimberley region, Porr and Bell (2012:198) provide an interpretation of the world-view held by the Ngarinyin elders. They recount an experience of visiting an art site in the Kimberley and a discussion with Mowaljarlai about how the paintings were made. Mowaljarlai explains that a man prepares himself by taking time out to quieten his thoughts, restricting food intake, and 'listening'. As part of the listening process the ochre is applied, but it is not considered that the man painted the image, rather it is the Wanjina that painted itself. This describes a very

ritualised, meditative, and religious process. The preparation and execution is likely to occur when an individual has removed themselves from the distractions of everyday domestic activity. Porr and Bell also describe the art as needing to be experienced as part of a dynamic and interactive process, as part of the law. The drawings are considered to be 'alive' and 'active' participants in the experience, they are considered to be in motion (Porr and Bell 2012:196). Again, this is describing a very engaged and focussed process requiring the experiencer as a participant in the process rather than just an observer of the art. They need to be free from other distractions as part of the process.

The distinction of the separation between the spiritual and domestic worlds can also be very apparent when considering this account by Porr and Bell (2012:195) on an occasion when they had visited an art site in the Kimberley. When they were about to leave to return to the domestic camp, the elders performed a smoking ceremony to ensure that the Wanjina spirits didn't attach themselves to anyone and leave the shelter with them, thereby bringing bad fortune to the person. There is a clear distinction here between the worlds of the spirits in the art shelter, and the domestic world of the campsite. Mathews (1897, 1895, 2005) and Howitt (1996) describe clear distinctions between the domestic camps and the ceremonial grounds for initiation ceremonies on the east coast. Large initiation ceremonies were performed on the east coast with some level of spatial separation from domestic activities. Close to the main camps ceremonial grounds were prepared, and when ceremonies commenced the initiates were removed from the camps at different times when undergoing specific rituals (Howitt 1996:509-560; Mathews 2005:104-134, 1897:2-3, 1895:414). These ceremonies were collective activities that helped maintain social structure and networks within the group (Mulk 1996). There is no record of small scale rituals that occurred within family groups, or within shelter habitations. The ceremonies recorded by Howitt (1996) and Mathews (1895, 1897, 2005) are large events that took place over a number of weeks.

McDonald (2008:298-350) describes both the use of shelters in the last millennium, and the application of a lot of the dry pigment art, as 'ad hoc'. Whilst this may be true for some sites, the evidence from this research suggests that some sites also had very deliberate and planned visits to apply, and to refresh the art. If we consider Mowaljarlai's (1988:690-693) descriptions of the purpose of rock art in the Kimberley and the behaviours associated with maintaining the art, he describes a very deliberate process. He describes the drawings as

‘images put down for us by the creator’. The art in the shelters all over the land is a ‘bible’, showing how nature was created. In order to bring increase and renewal the images are drawn, or redrawn, they are talked to, sung to and danced. This is describing behaviours involving ritual and performance, activities that are planned and have an objective, rather than being ad hoc.

When considering that 97% of rock art has been created in shelters suitable for habitation, and only 3% in sites not suitable for habitation, plus the volumes of art that are present increase in quantity relative to increases in the intensity of shelter use, there is a strong case for the coexistence of the religious and domestic contexts within shelters during each occupation event. Even those sites that have the strongest evidence to suggest that they were primarily sites of ritual and spiritual significance, include a morphology that enabled them to serve as habitation shelters. It is argued that this is the case because of the constraints that the landscape imposed upon the inhabitants, requiring them to use shelters in the most opportunistic way.

The integration of rock art with domestic habitation is the result of the resource availability and energy expenditure constraints imposed by the landscape and environment, and the spatial constraints of shelters, meaning that different contexts were required to exist within the same space. Space was perceived in a different way enabling contexts that might at other times be remote from each other, to occur within a shared space. Nearby sites that might have been the previous camp might have also taken on another role (Binford 1983:360-362) and have been used for the purpose of ritual and spiritual behaviour associated with the rock art. The spatial division within and around the broader habitation space being reflective of the profane and the sacred behaviours performed within this space (Mulk and Bayliss-Smith 2007:100). However the factors described earlier in this chapter that influenced group movement and the use of rock shelters including energy expenditure, resource availability and risk would have also influenced how sites were used for cultural activity. Any unnecessary additional movement in the rugged terrain would increase the energy intake requirements of the group. For example if a nearby shelter is only one kilometre away, if the energy expenditure requirements are considered (Kelly 1995:138-139), a return trip to this shelter in rugged terrain could significantly increase the energy intake requirements of a person. It is likely that resources were not plentiful in the areas

that were away from the major waterways and swamps. In these areas additional unnecessary movement would be avoided in the interest of risk mitigation. A more efficient use of the landscape, particularly during more stressful times would be to have a dedicated time for ritual performance, and to complete religious obligations within a shared space. Before and at the conclusion of these activities, the normal domestic behaviours associated with a camp would be undertaken including making fire, preparing and consuming food, the maintenance and use of tools, and sleeping. If Galanidou's (2000) concept of a 'cultural imprint' remaining as a result of the way space was used and perceived is considered and extended to include rock art, there is minimal evidence of the use of a broader habitation space extending beyond the shelter. Space was perceived in a way that enabled dual contexts to occur within the shelter. This perception of space is not unexpected for a highly spiritual people with a cosmology integrated with the everyday way of life.

The difference in the importance of each context is apparent in some sites where renewed art and sequences of superimposing are evidence in low intensity sites. Sites that were subject to sporadic and infrequent use as habitations were important spiritually as evidenced by sequences of the renewal of motifs.

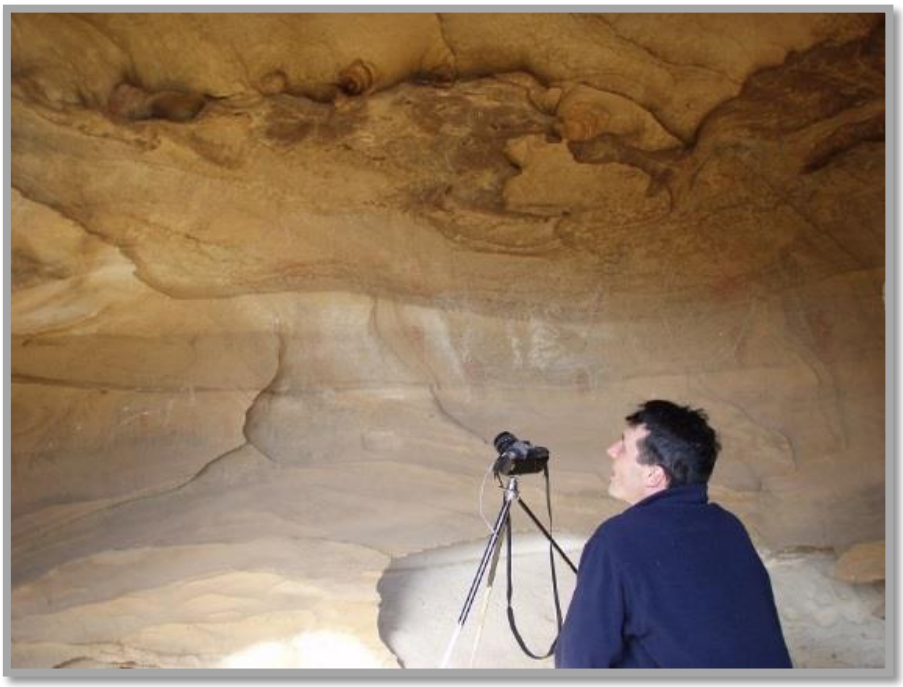

Figure 31: The Wallaby Cave is a Low Intensity site that has a surprising number of motifs with renewal and superimposing.

There is no evidence in the results that suggests that the viewing, and interaction with the art was exclusive. In this sense McDonald's argument that shelter art was for viewing by the public is upheld. There are also some sites that do not show clear signs of spiritual significance or ritual behaviour that may be as McDonald (2008:298) describes them, 'ad hoc' in nature, with the art being applied during a stopover, without pre planning or specific objectives.

6 Conclusion

This research achieved the aim of identifying site types, and categorising sites on the basis of the intensity of site use, and then statistically analysing the relationship between the sites and the rock art using multivariate statistical methods. This research applied a method that was based upon the approach used by McCall that was adapted to suit the conditions of the PYWBM.

The statistical analysis was applied in three different ways including to a combination of categorical and quantitative data, and then independently on both the quantitative and categorical data. In order to test these different data types and combinations the statistical methodology employed used MFA, MCA and PCA. It was found beneficial to test the data expressed in both categorical and quantitative data types in order to validate the interpretation of the results.

The methodology of categorising sites and applying multivariate statistical methods enabled more targeted analysis of the archaeology of the sites, and ultimately the identification of specific behaviours associated with these sites.

The research enabled more understanding of the use of rock shelters, and answers to the questions raised in the Introduction. Rock shelters in the PYWBM were used by small highly mobile groups. The energy consumption and expenditure requirements associated with moving through the terrain, the resource availability, shelter location and size, and group social requirements influenced the size of groups that used shelters, the time they spent there, and their movement within the landscape. It also constrained the activities performed within the occupation space. Sites do not show evidence that they were functionally specific, instead exhibiting varying degrees of intensity of habitation use. The activities performed at sites did not remain fixed as either domestic or religious.

Rock shelters provided an expedient source of shelter. When leaving shelters for daily foraging forays, the next shelter would often come within range of the foraging radii, creating a natural impetus to move camp, with a progression of camps that traversed the landscape. Rock shelters were focal points in the landscape that were readily used by people traversing the country. The size of shelters meant that they would only support a small group. Such a small group is likely to have remained together for only short periods

before they would need to reunite with the larger group to fulfil responsibilities relating to kinship relationships, and for the purpose of sharing resources and information as a way to mitigate risk, and for building and maintaining relationships. Low complexity of artefacts and associated raw materials in a majority of sites suggests that there was a low rate of re use of sites, and that resources were not plentiful.

Art motif content was analysed to identify motifs that were of significance to the Darkiñung on the basis of ethnographic records, and for behaviour associated with ritual, and renewal of the art. The analysis revealed that there are sites likely to be of greater ritual and spiritual significance than others. Some sites demonstrate greater significance through the presence of motifs of totemic and spiritual significance, motifs subjected to renewal and refreshing, large motifs representative of significance, and repetitive use of motifs suggestive of ritual behaviour. There is also a relationship between redrawn motifs at an individual site indicating that this site may have been dedicated to the renewal and increase of those beings represented in the images.

The analysis revealed that rock art, including drawings of spiritually significant characters, and art revealing behaviour associated with ritual and renewal, was not spatially separate from domestic habitation. The same constraints that influenced people's movement within the landscape also constrained and influenced cultural behaviour. Resource availability, energy consumption and expenditure, and risk mitigation strategies meant that spiritual, ritual and domestic activities shared the same space, but they occurred in a different context at different times, often within a single occupation event. Space was perceived in a way that enabled the co-occurrence of different contexts.

When people traversed the landscape, stopping to camp, the art probably acted as a sacred roadmap so that the landscape and the work of the totemic and creator beings could be understood, together with a person's place within this cosmology. This was part of the everyday connection of people with their spiritual worlds (Mulk and Bayliss-Smith 2007:98-99). At the times that the art needed to be maintained, renewed and redrawn, or when new images were drawn, the behavioural context within the site changed to that of ritual or religious performance, often for a period of time during the stay, which also involved domestic habitation. The art was not exclusive, it was integrated with the everyday life of the inhabitants.

6.1 Future research

The Literature Review section for the Perception of Space discusses the results of a comparison of sites from the Kimberley and the PYWBM that may be strongly influenced by different landforms and climatic conditions, and how the habitation space within these areas was perceived and used differently. A more comprehensive analysis between the east coast and northern Australia would enable greater insight into the influence of the landscape and environment on the perception and use of space. The results of this research may contribute to the global understanding of how these factors influenced hunter gatherer use of rock shelters, and the broader habitation space.

Detailed analysis of energy expenditure use required to traverse the terrain of the PYWBM and surrounding areas would provide a more accurate indication of the likely limits of foraging radii, and movement within the landscape. Current technologies enable the accurate measurement of energy expenditure. From this a better understanding could be obtained for the likely extent of movement, and foraging radii limits within the landscape. From this a methodology could be developed and applied to the broader Sydney Basin.

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