Spatial Analysis and Actor-Network Theory: A multi-scalar analytical study of the Chumash rock art of South-Central California.

(Volume 1 of 2 Volumes)

By

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Abstract

The aim of this research is to provide a more holistic approach to study Chumash rock art throughout their entire geographic region within South-Central California by applying geographic information systems (GIS), incorporating ethnohistoric and ethnographic data and utilising associated archaeological material under an Actor-Network Theory (ANT) framework. Through a review of past Chumash archaeological and rock art studies, I discuss where previous research is lacking and how that research was fragmentary due to focusing only on specific geographic areas or linguistic regions. As rock art is an artefact fixed within the terrain, I further argue it has a potential connection to the topography--particularly its relationship to Chumash landscapes and taskscapes by applying both formal and informed methodologies at multiple scales. By modifying the tenets of ANT to create a framework that uses the rock art data to define space, analyse its heterogeneity and connectivity and study its topographic entrenchment, this research conceptualises rock art's networks. To conduct this research, I collated a large body of spatial and descriptive information for 254 rock art sites and associated archaeology. Spatial analyses were performed at multiple scales using GIS as a heuristic to conceptualise site clustering, landscape entrenchment and anisotropic movement for the collated data. While the rock art sites were used to define the multi-scalar spaces, results show that the identity of the sites change throughout space and time where rock art itself is a network and not exclusive to one specific Chumash network. Analysis of the data shows that the topographic setting entrenches the rock art and begins to represent the dynamic assembly of its heterogeneous network relations. Movement through the landscape reflects how the sites were connected or structured within their landscapes and taskscapes. Overall it reflects rock art's interrelationships to the networked economic, social, ideological and political organisations of the Chumash and their rich ceremonial practices. Therefore, the Chumash rock art networks were as complex, dynamic, variable and heterogeneous as Chumash society and the rock art panels themselves.

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Glossary

Connectivity: The structure of the relationships within the heterogeneous topographical networks over multiple temporal and spatial scales. This term is an adaptation of ecological connectivity mapping through cost surface anlaysis applied by Latham et al. (2008) and, in this thesis, builds upon the entrenchment analysis to further topographically conceptualise organisational structures within the networks.

Entrenched/Entrenchment: The strength of the relationships within the heterogeneous topographical networks at multiple spatial and temporal scales where the stronger the network relationship the more it is apparent or reflected within the environment and the archaeological record. This term is an adaptation of the concept of entrenchment described by Inpen et al. (2007) and is the first step in identifying the network structures further expanded upon in the connectivity analysis.

Inclusive/Exclusive: An adaptation of the private versus public dichotomy first described in Chumash rock art by Hyder (1989) where inclusive refers to the varying degree that the population is allowed to view or interact with a rock art site while exclusive refers to the varying degree the population is not allowed to view or interact with a rock art site. Both terms are on opposite ends of a sliding scale that allows for multiple versions and reconstructions of the private/public dichotomy to exist.

Taskscapes: A term first introduced by Ingold (1993, 158) that describes an "ensemble of tasks", and further adapted by Robinson (2006, 33) to describe the mappable, associated activities and components of the activities found at rock art sites within the landscape at multiple spatial and temporal scales indicating a higher degree of inclusivity at the rock art sites.

Topographical heterogeneous networks: The overall connectivity and entrenchment of rock art and its associated archaeology to landscapes, taskscapes, the environment and the topography through the modified tenets of Actor-Network Theory based upon Inkpen et al.'s (2007, 537) 'topographical metaphor'. The data is used to define space and look outside of bounded territories within topographical space to understand the dynamic network relations between the rock art and the supernatural, social, economic, political and ideological aspects of the society.

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Chapter 1 Introduction

1.1 Introduction to Fieldwork and Research

The Making of Man

> After the flood Šnilemun (the Coyote of the Sky), Sun, Moon, Morning Star, and Sloʔw (the great eagle that knows what is to be) were discussing how they were going to make man, and Sloʔw and Šnilemun kept arguing about whether or not the new people should have hands like Šnilemun. Coyote announced that there would be people in this world and they should all be in his image since he had the finest hands. Lizard was there also, but he just listened night after night and said nothing. At last Šnilemun won the argument, and it was agreed that people were to have hands just like his. The next day they all gathered around a beautiful table-like rock that was there in the sky, a very fine white rock that was perfectly symmetrical and flat on top, and of such fine texture that whatever touched it left an exact impression. Šnilemun was just about to stamp his hand down on the rock when Lizard, who had been standing silently just behind, quickly reached out and pressed a perfect hand-print into the rock himself. Šnilemun was enraged and wanted to kill Lizard, but Lizard ran down into a deep crevice and so escaped. And Sloʔw and Sun approved of Lizard's actions, so what could Šnilemun do? They say that the mark is still impressed on that rock in the sky. If Lizard had not done what he did, we might have hands like a coyote today (Blackburn 1975, 95).

Figure 1.1: Animal 'hand-prints' embedded into rock. A sample of the petroglyphs at Bear Track Cave (CA-SBA-1627) in Los Padres National Forest, California. Photo by Michelle L. Wienhold.

South-Central California is the host to dynamic physiographic regions that are both awe-inspiring and breathtaking. Travelling north from the Santa Barbara coastline, where I had a view of the Northern Channel Islands (Figure 1.2) to the south, up through San Marcos Pass and into the Santa Ynez Mountain range, I could not help but be struck by the beauty and majesty of the area. Driving along San Marcos Pass or the Chumash Highway, I began to see navigation signs for Chumash Painted Cave State Historic Park (Figure 1.3). This marks the first sign travelling inland of the elaborate, polychromatic art of the complex hunter-gatherers that lived in this area beginning at least 10,000 years ago that are today called the Chumash people. By travelling from Painted Cave onto a small road called East Camino Cielo, I was afforded the stunning views looking south to the coastline (Figure 1.4, 1.5 and 1.6) or north into the backcountry and further inland (Figure 1.7 and 1.8). This beauty was just a sample of the area that was a home for thousands of years to the Chumash people.

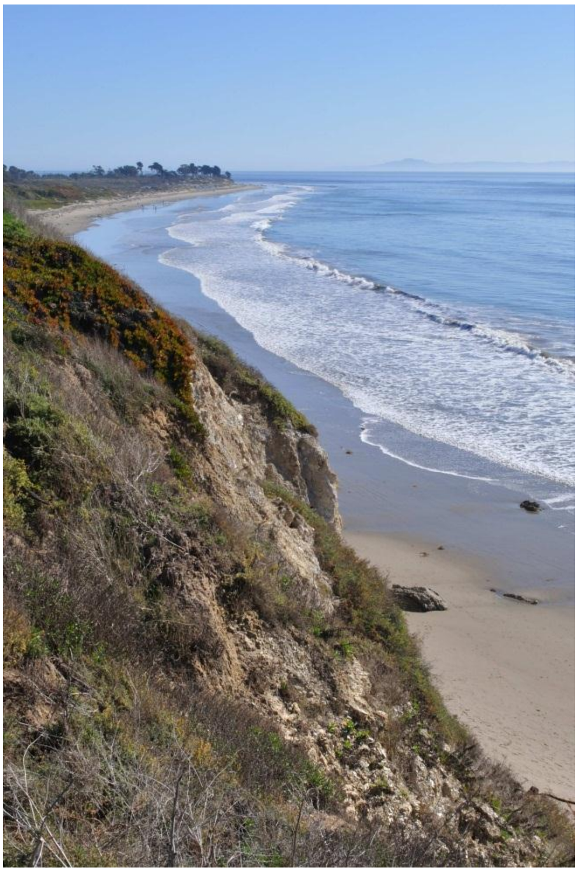


Figure 1.2: View overlooking a part of the Santa Barbara coastline in Goleta, California. Through the fog, you can barely make out the Northern Channel Islands. Photo by Marcello Di Bonito.

Figure 1.3: Painted Cave (CA-SBA-506) located in the Santa Ynez Mountains. Photo from the Santa Barbara Museum of Natural History. Photo © Mark Arnold.

Figure 1.4: A view from the Santa Ynez Mountains to the Santa Barbara coastline. Photo by Marcello Di Bonito.

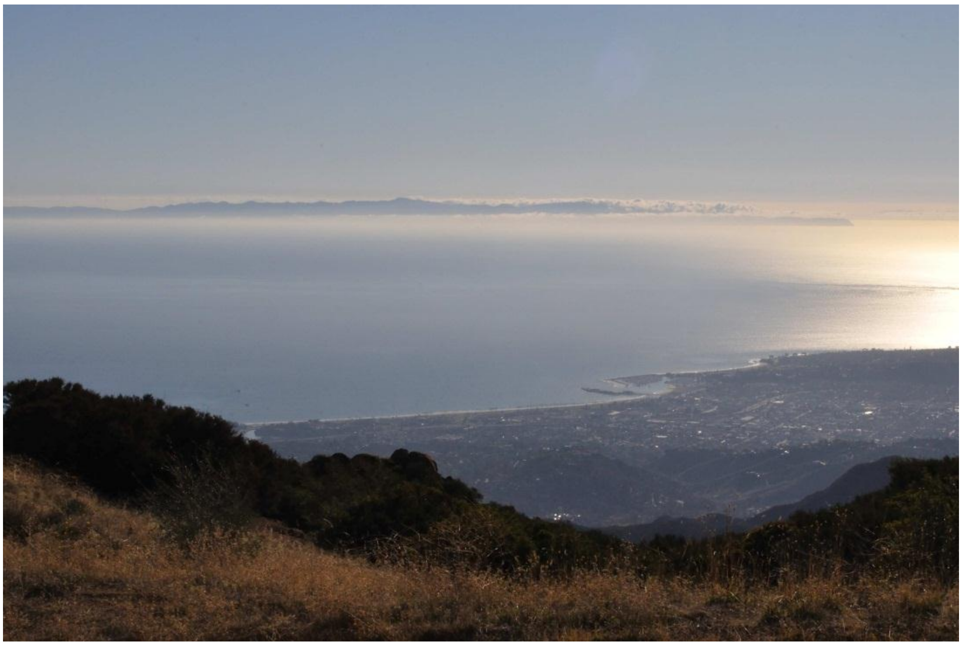


Figure 1.5: A view from the Santa Ynez Mountains to the coastline. Photo by Marcello Di Bonito.

Figure 1.6: A view from West Camino Cielo in the Santa Ynez Mountains of more of the mountain range and the coastline. Photo by Michelle L. Wienhold.

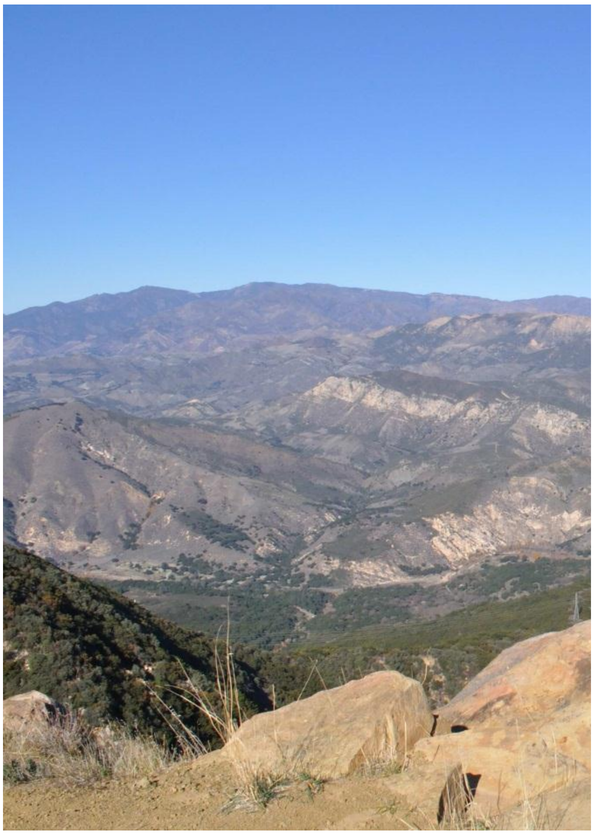


Figure 1.7: A view inland from East Camino Cielo Road in the Santa Ynez Mountains. Photo by Michelle L. Wienhold.

Figure 1.8: A view inland from East Camino Cielo road in the Santa Ynez Mountains with modern graffiti. Photo by Marcello Di Bonito.

During my fieldwork, I lived and worked at the Santa Barbara Ranger District in Los Padres National Forest within the backcountry. Hiking and exploring this rich landscape immediately near my temporary home provided a further backdrop of the area inhabited by the Chumash (Figure 1.9 and 1.10), and by experiencing this environment, I began to realise how expansive and intricate the overall Chumash network truly was. Further visiting rock art and archaeological sites in the immediate area (Figure 1.11), I began to conceptualise their multiple interrelationships that included rock art and its relationships with the surrounding archaeology and environment. Yet the rock art sites were also connected to sites and areas much further inland, and throughout the Chumash region, by the ubiquitous elements and motifs of the rock art and the archaeological material.

Figure 1.9: Santa Barbara Ranger District of Los Padres National Forest. Photo by Michelle L. Wienhold.

Figure 1.10: Santa Barbara Ranger District of Los Padres National Forest. Photo by Marcello Di Bonito.

Figure 1.11: Los Laureles Baptist Camp (CA-SBA-1484) located in the Santa Barbara Ranger District. Photo by Michelle L. Wienhold.

While living in California for six months from September 2011-March 2012, I had the opportunity to visit sites throughout the Chumash region with local archaeologists and site stewards for Los Padres National Forest. Sites such as Swordfish Cave (CA-SBA-0503)[1] (Figure 1.12) and Window Cave (CA-SBA-0655) along the Vandenberg coast; Condor Cave (CA-SBA-1633, Pool Rock (CA-SBA-1632), Bear Track Cave (CA-SBA-1627) (Figure 1.1), and Negus Cave (CA-SBA-1628) (Figure 1.13) in the San Rafael Wilderness; Painted Cave (CA-SBA-506) (see Figure 1.3 above), Los Laureles Baptist Camp (CA-SBA-1484) (see Figure 1.11 above) and Winchester Caves (CA-SBA-509) in the Santa Ynez Mountains. Finally through a field school on the Wind Wolves Preserve, I was able to visit Three Springs (CA-KER-3388) (Figure 2.6), Pleito (CA-KER-5619) (Figure 2.7), Lizard Cave (CA-KER-5525), Pond (CA-KER-1625; CA-KER-1636) (Figure 1.14), Echo (CA-KER-5571) and Chimney Springs (CA-KER-5615). I experienced the extreme variability of the Chumash environment and terrain through challenging hikes to remote areas to reach some of the rock art sites. For example, to arrive at the sites within the San Rafael Wilderness, the trailheads were reached through driving paved but narrow roads and vehicles were left for sometimes four-hour one-way hiking trips over rough and rocky terrain. Trails often had sheer drops to one side and hiking sometimes required scrambling uphill through thick chaparral as the trails had been washed away or destroyed through fire. Throughout my fieldwork and especially through the rock art site visits, I developed an appreciation for the rugged beauty of the South-Central California environment.

This experience also caused me to question the interrelationships that the rock art had with the Chumash landscape and other aspects of Chumash society such as their mythology (an example presented at the introduction) and their ideology. Therefore this thesis is about the exploration of the variable relationships that rock art had within Chumash society and to understand how everything within their landscape was connected or overlapped. I wanted to use GIS and spatial analysis to conceptualise these interrelationships at a variety of scales to synthesise the structuring principles or network relations that compose their networks through the

[1] This number refers to the California trinomial used to uniquely name an archaeological site. The first part of the trinomial refers to the state abbrieviation (e.g. CA), the second part is a reference for the county (e.g. SBA or Santa Barbara County) and the third is the site number.

use of rock art data, archaeology, and ethnohistoric and ethnographic information. My original research question was:

- **What relationships did rock art have within the various aspects of Chumash society and how does it reflect Chumash ideology?**

Figure 1.12: The swordfish motif and Swordfish Cave (CA-SBA-0503) near the Vandenberg coast. Photo by Marcello Di Bonito.

Figure 1.13: Photo of one motif at Negus Cave (CA-SBA-1628). Photo by Michelle L. Wienhold.

Figure 1.14: A view from Pond rock art site (CA-KER-1625; CA-KER-1636) on the Wind Wolves Preserve. Photo by David Robinson.

<u>1.2 Originality</u>

This thesis is the culmination of three years and two months of research to create a body of work that presents a more holistic study of Chumash rock art through theoretical applications and spatial analysis. Previous Chumash rock art analysis has focused on one of the multiple Chumash linguistic groups or was based on the physiographic regions (e.g. for the Santa Ynez Mountains and backcountry of the Inseño Chumash see Grant 1965; Hudson and Conti 1984; Hyder 1987; 1989; 2002; for the San Rafael Wilderness of the Inseño and Cuyama Chumash see Horne 1981; Lee 1981; for the Sierra Madre Ridge of the Inseño and Cuyama Chumash see Horne and Glassow 1974; Horne 1981; Lee 1984; Lee and Horne 1978; for the San Emigdio Hills of the Emigdiaño Chumash see Lee 1979; Reeves et al. 2009; Robinson 2006; 2007; 2010a; 2010b; 2011; 2013; In Press; for the Vandenberg coast of the Ventureño Chumash see Robinson 2004) while research of a more regional distribution only utilised a small sample of rock art sites (e.g. Hudson et al. 1979; Lee and Hyder 1991). The lack of a collated body of work utilising the regional distribution of rock art sites, with their known verified and validated geographic locations, was a gap in the research that needed to be filled to expand on Chumash rock art knowledge. It was also important to further incorporate rock art into the theoretical discussion on the complexity of Chumash society (e.g. Arnold 1992; 2001a; 2001b; 2004; Gamble 2008; Glassow 1996; Johnson 1988; 2000; Kennett 2005; King 1990).

Geographic information systems (GIS) and spatial analysis of Chumash rock art had been previously applied to the area attributed to the Emigdiaño linguistic group through Robinson's (2006; 2007; 2010a; 2010b; 2011; 2013; In Press) research, but without a full geographic distribution database, rock art analysis could not be expanded throughout the Chumash geographic region. My research, therefore, is extremely important to Chumash researchers and California rock art researchers as I have studied and analysed well over 1,682 archaeological site records from various land-holding organizations and data-curating institutions found within South-Central California that hold Chumash site information. From the extracted information during my six-month fieldwork, I was able to create the first Chumash rock art database with 254 known rock art sites (see Chapter 6 for more information on data collation and database creation). Furthermore, I incorporated specific and relevant information concerning rock art types, ubiquitous motifs, and associated archaeological material to conceptualise, contextualise and understand how rock art is associated to both their landscape and taskscapes.

Through this database, I was able to successfully apply new and innovative theoretical methods utilising Actor-Network Theory (ANT). Various reserachers have described the Chumash region as a variety of social, economic and political networks or interrelationships (e.g. Blackburn 1976; King 1976; Gamble 2008; Robinson 2011). Through GIS and spatial analysis at multiple scales, I was able to further describe these network relations using rock art data with positive results. By expanding on the extensive research previously performed on Chumash rock art, I have created a more holistic picture of how rock art was integrated within Chumash society and how the whole Chumash region is comprised of multi-scalar, heterogeneous networks. I further demonstrate how rock art is also interwoven, connected and entrenched within the social, economic, political, and ideological networks and supported through the ethnographic and ethnohistoric literature.

Below is a list of the originality of the work presented in the following chapters.

1) No complete database of all known Chumash rock art sites previously existed encompassing all of the linguistic and physiographic regions attributed to Chumash society. Therefore, I created the first comprehensive Chumash rock art database.

2) Incorporating information on the different rock art styles, ubiquitous motifs and associated archaeological material further comprehensively expands the new information presented in the database.

3) Therefore, while geographic information systems (GIS), spatial analysis and quantitative analysis have been done for a selection of the various linguistic and physiographic regions, I applied the first GIS and spatial analysis to the whole Chumash region.

4) Ripley's *K*-function has never been used to study rock art sites.

5) I also incorporate a strong theoretical basis for my study of Chumash rock art through the application of ANT and the modification of its tenets. ANT has never been applied to Chumash rock art or rock art studies within the state of California.

6) Chapter 4 presents the first literature review of international applications of GIS, spatial analysis and quantitative applications to rock art sites.

1.3 Conclusion

The Chumash oral narrative at the beginning of this chapter describes an interaction between the First People and rock that created a permanent record in the sky through Lizard's trickery. Although little information exists within the ethnohistoric and ethnographic literature concerning the creation of rock art (Hudson and Underhay 1978), information does exist concerning the rich and nuanced interrelationships that existed between the various aspects of Chumash society. Rock art was a part of these variable relationships. The next chapter begins with a detailed overview of the Chumash to begin to understand their society through the ethnohistoric and ethnographic literature and the archaeological record. Furthermore, in order to create a theoretical background to study rock art's interrelationships, I will expand on past theories used to study both Chumash society and their rock art.

Chapter 2 Chumash Society and Current Theoretical Research: A Critical Perspective

2.1 Introduction

In order to conceptualise rock art and the role it played within the Chumash society, it is necessary to discuss not only the society itself but also current theoretical research. The research aids in better understanding of Chumash social complexity, trade and economic systems and subsystems, political ties and the set of beliefs that defined and structured their society—their ideology. It is necessary to understand the Chumash people and how they interacted within their geographic region. Furthermore, this chapter describes what a distinctive society the Chumash were, not only within California but also worldwide. While their rock art is considered some of the most complex in the world, it is perhaps ironically left out of the more theoretical discussions on Chumash complexity (see Robinson 2007).

Archaeological research of the Chumash is extensive, but the most intensive research is focused on the Island and Coastal Chumash and their role as complex maritime hunter-gatherers (e.g. Arnold 1992; 2001a; 2001b; 2004; Gamble 2008; Glassow 1996; Johnson 1988; 2000; Kennett 2005; King 1990). Most of the recent and current literature on prehistoric Chumash society is based upon ethnographic/ethnohistoric accounts and archaeological investigations on the Northern Channel Islands and along the Santa Barbara coastline (see Figure 2.1 below). Spanish explorers wrote the first ethnohistoric documents that provide important details about the Chumash. Further documentation is from the Franciscans of the missions who were responsible for forcing the Chumash's conversion to Christianity and assimilation to Western society. While there is no dispute that these ethnohistoric authors produced a wealth of information concerning the Chumash, it must be read with caution due to biases. The voice within the first written accounts is, at its worst, paternalistic due to their ethnocentric views that the indigenous people were inferior, and their writing can be disrespectful to the Chumash's native cultural beliefs (Gamble 2008, 41). As Kennett (2005, 92) states: "the vagaries of the ethnohistoric record warrant suspicion and the proposition requires independent evaluation with archaeological data". Further information exists based on the ethnohistoric evidence gathered since 1542, through the mission period and culminating with the work of ethnographer J.P. Harrington during the first half of the 20th century (see further discussion in Robinson 2013).

Contextual information is found from the mitigation of habitation sites, large shell middens and material associated with cemeteries. In comparison, inland and interior Chumash groups have received very little attention from scholars over the years. The information from the island and coastal excavations is extrapolated to cover the extensive and diverse geographic and cultural area (Robinson 2006), but the inland and interior inhabitants were not the maritime hunter-gatherers that lived on the islands and coastal regions. While the inland and interior regions have been extensively researched in the past (e.g. Horne 1981), research on the interior Chumash focusing on the rock art and archaeological context, is being renewed by Robinson's (2006; 2007; 2010a; 2010b; 2011; 2013; In Press) research on the Wind Wolves Preserve located within the Emigdiaño linguistic region (see Figure 2.3 for a map of linguistic regions below). The interior is being additionally explored through research on cache caves, defined as "numerous dry caves, distributed across the Santa Barbara backcountry region, are associated with assemblages of remarkable indigenous material culture" with their dry environments providing ideal conditions for well-preserved organic artefacts (Robinson et al. 2012, 283). Cache caves are currently being analysed for their role within Chumash society and as potential post-contact refuges (see Whitby 2012; Robinson et al. 2012). Whitby (2012) has also created a comprehensive database of cache caves including the associated artefacts. Overall, bead chronology has played an important role in dating the sites (King 1990) and developing an overall chronology, while understanding the socio-political complexity of the Chumash is central to most of the research done today (see more below).

The rock art of the Chumash is considered some of the most elaborate and complex in the world with its compositions of polychrome paintings and anthropomorphic, zoomorphic, geomorphic and variety of abstract designs. The focus of much of the rock art research has been on conservation and preservation, style and chronology and hypotheses on suitable environments where the rock art is found (see Chapter 3 for a review of theoretical studies on the rock art of the Chumash).

Unfortunately, as I discuss further below, rock art research is rarely integrated within the main theoretical studies of the Chumash, and oftentimes, rock art's archaeological context and spatial associations are neglected. Rock art is simply mentioned as a result of supernatural interactions, often by shamans, during vision quests and maintains the idea that there was an exclusion of the general population at these sites (e.g. Whitley 2000). It has been disconnected in the intensive archaeological and theoretical investigations on the rise of the Chumash elites along the islands and the coast, yet rock art is oftentimes found in association with the archaeology. On the islands there are three known rock art sites (Jennifer Perry pers comm. 2013). The majority of the rock art sites are found within the inland and interior where the chronology of these complex paintings cannot be confirmed without damaging the integrity of the site. Therefore, researchers bypass the incorporation of rock art studies within theoretical analyses of the rise of socio-economic and political complexity centred on the island and coastal populations. Rock art is still an important component of Chumash society, and due to its fixity and immobility within the landscape, would have played a role in the many networks and interrelationships that created their society. It must be included in future theoretical discussions.

In this chapter, I discuss the complexity of the Chumash and highlight the cultural theories that are being extrapolated over large stretches of varying physiographic and ecological regions to describe their elaborate socio-economic and political systems and subsystems. I critically argue that rock art, an important aspect of Chumash society, has been ignored in past decades within the main theoretical discussions on the rise of Chumash complexity. Rock art's integration into current theoretical discussion is often left out due to a lack of chronology, but as a major and complex part of Chumash society, it should be above more than a few sentences or left to a group of rock art researchers to analyse. Importantly, in the following section, I will cover the information that currently exists concerning the prehistoric and historic Chumash as an introduction and contextual background to understanding the role of Chumash rock art within their society.

2.2 Chumash Complexity

2.2.1 Chumash Geography

The Chumash people inhabited what is now within the boundaries of modern day California, USA (see Figure 2.1). Their territory can be described as falling within the south-central part of the state that includes three broad ecological regions: Channel Islands, coastal zones and inland and interior areas (Arnold, 2001a). The islands consist of the Northern Channel Islands, with Santa Rosa, Santa Cruz and San Miguel inhabited year-round. Anacapa Island was only inhabited seasonally due to the lack of freshwater. The coastal populations lived across the calm, broad Santa Barbara Channel in present-day Malibu and extended up the coast to the northwest at Point Conception. At the time of European contact, most of the Chumash populations resided on this stretch of coast due to its rich marine and terrestrial resources. North of Point Conception to the north of the modern city of San Luis Obispo lived much smaller populations due to the heavy surfs making it less hospitable (Glassow 1996, 5). Inland Chumash groups ranged away from the coastal populations from the Santa Ynez Mountains eastward to roughly the Sierra Madre Ridge while the Interior Chumash groups ranged eastward to the San Joaquin Valley (Gamble, 2008, 6). This rugged and ecologically variable geographic region of the inland and interior is where most of the Chumash rock art is located.

Figure 2.1: The Chumash geographic region and cultural boundary developed by Kroeber (1925) with modern cities and boundaries.

The description above does little to understand how the Chumash perceived their "interaction sphere", a highly applicable term used to described their world originally coined by Hudson and Blackburn (1979, 24). From the ethnohistoric and ethnographic record, research has found that according to the Chumash their geographic region was comprised of a series of three, and possibly up to five, floating worlds that were stacked one above another (Blackburn 1975, 30; Hudson and Underhay 1978, 40). The middle world is where humans lived and where their day-to-day events took place (Blackburn 1975, 30). Hudson and Underhay (1978, 40) state:

> The Lower World was called *C'oyinashup* and was occupied by *Nunashɨsh,* powerful supernatural beings who were considered generally malevolent and dangerous to man. They were usually depicted in Chumash myths (and rock art?) as deformed or misshapen. *'Itiashup* was the Middle World, supported by two giant serpents whose body movements caused earthquakes. It was the home of the "First People", supernatural beings who were ambiguously described as having both human and animal characteristics and behavior; as might be expected, their culture was much like that of the Chumash themselves. However, the "First People" were not modern Chumash men, women, and children for they made their initial appearance in the Middle World prior to the creation of man. The Upper World was called *'Alapay, Mishupashup, or 'Alapayashup*. It was supported by a giant eagle whose wing movements caused the phases of the moon, and perhaps also solar eclipses. It

> was occupied by various celestial objects recognized as supernatural beings—Sun, Moon, Morning Star, some planets, and significant stars and constellations…

It was said that, in ancient times, the world was transformed through a flood that caused the "First People" to ascend into the Upper World and to also change into many of the flora and fauna in the Middle World and this is when humanity was created (*ibid*, 40). The Middle World was considered the centre of the universe and was comprised of an ocean where many small islands were floating; the largest, central island was where the Chumash dwelled (Blackburn 1975, 30). Attributes of this island were considered powerful, especially the mountaintops and various bodies of water where power was concentrated (*ibid*, 30). The mythology behind the Chumash worlds was even further distinct and complex creating rich oral narratives that were passed down through generations (see Blackburn 1975; Hudson and Underhay 1978; Librado 1981).

2.2.2 Palaeo-environment

The Chumash topography and environment were complex and dynamic throughout prehistoric and historic times. Their geographic area was highly affected by El Niño/Southern Oscillation (ENSO) events (the fluctuations of the sea-surface temperatures (SST)) of the Pacific Ocean that happens roughly every 7 to 19 years (Kennett 2005, 60). Events such as these were responsible for the environmental perturbations and the numerous climate patterns from the islands to the inland and interior. They are found to be even more dynamic at the decadal scale (Kirby et al. 2010). While the socio-political and economic impacts of these perturbations are under debate (e.g. Raab et al. 1995; Arnold et al. 1997; Kennett and Kennett 2000; Gamble 2005), it is currently accepted that for at least the past 10,000 years this area experienced dynamic sea temperature fluctuations and drought cycles. It is based on intensive palaeo-climatic and -environmental studies from the analyses of a variety of proxy data for the western United States (Cook et al. 2004; Woodhouse et al. 2010).

These fluctuations impacted the varying physiographic, ecological and linguistic regions differently but would have caused changes over time to the marine and terrestrial resources directly affected by changing SSTs and overland flow. Overland flow and evidence of prehistoric earthquakes along the San Andreas Fault line (see Sieh 1978) show that the palaeo-topography was also dynamic and susceptible to a wide variety of impacts and transformations. Examples of the effects of past climate change within the inland/interior regions were experienced through intermittent drought where “grass, sage, and chaparral seeds often lie dormant during drought years and germinate after fires or seasonally high rainfall” and “during La Niña intervals (between El Niños), drought is more common and terrestrial productivity lower” (Kennett 2006, 61). Environmental changes within this part of California were sometimes swift, happening at a scale of only a few years or decades, and entailing both changes in temperature and precipitation that would often “resculpt landscapes and rapidly change the nature of the habitats they contain” (USDA Forest Service 2003).

2.2.3 Chumash Language

No written records for the Chumashan language exist before the 18th century (Jones and Klar 2005, 472). Latham (1856) first named the language “Santa Barbara”, but Powell (1891) later renamed the language family as the “Chumashan” language. The word “Chumash” was chosen by Powell (*ibid*), and refers to the name the Coastal populations called the inhabitants of the Channel Islands, especially Santa Rosa, meaning, “bead maker”. The Chumashan language family, while once thought to be related to the *Hokan* language family (Golla 2011), is now purported to be unrelated to any other language family found worldwide (Jones and Klar 2005). The Chumash linguistic family is broken down into the Northern Chumash or Obispeño, Island Chumash and Central Chumash and is further divided into different dialect clusters that are associated with the Franciscan missions (see Figure 2.2). The three main branches roughly correspond to the major ecological zones found within the Chumash territory (Golla 2011, 194) (Figure 2.3). Further studies by Beeler and Klar (1977) explicitly studied the distribution of the Emigdiaño linguistic group and analysed their distinct vocabulary. All Chumash languages have been extinct since the death of the Mary Joachina Yee in 1956, a native speaker of Barbareño (Grant 1978b, 505).

2.2.4 Chumash Timeline

The prehistoric Central California timeline originally consisted of three main periods, developed around 1939, and was based upon information from beads and other Chumash ornaments (King 1990). The periods consisted of the Early, Middle, and Late Periods. Arnold (1992) further expanded this based upon her research on the

Northern Channel Islands and the Coastal Chumash to include a Middle/Late Transition Period (see Figure 2.4). As was stated above, the earliest evidence for Chumash occupation on both the mainland coast and on the northern Channel Islands is around 10,000 – 12,000 BP which correlates to the terminal Pleistocene and early Holocene (Arnold 2001a, 13). Studies suggest that some of the northern Channel Islands were inhabited at around 13,500 BP, and that habitation of all the major Channel Islands happened at around 7,500 BP (Kennett 2005, 4). In addition, the period between the first documented contact of the Spanish and the Chumash in 1542 until 1769 is known as the Proto-Historic as prior to this date contact was not consistent (Gamble 2008).

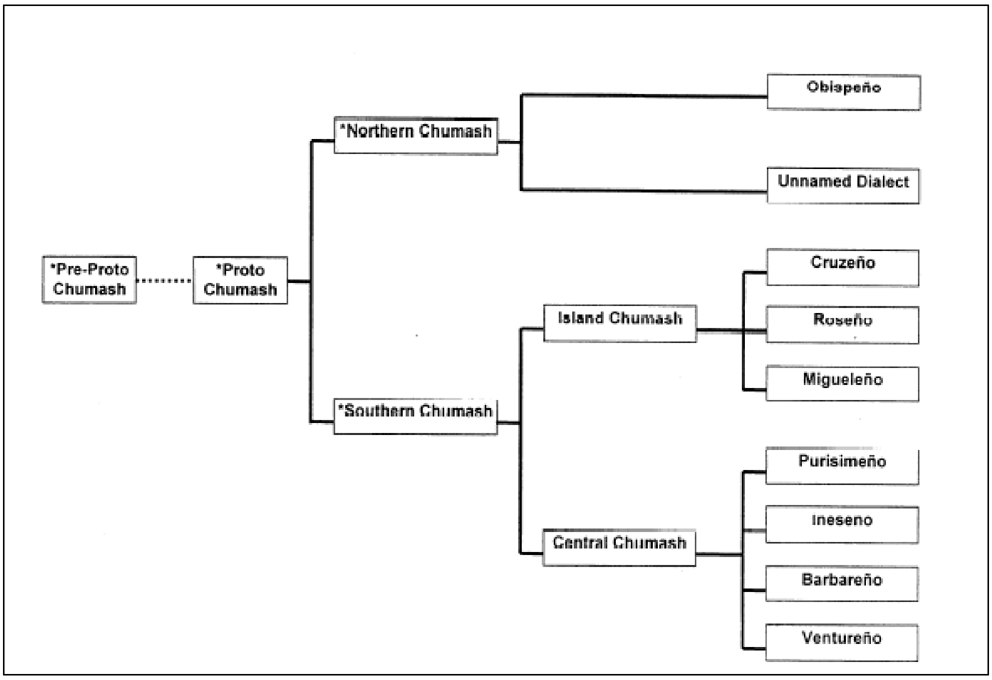


Figure 2.2: Language tree of Chumash/Chumashan language family and dialect clusters after Spanish contact in Jones and Klar (2005, 473, Figure 8).

Figure 2.3: Chumash linguistic boundaries and neighbouring indigenous groups as defined by Kroeber (1925) taken from Robinson (2010a, 796, Figure 1).

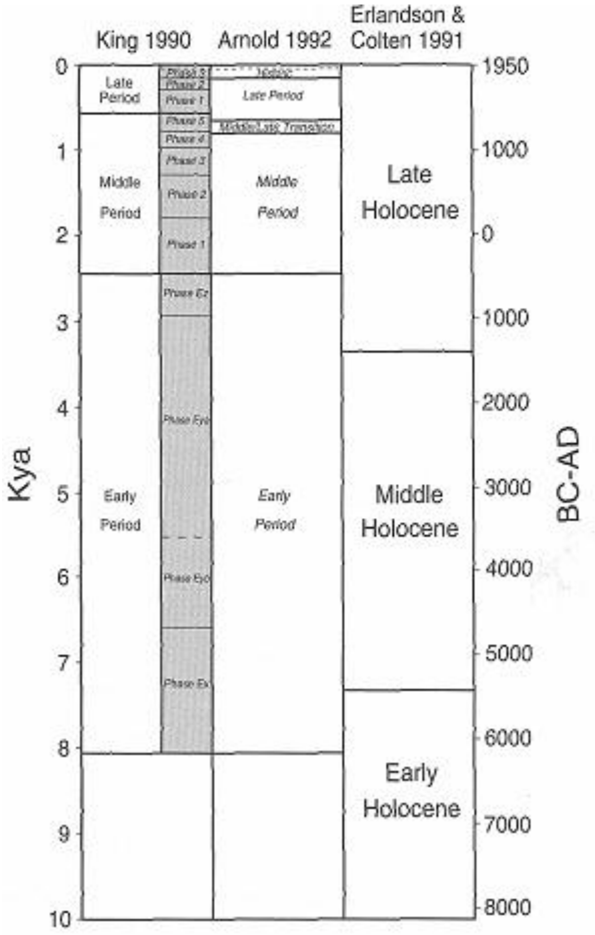


Figure 2.4: Chumash chronology for Northern Channel Islands. The time period 1542-1769, which is not included, is known as the proto-historic period (from Kennett 2005, 81, Figure13).

2.2.5 Chumash Social and Political Organisation

The Chumash, as complex hunter-gatherers, had a rich and elaborate socio-political organisation as reflected in the ethnographic and ethnohistoric literature and mortuary contexts. Communities along the Santa Barbara Channel, at the time of first contact, were considered large and complex compared to the rest of California because of their permanence and internal organisation (King 1990; Robinson 2006). It is purported that a shift from a mostly egalitarian society to a hierarchical society happened around the end of the Early Period along the Santa Barbara coast where power and wealth became inherited and not dependent upon economic wealth (King 1990). A Chumash settlement was the political centre where the socio-political structures were organised (Gamble 2008, 8). As Robinson (2006, 53) states “the role of the village as *axis mundi* in Chumash life is central to understanding social organisation”. Gamble (2008) states that the villages along the coast were more powerful due to their control of goods and trade networks passing between their region to the islands or inland/interior regions. All settlements had chiefs (*wots* in the Chumash language) where status was gained through inheritance, while other settlements may have had more than one secondary chief referred to as assistant chiefs (King 1990). However, Johnson (2000) has recently argued that, along the Santa Barbara Channel, the villages were more autonomous and heterarchically structured. According to J.P. Harrington (1942), there were female chiefs who inherited the position by being directly related to the chief (i.e. sisters or daughters).

Chumash households were comprised of a husband, wife, their children and an older relative (Johnson 2001, 54). Marriage was mostly matrilineal and created a social structure within each village comprising of closely related women and unrelated men (*ibid*, 54). Chief's marriages were different as they were polygynous. The wife or wives of the chief moved in from distant villages to secure political ties once he was established in his position of authority (Arnold 2001). Johnson (1988, 170-179) purports that some wives of chiefs did not move to her husband's village, but stayed in her natal village, and only saw him when he visited. Kennett (2005, 187) suggests that for the Channel Islands "the matrilocal residence pattern evident on the islands may be a product of a persistent threat from mainland communities that started during the early stages of the Late Holocene (1,300 BP) and intensified between 1,300 and 650 BP." In contrast, the Purismeño (Figures 2.2 and 2.3) may not have had a matrilineal organisation, according to mission data, nor did they have an elaborate or as well-defined chiefdom status; there was a less structured social and political organisation (Glassow 1996, 17).

In terms of gender roles, on the islands, "both men and women are reported in roles as bead makers, healers, shamans, ceremonial dancers and political leaders" (Johnson 2001, 68). Gender division, though, was apparent within their subsistence activities as observed during the Proto-historic and Historic Periods (Kennett 2005, 77); men were fishermen and women gathered plants and shellfish (Johnson 2001, 68). More recent research has begun in the past two decades on the roles of non-binary genders within Chumash society acknowledged in the ethnographic literature (see Hollimon 1997; 2000). Women and third-gendered men (biological males who adopted female roles called *'aqi*) were also responsible for the construction of often elaborately decorated, woven and twined baskets used for serving food and holding liquids (Gamble 2008). Third-gender males and post-menopausal women were also practitioners for the important mortuary rituals (Hollimon and Murley 2012).

Women could independently hold powerful positions within society that were not dependent on her husband's status, and they could control their own wealth (Blackburn 1975, 56-58). Women's statuses were often reflected within burial contexts and were sometimes associated with high-status and ritually important artefacts (Gamble 2008, 217). While the Chumash lacked any form of monumental architecture, gender-and sex-based spaces were constructed within the settlements for specific ritual observations. They included: menstrual huts, childbirth huts and male puberty huts that were intended for isolation during these rites of passage (*ibid*). Within Chumash society, "females were often depicted as malevolent beings who were dangerous or potentially dangerous, reflecting a tension or antagonism that may have actually existed between men and women" (*ibid*, 217). Gender and status differences were also reflected in the Chumash clothing and ornamentation. Women wore animal skins, often from deer or otter, as skirts (*ibid*, 2). Men did not wear clothing and painted their bodies, but were also know to adorn fur capes that fell to the waist and placed ornaments in their hair, such as beads or feathered headdresses (*ibid*, 2). Chiefs also wore fur capes, but these fell to their ankles and hair ornaments were bone pins "that were attached to long chert knives" (*ibid*, 2).

Additional evidence also argues that regional chiefs may have had authority over many other settlements, perhaps through marriage ties (Johnson 1988). Hudson and Underday (1978, 27) describe these networks of political settlements as "provinces" that were defined as geo-political territories consisting of a number of villages and other smaller permanent settlements or communities. Within each province there were at least one or more chiefs governing the individual communities (*ibid*, 27). Leaders of the individual communities were then further organised into a larger political council for the entire province (*ibid*). Evidence of autonomy between these provinces is shown by the numerous conflicts between the various provinces and documented during the early Historic Period (Johnson 2007). Furthermore, religion is purported to have had an even more powerful role in tying together multiple provinces (Hudson and Underhay, 27). Yet, they (*ibid*, 31) also state that there was also documented unease also between the religious territories as:

> It would appear too that each religious territory, despite the advantages of mutual interaction in economics and religion, maintained a cautious and even untrusting relationship with its counterpart. Relationships may sometimes have become competitive, perhaps with regard to trading activities with distant places inland or on the islands, or in the case of threatened territorial expansion.

Many other specialists also held influence and power within each settlement or community. A select few of the specialists, including the chiefs and their families, were all members of a group called the *'antap* society that consisted of 12 members who joined the group through initiation as children (See Table 2.1 for a selective list of the Chumash socio-political and economic organisation) (Gamble 2008, 56). It is also purported that the *'antap* society served as a means to integrate their members with other settlements throughout Chumash territory (*ibid*, 57) and is oftentimes referred to as a cult. Within most of the settlements the *'antap* were allocated the most substantial architectural space, the sweat lodge, that was not available to any non-members (*ibid*). Chumash also had members who were shamans and were in possession of magical powers often used to cure people but could also be malevolent (*ibid*). Hudson and Underhay (1978, 32) describe their benevolence as:

> Individually, the general rubric of shaman could be applied to cult members; for example, they had the ritual knowledge and supernatural powers to control the weather (divert or advert storms, and make rain begin or stop). They were also the ones entrusted with the administration of *Datura* and other medicines, the performance of rituals to cure the sick, or the aiding of an individual seeking a vision quest or dream helper in order to acquire supernatural power of his own.

The position of shaman was one of power through specific esoteric knowledge, as the Chumash believed that the world was filled with the supernatural that could only be controlled by the shamans (Gamble 2008). Oftentimes, shamans are purported to be men based from ethnographic evidence for neighbouring groups, such as the Gabrieliño, and women who did occasionally hold this role were said to be post-menopausal and considered evil (Whitley 2000, 29). Shamans are concluded to have created the rock art found within the Chumash region at the end of a vision quest brought on by ingesting hallucinogens such as *Datura* or *toloache*. The location of the rock art was considered to be a portal into the supernatural realm. The concept of rock art and shamans will be further expanded upon and critically reviewed in Chapter

3. Briefly here I will also touch on the position of the astrologer/astronomer as described by Hudson and Underhay (1978) and Blackburn (1975) who was also a member of the *'antap* cult. Their role within the society was to observe the celestial forces and how these forces affected the world (Blackburn 1975). Hudson and Underhay (1978, 32) discuss the astrologer's role:

> Quite logically his guiding world-view (or more correctly, cosmic-view) centered upon the acquisition of shamanistic powers from celestial beings, and the predictive-interactive abilities conferred by this knowledge. His knowledge allowed him to forsee man's future, and he could take steps to alter (when possible) the course of events for the common well-being of the people residing within his province. For the Chumash, the cosmos was seen as involving vast supernatural forces in a state of flux, and there were always overtones of peril of cataclysm for man which could be foretold and even avoided by exercising the proper rituals, knowledge, and special paraphernalia.

That paraphernalia could very well be the rock art found within the Chumash interaction sphere. Furthermore, there is evidence of a rock painting being made by a neighbouring Gabrieliño astrologer and told by Maria Solares, one of J.P. Harrington's informants. The narrative discusses portable rock art and a malevolent astrologer (*ibid*, 36):

> …a long time ago a great famine was created by an astrologer who painted several figures on stone of men and women who were bleeding from the mouth and falling down. This "evil" astrologer took the stone and went into the hills to expose it to the sun. Prayers for sickness were then made, and his efforts were rewarded. No rain came for the next five years, and many people died from hunger. Fortunately for people, a group of sorcerers found out about the painting. They saved people from death by tossing the stone into a body of water. This remedy apparently worked for soon it began to rain.

Chumash Name	English Name	Description
Wot	chief	Funded and arranged feasts, owned ceremonial paraphernalia, cared for poor and visitors, oversaw other offices, maintained stores.
temi or *paqwot*	"big chief"	Had jurisdiction over several settlements. Could mobilize these villages in case of war. Other duties probably similar to those of the *wot*.
shan or *san*	assistants to the *'antap*	Group of eight. Aid the *'antap*.
Ksen	messenger	Relayed messages to other settlements regarding feasts and other matters, carried money.
'alseke or*'i'enheshhesh*	"taker of the souls," executioner	Executed people.
ca canay y al or *jilicnash*	judges	Determined timing of feasts and passed sentences by order of the chief if crimes were committed.
paxa oralpaxa	ceremonial leader	Presided over ceremonies, collected offerings and fines, made announcements. Next to chief in power.
'antap	member of elite religious society	Group of 12 initiates in every major village, high status individuals, performed dances and music at ceremonies.
'altip'atishwi	master of herbs and keeper of poisons	Sorcerer with many herbs, poisoned wealthy individuals to insure they gave money or resources at ceremonies. Wore bags of poison. Member of *'antap*.
'alaqtsum	he who kisses	Captain of search parties at feasts to insure that no person had stolen anything.
'alchuklash	astronomer and astrologer, shaman/priest, smoke-doctor, pipe-doctor, included females and males	Determined phases of sun and moon, named newborns, foretold future, administered toloache, interpreted dreams, reported illnesses and social problems to the chief, cured the sick, smoked tobacco at rituals, handled charmstones, knew astrology, made rain, diverted storms, member of the *'antap.*
'alalxiyepsh	regular or curing doctor, herb doctor; included females and males	Paid for curing, not a sorcerer.
alaxtut'uch	sucking doctor	Extracted disease-causing objects from victims.
'alaleqwel 'itomol	"proprietor of a canoe"	Canoe captain or owner.
'aqi	undertakers	Dug the graves of dead people, "two-spirits", and post-menopausal women.

Table 2.1: A selection of the Chumash social, political and economic organisation taken directly from Gamble (2008, 58-59, Table 9). See Gamble (2008, 58-59) for a more comprehensive list and a full bibliography for each of the organisational roles.

2.2.6 Chumash Material Culture

The study of material culture and the role it has played in economic and socio-political development of Chumash society, especially the rise of the elites, has been predominant within the literature (e.g. Arnold 1992; 2001a; 2001b; 2004; Gamble 2008; Glassow 1996; Johnson 2000; Kennett 2005; King 1990). While these theories will be further explored below, this section aims to describe Chumash material culture, especially those artefacts that played an important role in defining their society as complex hunter-gatherers. The research has combined both the ethnographic and archaeological record to understand the structure of Chumash society throughout prehistoric and into historic times. One of the first series of comprehensive publications was created by organising J.P. Harrington's extensive notes that were subsequently published by Hudson and Blackburn (1979; 1983; 1985; 1986; 1987). In combination with the archaeological record, this has been significant to further synthesise Chumash society and provide information on their expansive and unique artefacts.

The *tomol*, or plank canoe, was central to Chumash heritage and facilitated advanced maritime travel networks, fishing and resource exchange between the Santa Barbara coastal areas to the northern Channel Islands (see Hudson et al. 1978 and Gamble 2002 for a more comprehensive description and discussion) (Figure 2.5). Evidence for their emergence is dated to about 1300 years ago although this is still debatable amongst Chumash researchers (Gamble 2008, 61). Past Point Conception, the Purismeño did not use plank canoes. *Tomols* were constructed using redwood that drifted down the coast of California, due to inaccessibility of large suitable trees, and sealed or waterproofed with asphaltum, a natural mineral found within the Chumash region. As one of the most expensive items of the Chumash, construction was laborious, often taking six months, and knowledge of the craft was only available to a few members of their society (Gamble 2002, 305). These vessels were usually about 8 to 30 feet (2.4 to 9 metres) long and would carry up to 12 or 13 people (Gibson 1991).

Owners of the *tomol* held high positions within Chumash society and were members of a craft guild whose membership was hereditary (Gamble 2008, 238) (Figure 2.4). Canoe owners held a position of power and wealth within Chumash society where money (shell beads, see below) was exchanged for transportation or maritime goods (*ibid*). *Tomols* were also used to transport the dead of high-ranking members of society, usually chiefs, into the afterlife (*ibid*, 2). This technology was utilised by the neighbouring Gabrieliño and it is believed that they obtained knowledge of the *tomol* from the Chumash (Hudson et al. 1978, 22). Arnold (2001a, 13) hypothesises that this travel over water was much more efficient in energy expenditure than carrying goods over land. Furthermore, Arnold (2001b, 288) states that the plank canoe was one of the most important socio-political aspects of their material culture as it was both an economical and temporal investment and crucial in the rise and maintenance of trade between the coast and the islands. The Chumash also used another more small-scale form of watercraft called a *balsa*, a raft made of tule reeds and sealed with asphaltum (Gamble 2008). These craft were likely common before the inception of the *tomol* and allowed the Chumash to travel and settle the Channel Islands. They usually held two to three people and were still used up until historic times.

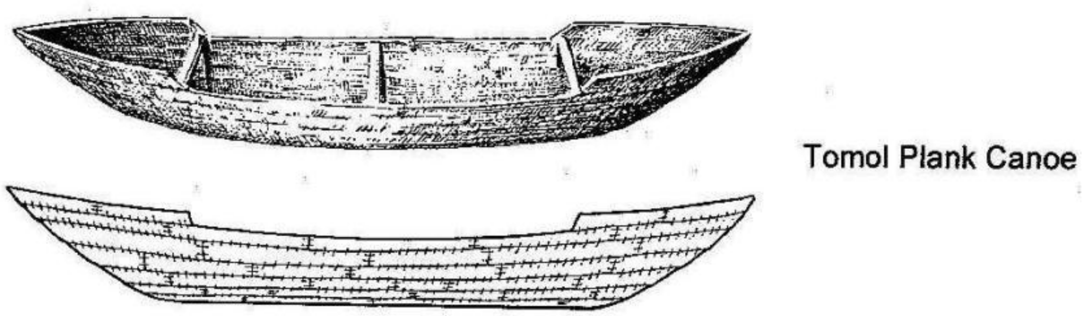


Figure 2.5: Plank canoe or *tomol* utilised for ocean travel by the Chumash. Figure © Terry Jones

Shell beads were another very important aspect of the Chumash material culture, and the shell-working industries were mostly concentrated on the Channel Islands where shell resources were abundant. It is estimated that this industry was prominent on the northern Channel Islands for over six centuries (Arnold and Graelsch 2001). King (1990, 63) states, "all types of beads made and used by the Chumash were the most frequently used manufactured valuables used to maintain the Chumash economic system". The bead assemblages and sequences, especially associated with human burials and large shell middens or residential deposits, are used as a direct reflection of the shift in Chumash economic systems and subsystems, social organisation and in developing the Chumash chronology. As such, there has been a disagreement amongst scholars on the precise interpretation of the archaeological record associated with bead assemblages, and importantly, the role they played in the rise of the Chumash elites (e.g. King 1990; Arnold 2001a). The discussion stems from whether or not environmental perturbations during the Transition Period (AD1150-1300) were one of the main causal elements in the development of the complex socio-political structure of Chumash society (see more of a theoretical discussion below).

The bead used within the Chumash monetary system was the *Olivella biplicata* cupped bead that came to use during the beginning of the Late Period (King 1990). As mentioned above, they were considered a type of monetary exchange and played an important role in the Chumash socio-political and economic structure. Beads were used in local exchanges on the islands but were most often used to create a network of trade with the mainland Chumash (Arnold and Graesch 2001, 71). Other beads were worn as ornamentation to differentiate a person's status, but as society changed from non-egalitarian to more centralised elites, King (1990) argues there was less focus on body ornamentation to distinguish wealth. Although the differentiation of bead types evolved at the end of the Middle Period, or during the Transitional Period as argued by Arnold and Graesch (2001), their purpose is hypothesised to be more economic because wearing them for display would have prevented their use within the exchange system (King 1990).

Bead manufacturing was undertaken by both sexes, but it may have been an occupation for those members of Chumash society that were not physically able to participate in more strenuous activities (Johnson 2001). Other types of beads were also used such as *Megathura crenulata* ring ornaments, giant rock scallop beads, clam tubes and discs and red or black abalone epidermis discs amongst many others (King 1990). Chumash scholars have placed certain bead types as representing certain elite members (see King 1990, 196 for further descriptions and associations). Many of these bead assemblages have been found in caches and within burial contexts during mitigation (*ibid*). Most ornamental beads were constructed from the red or black abalone and found associated with other prestigious material culture (Arnold and Graelsch 2001). Evidence of extensive trade of Chumash shell beads and other material goods has been found as far as the Southwest and Great Basin (Bennyhoff and Huges 1987), but this exchange network seems to have diminished during the Middle to Late Periods (Arnold and Graelsch 2001, 111). With archaeological evidence of the increase in shell bead production during this time, the continuation of bead making points to a continuation of their internal exchange network (*ibid*).

Items utilised in the construction of the shell beads (i.e. microliths such as microdrills) have also shown an increase in production during the same time as bead production increased. The supporting industry of microlith production is concentrated on the northern Channel Islands, predominantly on Santa Cruz Island where there are large chert quarries (Arnold et al. 2001). This industry also shows a marked increase in production during the Transitional Period, corresponding to the increase in bead production (*ibid*). Archaeological evidence shows that these quarries were also areas of microlith production and that microblades were exported to the shell-making villages where they were transformed into microdrills (*ibid*). This further confirms the extensive internal demand and intricate trade network practiced by the Chumash.

Finally, other types of material culture must be mentioned, as they are synonymous with Chumash society, although less is published as they have yet to be identified as reflective of the rise of complex socio-economic systems and subsystems. Chumash women and the men adopting female roles also predominantly gathered the material and constructed the types of material goods described here. Much of the Chumash material culture was made from the local plant material that was gathered within their landscape. Blackburn and Anderson (1993, 23) claim that plant material made up roughly 65% of Chumash material goods. Plants were used in the construction of Chumash architecture and also in the construction of the *balsa*. Further items include, but not exhaustive: fishing nets, baskets, mats, water bottles and various types of cordage and twine (Gamble 2008, 28). Baskets used for the storage of liquids and water bottles were internally coated with asphaltum to seal the container. Wood, as stated above, was used in the construction of the plank canoes, but more local wood was also used in the creation of wooden bowls, trays, spoons and bows and arrows amongst many others (Hudson and Blackburn 1983). Milling implements were also used. *Manos* and *metates* were originally used in the grinding of small seeds, but during the Early Period, a shift was made to using mortars and pestles for larger nuts (King 1990).

2.2.7 Chumash Rock Art

By being continuously and extensively studied for well over a century by ethnographers, historians, archaeologists, artists and amateur enthusiasts, Chumash rock art has become world renowned for its complexity (See Table 2.2 for a brief outline of past Chumash rock art researchers). While rock art (both petroglyphs, pictographs and stand-alone cupule boulders) is found throughout the various Chumash linguistic geographies and their overall landscape, the most complex and intricate panels are located within the Emigdiaño linguistic region of the interior (see Figures 2.6 and 2.7).

Rock art, as with the archaeology of California and most of North America, was distinctly grouped into specific regional and stylistic categories by Heizer and Clelow (1973), similar to the culture history movement, and is based on stylistic/artistic interpretations of the art. These broad categories are often used today when describing various rock art traditions within the state. Petroglyphs, or pecked stone art, were grouped into four categories: the Great Basin style, the Central Sierran style, the Southwest Coast style and the North Coast style (*ibid*). While pictographs, or painted art, were grouped into five categories: the South Coast Range Painted style, the Santa Barbara Painted style, the Southwest Coast Painted style, Southern Sierra Painted style and Northeast Painted style (*ibid*). Lee (1984, 13) argues that these categories are much too simplistic to understand the stylist nuances and variations found within the differing traditions and describes Chumash rock art as the "Santa Barbara Style" to include petroglyphs and to offer an inclusion of the stylistic variations. As she states (*ibid*, 13), "this style has certain underlying attributes and specific motifs which recur throughout the area". Lee further expounds that Chumash pictographs are, in very general terms, bilaterally symmetrical, painted with fine lines and are delicate (*ibid*). Whitley (2000) further describes Chumash rock art as belonging to the South-Central Painted tradition that includes the polychromatic art of the Yokuts.

Rock Art Researcher	Affiliation	Rock Art Research Description
Walter James Hoffman, MD (1846-1899)	Smithsonian Institution, Bureau of American Ethnology (BAE); Anthropological Society of Washington	Documented the indigenous peoples of the USA; assisted Mallery in collating information through interviews on pictographs, pigments and "gesture-language"; illustrating rock art sites for Mallery's and his own publications.
Colonel Garrick Mallery (1831-1894)	U.S. military; Bureau of American Ethnology	Based in Washington D.C., corresponded with other researchers in the field to complete publications on picture-writing and "gesture-language"; believed that rock art was an illustration of "gesture-language" and a stage of the evolution of the written language.
Julian Steward, PhD (1902-1972)	Department of Anthropology, University of California Berkeley	Collating the work of other field researchers through research and correspondence; studied and mapped rock art as element distributions using a culture historian approach; created elemental categories for rock art across broad geographical regions; attempted chronological sequences and interpretations.
Robert F. Heizer, PhD (1915-1979)	Department of Anthropology, University of California Berkeley; Director, University of California Archaeological Survey; Coordinator, Archaeological Research Facility	Created descriptions of element categories instead of using graphic representations to define styles of rock art; studied the reason for the rock art, concluded that rock art was a form of hunting magic through hypothesis testing during fieldwork; created extensive site maps through survey and mapping. (See also C.W. Clewlow, Jr below).
Martin A. Baumhoff, PhD (1926-1983)	Department of Anthropology, University of California Davis	See Heizer above.
Campbell Grant (1909-1992)	Artist and Illustrator; Animator, Walt Disney Studios	Documented rock art through photography and illustrations; focused on the detail, technique, form and colour of rock with the eye of a professionally trained artist; created extraordinary visual graphics of the rock art; introduced an understanding of regional and stylistic variation; humanised the Chumash as great artists.
Carl William Clewlow, Jr., PhD (Unknown)	Ancient Enterprises; Research Associate, Nevada State Museum	Collating data through correspondence for all known sites in California; created the standard of stylistic interpretation that is still used today; no real fieldwork.

Table 2.2: Table synthesising previous influential rock art researchers from 1883 to 1973 created from Robinson's (2006, 4-21) review and not included in this thesis.

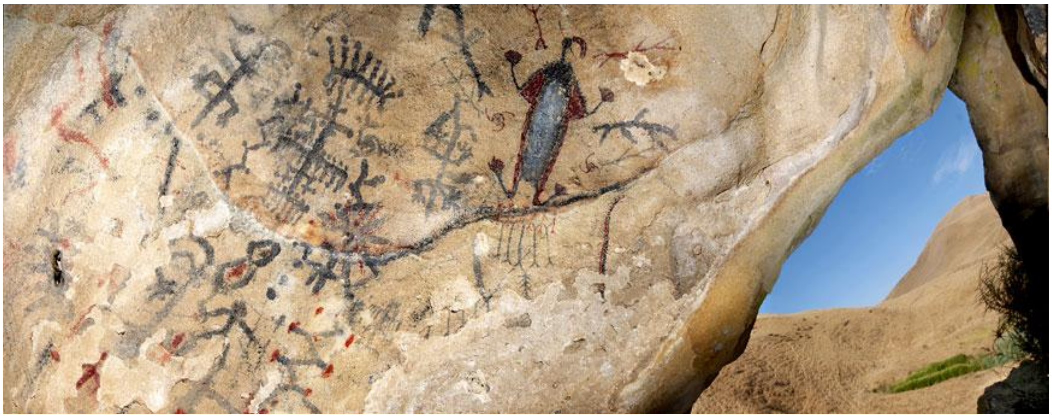


Figure 2.6: The complex rock art site of Three Springs (CA-KER-3388) located on the Wind Wolves Preserve. Photo by David Robinson.

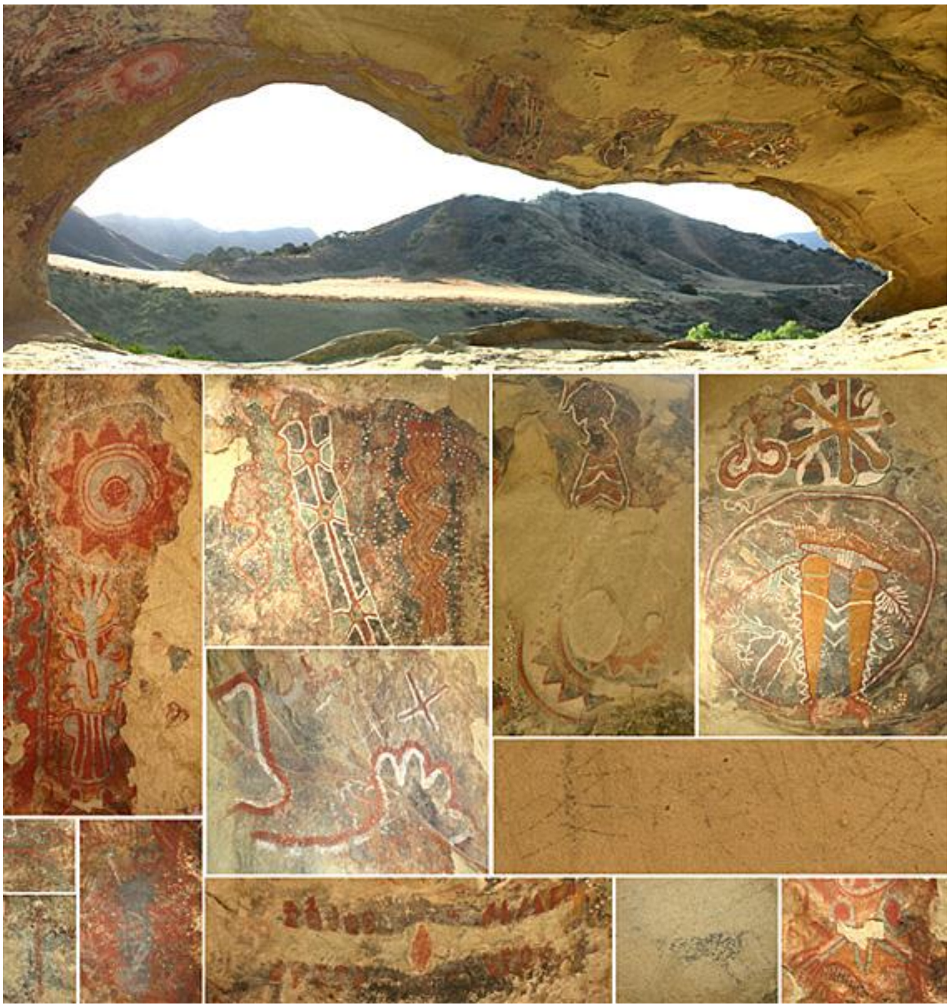


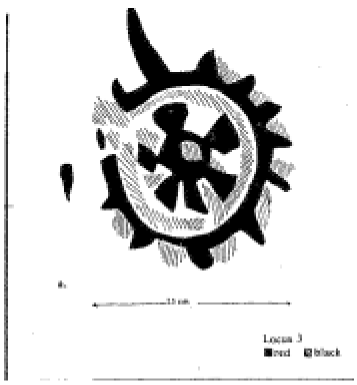
Figure 2.7: Photograph of the various motifs and panels at the Pleito Creek Site (CA-KER-5619) one of the most complex of all the Chumash rock art sites. Photo by David Robinson

The polychromatic colours used to paint the pictographs were created using local minerals mixed with a binder such as oil, water or bodily fluids (i.e. blood) (e.g. Scott et al. 1994). Red paint was created using iron oxide or hematite, yellow paint was limonite or yellow ochre, white was created using diatomite or kaolin clays, black was made with hydrous oxide of manganese or charcoal (Grant 1965; Whitley 2000). The more common colours of red, white and black have been studied within the literature (see Scott and Hyder 1993) with red being the most common colour observable today (Reeves et al. 2009). The more rare colours, blues and greens, have more recently been further analysed by Scott et al. (2002). They found that blue is more of an "optical blue" made from a mixture of white and ground charcoal (black) that creates an illusion of a blue colour (Scott et al. 2002, 190; Reeves et al.2009). Greens consist of green earth, which is celadonite or glauconite (Scott et al. 2002, 191). In addition, Whitley (2000, 37) hypothesizes that the minerals used for pictographs were found at the various hot springs located within the area.

Application of the art was done using the fingertips, sticks, and a variety of brushes or even using a mineral such as hematite (Grant 1965). Design elements and motifs were constructed using several techniques such as " solidly painted in red or black, a red outline filled with black or the dot technique" and "…many designs are either formed by or embellished with fine dots" (Lee 1984, 13) (Figure 2.6). Anthropomorphs and zoomorphs within Chumash rock art typically have appendages that bend upwards at what appear to be the elbows and knees (Robinson 2006). While many elements and motifs are similar to that of the neighbouring societies, scale is an important aspect in determining the Chumash style. For example, Yokut's rock art consists of much larger elements (*ibid*), use much thicker lines and heavier pigment application (Robinson 2006, 90) and the appendages of the anthropomorphs and zoomorphs of the Yokuts point downward (Sprague 2005). Furthermore, pictographic panels are sometimes found to utilise natural cracks or indentations found on the rock surface but rarely do they depict any full composition and are seemingly motifs or elements floating in space (Lee 1984,14).

There are two recognized ubiquitous styles found within the Chumash landscape: the "sun-wheel" or "sun disc" (see Figure 2.8a and b) and the "aquatic" motif (see Figure 2.9 and Figure 2.10). Lee (1984, 13) describes the "sun-wheel", "with its many variations from simple circles to elaborate versions with radiating rays". The "aquatic" motif is a straight or curved line with bifurcated ends that are either rounded or sharp and may also consist of "bar-like projections, which resembles a 'dorsal fin' or "…a 'tongue-like' projection from one of the bifurcated ends" (Hudson and Conti 1981, 224). The term "aquatic" motif is problematic because it immediately assumes an association with water to the motif with little supporting ethnographic evidence. Hudson and Conti (*ibid*) hypothesise that the motif is an abstract symbolic representation of the swordfish, an important figure in Chumash mythology. Grant (1965) first introduced the aquatic association and the title of "aquatic motif". For the purposes of this study, 'bifurcated' motif will be used as it is more descriptive than symbolic and does not make any assumptions pertaining to the symbolic meaning of the art.

Bifurcated motifs were further deconstructed based on their varying elements and more elaborate typology was created for their study (Hudson and Conti 1981) (Figure 2.8). The motif itself occurs both singularly, in multiple groups of bifurcated motifs and is also integrated within whole panels of other motif types. Bifurcated figures can be simplistic or ornate, with its distribution found throughout the various Chumash linguistic groups. Hudson and Conti (*ibid*) also found that it often occurs at sites associated with circular elements. Specifically, Hudson and Conti (*ibid*) consider its symbolic meaning to be tied to Chumash supernatural myth and ritual, as was stated above, representing the swordfish, which plays an important role in Chumash mythology. The swordfish is considered the chief of all fish according to Harrington's informant, Fernando Librado (Blackburn 1975, 102). Finally, many of the geometric elements and motifs that are found at the rock art sites are also found as decoration on various artefacts. For example, many Chumash baskets have some of the geometric motifs woven within them, and the bifurcated motif was found on a stone pipe (*ibid*).

2.8a 

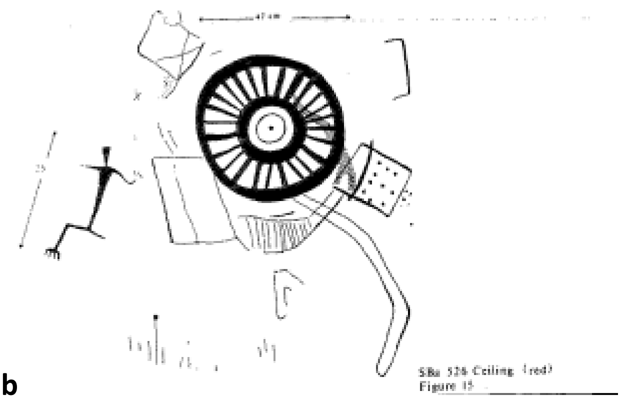
2.8b 

Figure 2.8 a and b: Examples of the sun disc motif taken from Lee (1984, 26, 36, 2.8a from Figure 37 and 2.8b from Figure 15).

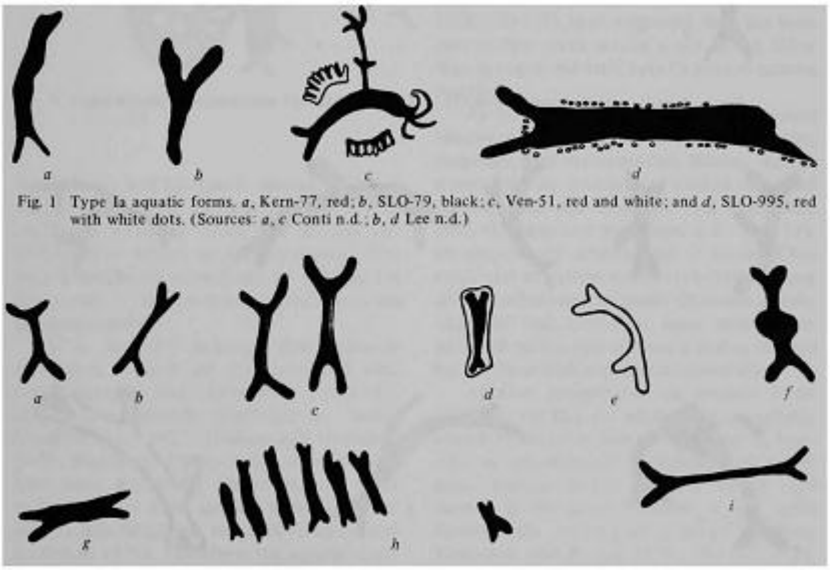


Fig. 1 Type Ia aquatic forms. *a*, Kern-77, red; *b*, SLO-79, black; *c*, Ven-51, red and white; and *d*, SLO-995, red with white dots. (Sources: *a*, *c* Conti n.d.; *b*, *d* Lee n.d.)

Fig. 2. Type Ib aquatic forms. *a*, SBa-101B, red; *b*, Ven-35, red; *c*, Ven-160, red; *d*, Ven-347, red with white outline; *e*, SLO-336, red; *f* and *g*, SLO-100, red; *h*, Ven-35, red; *i*, SBa-1200, red. (Sources: *a-d*, *f-h* Conti n.d.; *e*, *i* Lee n.d.)

Fig. 3. Type Ic aquatic forms. *a*, SLO-105, red; *b*, 4SLO-AS-668, red; *c*, Kern-77, red with white outline. (Sources: *a-b*, Lee n.d.; *c*, Conti n.d.)

Fig. 4. Type IIa aquatic forms. *a*, Ven-195, red; *b*, SBa-1380, red. (Sources: *a-b*, Conti n.d.)

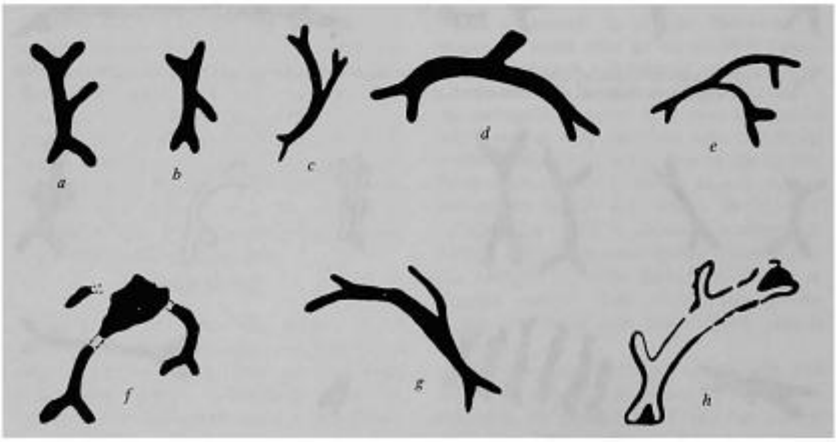


Fig. 5. Type IIb aquatic forms. *a*, Ven-160, red; *b*, Ven-119, red; *c*, SLO-79, red; *d*, Ven-51, red; *e*, SLO-79, black; *f*, SBa-101 (SBa-565), red; *g*, SBa-138, red; *h*, SLO-995, red. (Sources: *a-d*, *f-g*, Conti n.d.; *e*, *h*, Lee n.d.)

Figure 2.9: The various forms of the bifurcated motif or "aquatic" motif as compiled by Hudson and Conti (1981, 225-226, Figures 1-5). Original figures are not to scale.

Figure 2.10: Photo of the bifurcated motif at Alder Creek (CA-SBA-0347). Photo from the Los Padres National Forest archives.

While petroglyphs are not as common as pictographs for the Chumash (refer to Chapter 6 for actual counts), they are present throughout the region. Cupules, one of the most commonly occurring petroglyph throughout California, are one of the most enigmatic types of rock art (Figure 2.11). While this is often argued to be due to a lack of ethnographic evidence and comprehensive research associated with cupules (Hector 2009), its enigmatic state is also based on the fact that cupules are non-representational (Sutton et al. 2001). Cupule petroglyphs consist of small, shallow cup marks pecked into the rock surface, often occurring on the vertical face of a rock associated with pictographs, found on stand-alone boulders, associated with bedrock mortars (BRMs), show remnants of pigment and are often clustered in high densities (Hector 2009).

Figure 2.11: Photo of associated cupules at Condor Cave (CA-SBA-1633). Photo by Michelle L. Wienhold.

Associated archaeology at rock art sites is common (i.e. bedrock mortars, middens, campsites) (Robinson 2011) (Figure 2.12), but whether or not they are contemporaneous cannot be confirmed. If rock art had been made earlier than the archaeology then there would have been visual interaction with the rock art. Further mitigation and survey of rock art sites needs to be undertaken to provide a better picture of the true nature and chronology of rock art and its archaeological associations. Contextual information has been shown to be quite important and have strong associations based on research by Horne and Glassow (1974) in the Sierra Madre Ridge and Robinson (2006) in the Emigdiaño region.

Conservation of rock art sites is still an important aspect of rock art research. While rock art is found throughout the Chumash landscape, it is subject to environmental destruction based on its placement and susceptibility to natural erosion through wind and water (*ibid*). Unfortunately, vandalism has been the number one most devastating threat to these sites through chipping away the paintings from their context and outlining the elements with white chalk for black and white photography (*ibid*).

Figure 2.12: Photo of associated archaeology (bedrock mortars) at site CA-SBA-1669. Photo from Los Padres National Forest archives.

2.2.8 Chumash Subsistence, Diet and Cuisine

The Chumash subsistence and diet was as varied and diverse as their landscape. The varieties of food resources in the different regions were also important items within their exchange network, especially during the Transitional Period. Those living on the islands and coastal regions depended predominantly on fish and sea mammals while those in the inland and interior regions depended on terrestrial fauna, mostly deer, and plant food (Glassow et al. 1976; Horne 1981; Glassow 1996; Armstrong 2011). The surpluses from these regions were then traded internally using their shell currency to maintain a variable diet to sustain their populations. While the Chumash were likely exposed to farming and agricultural practices during their inter-regional trade during the Early Period, they never adopted the practice (Arnold 2001a). A variety of reasons have been suggested for perpetuation of their hunter-gatherer subsistence including, the presence of rich soils, large estuaries, marine resources and the abundance of terrestrial resources (*ibid*, 5). It has been documented that, at European contact, the Chumash promoted plant growth by controlled burning to clear dead plant material and increase soil quality (Timbrook et al. 1993). The Chumash had adapted to a rich environment, manipulated their resources to sustain their populations and efficiently utilised human labour (Arnold 2001a, 6).

To sustain their populations the Chumash also relied on non-marine resources that included: deer, rabbits, jackrabbits, squirrels, gophers and a variety of coastal birds amongst others (King 1990). Stored food was consumed during the winter months when marine resources were oftentimes scarce (*ibid*). Also, plant foods that were used by the Chumash were not readily available during the winter months so were stored along with sun-dried meat and fish for consumption during this time (*ibid*). Structures and dry granaries were built alongside houses for drying and storage whilst pits inside homes and caves were also used to store food resources (Gamble 2008). Sea mammals were also a part of the Chumash diet, especially during the Late Period, for the coastal settlements (*ibid*, 154). It is hypothesised that, during the winter months, the Chumash lived together in permanent villages consuming stored food, but in the spring, the populations were much more mobile (e.g. Horne 1981). One important food item, and the most discussed in Chumash literature was the acorn, although other foodstuffs such as pine nuts, juniper nuts and chia sage amongst others were used (Timbrook et al. 1993). On the islands, Santa Cruz had the most oaks, although after the Late Period, there is reduced evidence of acorn processing (Delaney-Rivera 2001, 180), but the inland and interior regions had the most access to acorns. The increase in importance of acorns within the Chumash diet is apparent with the change from *manos* and *matates* to mortars and pestles during the Early Period (Fagen 2003). Mortars and pestles were hardy enough for the mashing of these hard nuts. Furthermore, bedrock mortars (BRMs), depressions in rock from the grinding of nuts and grains, were used in the inland and interior and are oftentimes associated with rock art sites (Robinson 2011). Processing of the acorns was labour intensive requiring the removal of tannic acid with water and included drying and storing for the winter months (Basgall 1987). The Chumash were highly mobile and would travel to resource patches to gather and process their foodstuff especially during the later summer/autumn. These resource patches were such a valuable commodity that they were defended if anyone trespassed and this trespassing could result in conflict (Gamble 2008).

Not included in the discussion of Chumash diet are their ideas of cuisine preference and specific food choice, which can be inferred through individual site excavation, and further analysed by specific trade of preferred foodstuffs found in other ecological regions (e.g. Armstrong 2011). Societal food choice of the Chumash would have been diverse, but the archaeological record of cuisine can provide research on what Smith (2006, 481) states, "…as a component of social cohesion in which society-wide preferences are expressed in daily practice." Overall studies based on cuisine choice can help to understand that food preference would have motivated the Chumash to pursue a network of trade with groups in different ecological regions or to gather specific types of food from nearby resources.

Feasting was an important part of the Chumash society both politically and economically and usually occurred during one of the many seasonal ceremonies and rites of passage celebrations (Gamble 2008, 180). It is hypothesised that the feasts allowed chiefs to strengthen and create inter-and intra- political ties and alliances (Blackburn 1976). Three of the most important public ceremonies were "the *hutash* or fall harvest ceremony", the "*kakunupmawa* or winter solstice" and the mourning ceremony (Librado 1977). Gamble (2008) describes the feasts as taking part at villages located on the Santa Barbara coast and gathering people from the inland, interior and the islands that often lasted for many days. Feasts consisted of chiefs in the host villages providing food for the guests, but also required the guests to provide for the feast in food and gifts (Delaney-Rivera 2001). Food items were presented during feasts and were further supplemented by rare foods and prestigious goods.

2.2.9 Initial Contact (Proto-Historic – Historic)

Initial contact with the mainland, coastal and island Chumash began on October 1542 when Portuguese explorer, Juan Rodriguez Cabrillo, on behalf of Spain, sailed to find populations with considerable wealth and obtain information concerning trade routes to Asia (Beebe and Senkewicz 2001,31; Gamble 2008,38-39). The Chumash are considered to be the first major group of indigenous Californians to have interaction with Europeans (Grant 1978a). Thus began the Proto-historic Period, which involved only a few further interactions between Europeans and the native Californians. Although Cabrillo wrote the first documentation of Chumash villages, his death resulting from skirmishes with the Chumash led to his burial and destruction of his diary on what is purported to be San Miguel Island. Further expeditions 60 years later resulted in the naming of the Santa Barbara Channel by Sebastián Vizcaíno (*ibid*, 505). In 1769, Captain Gaspar de Portola´, on his way north, encountered the Chumash. Accompanying him on his journey were Lt. Pedro Fages, Miguel Constanso and Friar Juan Crespi who all wrote important ethnohistoric accounts of the Chumash and their practices (*ibid*, 505). European goods (such as glass beads and iron needles) at initial and subsequent contact were introduced to the Chumash and are apparent in the archaeological record. Three years later, in 1772, began what is referred to as the Mission Period, with the construction of the first Franciscan missions, and lasted until 1834 when the missions were secularised. Of the 21 Franciscan missions constructed in California, roughly a quarter of them would become home to the Chumash. They were: Mission San Buenaventura, Mission Santa Barbara, Mission La Purismo Vieja (see Figure 2.13), Mission Santa Ynez and Mission San Luis Obispo (Arnold 2001a). While the coastal Chumash may have had the most interaction with the Spanish, Graesch (2001, 262) states that "…separated from the mainland by the broad Santa Barbara Channel, at least 2 generations of Island Chumash maintained an impressive degree of continuity in traditional lifeways during Spanish occupation of Alta California".

Figure 2.13: Mission Purismo Vieja, near Lompoc, CA, that is now a State Historic Park. Photo by Marcello Di Bonito.

The same year that began the Mission Period, Fages became the first Spaniard to enter the San Emigdio region (located within the San Emigdiaño linguistic boundary in Figure 2.3) (Robinson 2006). In 1790, the first major documented expedition was led into the interior in search of resources to be exploited especially for mining. In contrast, the Chumash viewed this interior area as a place to escape missionisation and Spanish persecution that caused tension and conflict between the two groups (*ibid*). It created a mix of both interior, coastal and island Chumash living in the interior and, as Robinson (*ibid*, 114) describes, "…particularly after the revolt of 1824 when a new community was configured calling themselves the *Hool*". Mission records have provided a wealth of information concerning the Chumash predominantly studied by Johnson (1988). As Johnson (2001, 53) states " early mission and census records provide the most important sources of information to reconstruct the ethnohistoric context of Chumash cultural behaviour documented in Harrington's ethnographic papers." Their missionisation sadly resulted in documented epidemics and their forced indoctrination into Christianity (Johnson 1988). During the Chumash missionisation, important aspects of prehistoric Chumash society were lost or prohibited by strict rules set forth to integrate them into Christianity.

2.3 Theoretical Approaches to Studying the Chumash

Research and analysis on Chumash political networks, marriage ties, craft specialization and control of economic systems and subsystems by coastal Chumash elites has been the focus of most of the important literature published internationally (Arnold 1992; 2001a; 2001b; Arnold et al. 2004; Gamble 2008; Glassow 1996; Johnson 2000; Kennett 2005; King 1990). Geographically, these studies have mainly been on the Santa Barbara coastal region (King 1990; Gamble 2008), the Vandenberg coast (Glassow 1996) and the northern Channel Islands (Arnold 1997; 2001a; Arnold 2001b; Kennett 2005). The main research focus has been on the analyses and theoretical discussions on the rise of Chumash hunter-gatherer complexity, where the focus is mainly on the subject of complex *maritime* hunter-gatherers. Past and present research highlight two general hypotheses that centre around the relationship between the rise of a non-egalitarian society and the Chumash economic systems and the role of palaeo-environmental transformations.

First, there are hypotheses concerning the role of the environmental perturbations and fluctuating SSTs of the Transitional Period that created the appropriate conditions to trigger an increase in bead production and trade network negotiations that were beneficial to people who owned canoes along the coast (Arnold 1992; 2001b; Johnson 2000). As Gamble (2008, 93) states "proponents of palaeo-environmental models suggest that stressful environmental conditions served as a trigger for punctuated change". Second, researchers speculate that the Chumash socio-political and economic structures were established during pre-Transitional

Period developments of elite network relationships during times of resource abundance along the coast (Gamble 2008; 2008; King 1975; 1990), because hunter-gatherers would be less affected than agricultural societies by environmental fluctuations (Gamble 2008, 93). Both hypotheses of Chumash complexity are extrapolated into the interior/inland regions where non-marine societies have been shown to live and participate in political and economic networks with the coast.

More specifically, theoretical applications used to study Chumash societies have encompassed evolutionary, ecological and behavioural theories to study their socio-political and economic complexity. King (1990) used an evolutionary approach to study the coastal groups and hypothesised that changes in artefacts will reflect the changes in social systems and their organisation. Both Glassow (1996), and to a much greater extent, Kennett (2005), looked at theories within Human Behavioural Ecology to focus the research from the group to the behaviour of the individual with an overall emphasis on competition and cooperation in a variable climate (*ibid*, 8). Kennett (*ibid*, 238) further refined his study to include human demography, environmental degradation and changes in diet breadth on the northern Channel Islands. Glassow (1996) looked at population growth and environmental change in a much broader analysis within the Vandenberg region. Environmental stress and human agency, as hypothesised by Arnold (1997; 2001a; 2001b), were the determining factors of the rise of the complex Chumash societies based on the archaeological record on the northern Channel Islands. In contrast, Gamble (2008, 13) suggests that the social hierarchy was established from a demand for material goods due to an increase in resource abundance. This allowed for select individuals to gain control and power over exchange of these items. Finally, very little mention of rock art, if at all, is included in these studies and has been surprisingly absent throughout the history of Chumash complexity studies until recently. It is rarely incorporated into the theoretical analyses and the various economic and social relationships that are used to define the Chumash as complex.

As was outlined above in the rock art section, the Santa Barbara Painted style is not only found near and along the coastal areas, it is also similar to that of the Yokuts whose region is located further within the interior (Figure 2.2). Stylistic similarities of the rock art point to a more complex network of information across societies that are further supported by the use of the *tomol* by the Gabieliño, and internally represented by the presence of ubiquitous rock art elements and motifs across the many Chumash linguistic boundaries. Therefore, the overlap of technology and style within and between groups show that the exchange networks were not necessarily about resources but also included ideas and information. In the following, I briefly outline and synthesise the theoretical studies in order to provide an understanding of the Chumash cultural networks and demonstrate a lack of rock art incorporation into these cultural complexity analyses.

2.3.1 Evolutionary Theory

Chester King's (1990) study of shell beads and ornaments associated with burials and archaeological sites of the Chumash in the Santa Barbara coastal region used diagnostic changes in artefacts as a reflection of shifts in socio-political and economic organisation. By using basic tenets of evolutionary theory that postulate, "…for any particular control function senses are stimulated by artefacts which most efficiently communicate information connected with the control function", he hypothesised that the bead and ornament sequences found in burials and at archaeological sites would reflect prehistoric social variability (*ibid*, 11, 19). King (*ibid*) suggests that the bead assemblages represent a shift to a more socially stratified society during the Middle Period. As a result, the shift created less of a demand on the economic system for obtaining power and more of a demand on the exchange of goods. The economic interactions were controlled by those in leadership positions, and are a reflection of the evolution of inherited power during the latter two periods (*ibid*, 118). King (*ibid*, 105) found that there were less changes to bead types during the Early Period than the subsequent Middle and Late Periods. The shift from the Middle to Late Period was represented by a marked difference in shell beads, especially in terms of variety, and an increase in production that lasted through the Late Period (*ibid*, 100,106).

2.3.2 Agency and Environmental Stress

Arnold (2001a, 6) in her study of Chumash sites in the northern Channel Islands uses human agents and their manipulation of the environment and resources as the most important factor in the evolution of political development in Chumash society. She purports that studies of the people or agents themselves answer questions concerning the reasons complex hunter-gatherers developed into complex chiefdoms that cannot be simply explained by using environmental conditions (*ibid*, 6). Further discussion is made pertaining to the different explanations that are applicable to the rise of the complexity of the Chumash. These range from control over trade or exchange, manipulation of information by a privileged few, control of religious and ceremonial life, ownership of the few environments with important resources, and the increase in the production of resources or goods (*ibid*, 10).

Arnold (*ibid*, 22) argues that, on the Channel Islands, the transition from a non-egalitarian to an egalitarian society happened much later than King's (1990) study in the Santa Barbara Channel region. She states that the Transitional Period (AD 1150-1300) at the end of the Middle Period was a time of socio-economic and political reorganisation for the Island Chumash (2001a). Based on the archaeological excavations and analysis of artefact assemblages, Arnold (*ibid*, 32) says that the evidence suggests that environmental conditions such as drought and the disruption of SSTs affected the populations living on the northern Channel Islands. It was during these times that groups of opportunistic, geographically well-positioned people would benefit by manipulating technology, human labour and environmental resources in order to rise as leaders (*ibid*, 31). These developments included: the plank canoe, small-scale crafts, specialised craft production, exchange systems, bead currency and other goods associated with status, for example (*ibid*, 288-289). Her hypothesis points to a more abrupt change and adaptation through human response to environmental change.

2.3.3 Human Behavioural Ecology

Glassow (1996) studied the Purisimeño Chumash that lived on the Vandenberg coastal region. Unlike the Chumash that lived on the northern Channel Islands and the Santa Barbara coastal region, he postulated that these people were not using the plank canoes due to the inhospitable Pacific waters or have the same complexity in political structures (*ibid*, 17). The Purisimeño were linked to other Chumash groups via exchange networks facilitated by the use of shell bead currency (*ibid*, 18). Glassow's (*ibid*, 38) study looked at optimal foraging theory and diet breadth with respect to the populations living in this area of California.

Optimal foraging theory proposes that organisms will try to find the most efficient and high caloric foodstuffs in order to expend the least amount of energy (*ibid*, 38*).* Diet breadth causes organisms to expand their diets at times of environmental hardship or population growth when there is pressure on current resources (*ibid*, 115). In respect to the groups of people living on the Vandenberg coast, Glassow (*ibid*, 38) suggests that severe, constant and extreme hardship would have created an increase in diet breadth and unfavourable environmental conditions would have caused population decrease and changes in technology. Furthermore, he states (*ibid,* 38) that the people living in this area may have produced lithic material to be used in trade with other Chumash populations. He also hypothesises that at times of high population density, a network of trade and exchange would have been more desirable in this area than expanding diet breadth (*ibid*, 40).

The archaeological record along the Vandenberg coast shows that in times of environmental stress, population density was low, and when the climate was cooler, the population density was relatively high (*ibid*, 113). The results of his excavations also found that population density did not experience a gradual increase throughout prehistory but experienced periods of pointed increase and decrease in density (*ibid*, 103). Another conclusion of this study was that populations during the Late Period increased significantly when compared to earlier periods (*ibid*, 137). He also states that technological advances during the Late Period, such as acorn processing, hook-and-line fishing, seine fishing and the bow and arrow, may have promoted high population density and removed environmental pressure during unfavourable climatic conditions (*ibid*, 137). Economic exchange and trade with other Chumash groups also supported the higher populations and population growth from the Santa Barbara region may have spilled into this neighbouring region (*ibid*, 137-138).

Kennett (2005) uses human behavioural ecology (HBE) to study the Island Chumash of the northern Channel Islands. HBE is the "study of evolution and adaptive design of human behaviour within specific ecological contexts and is useful for formulating hypotheses and identifying important environmental and social selective pressures of the past" (Winterhalder and Smith 2000, 51). Kennett emphasises competition for resources, which involved either violence (i.e. warfare) or cooperation (i.e. exchange) as responses to environmental stress such as drought brought about by environmental perturbations (Kennett 2005, 8). Island Chumash responded to these social and climatic conditions with permanent settlements, a greater dependence on fishing, producing items for exchange with the mainland and less violence (*ibid*, 8*).*

Kennett's (*ibid*, 14) use of HBE was to understand questions concerning changes in subsistence strategies, settlement patterns and land use, demographic change, competition, cooperation and changes in social hierarchies (*ibid*, 14*).* Again there is a study of diet breadth, but Kennett (*ibid*, 29) states that this is very applicable to the northern Channel Islands due to its localised scale and patchy environment and is optimal for this theoretical approach. Secondly he focused on central place foraging theory which "is constrained significantly when foraging from a central location due to costs associated with round-trip travel and natural limitations on load size" (*ibid*, 30). Finally, he used ideal despotic distribution, a variation of the ideal free distribution theory, which states that the superior competitors will push those of lesser ability to less productive habitats (*ibid*, 35).

The diet breadth study shows that the population density of the Island Chumash did, in fact, become more dependent on fish probably due to overexploitation of intertidal habitats and the production of more shell bead money for exchange during the Late Holocene (*ibid*, 218-219). Kennett (*ibid*, 219) discusses that this can be concluded as an expansion of diet breadth due to the trade of goods for resources. Site placement and residential stability were also concluded to be a result because less time is spent hunting or gathering prey which required the expenditure of large amounts of energy while more time is spent on lower ranked prey, such as fish (*ibid*, 220). Central place foraging theory provided a more robust analysis than diet breadth because it works well when resources are patchy and where the goals are differentiated by age or sex (*ibid*, 224). The results show that site placement was chosen based on costs of transportation to a resource or habitat and on energy expended (*ibid*, 228-229). Ideal despotic distribution, when combined with the above two theories, show how it is a good model for "economic intensification" (*ibid*, 229). The model shows that populations will expand to the lesser habitats due to technology or exchange with others, which is applicable to the Chumash on the northern Channel Islands, because resources are distributed unevenly (*ibid*, 230-231).

2.3.4 Network Strategies and Wealth Finance

Gamble (2008, 13) purports that the Chumash of the Santa Barbara coast's social hierarchy was a result of resource abundance that created inequalities and socio-economic complexities. She states that times of environmental stress may have affected the Chumash societies, but this would have been more substantial for agricultural societies rather than complex hunter-gatherer societies (*ibid*, 13). Her hypothesis states that the Chumash used a network strategy in which certain individuals gained powerful, wealthy positions in society due to the demand of certain resources and goods (*ibid*, 13-15). She states that three types of transactions were part of the economic system: "redistribution, free market trade and commerce" (*ibid*, 61). The prestige goods were then redistributed during ceremonies involving feasting with the most powerful members of society responsible for the organisation (*ibid*, 61*).* The feasts were attended by many of the different Chumash linguistic groups, from mainland California and the islands, which used these gatherings as a means of trade and redistribution of goods and resources (*ibid*, 61-62). During these feasts and funerary ceremonies, the Chumash destroyed prestige goods (*ibid*, 189). The chiefs saw that any economic risk due to environmental stress was minimised by practising "diversification, intensification, physical storage, redistribution, exchange, alliance formation, and the use of currency as a form of social storage" (*ibid*, 201). Therefore, the chiefs practised reciprocity and participated in a "peripheral market economy" which used shell bead money for trade (*ibid*, 234-235).

Gamble (*ibid*, 244) goes on to further state that the destruction of prestige goods through burial or ceremonial burning would prevent inflation and make sure that there was still demand and value associated with these goods. The chiefs of these Chumash societies achieved their power from controlling the exchange (e.g. owning plank canoes) and playing an integral role in the redistribution of wealth (*ibid*, 280). She also states that any violence or warfare among the Chumash people was a direct result of uneven distribution of wealth and a shift in the trade and exchange systems (*ibid*, 273). Finally, Gamble (*ibid*, 282) discusses that the societies that use network power do not have large monuments present in their landscapes because the goals of these types of societies do not include the use of community projects to "build group solidarity". This is highly applicable to what is present in both ethnographic data and the archaeological record for the Chumash.

2.3.5 Taskscapes

Since 2006, *The Enculturating Environments Project* has been working to bridge the gap between current theoretical work on Chumash society and the role of rock art. Robinson's (2006; 2010a; 2010b; 2011; 2013; In Press) work has studied the role of associated archaeological material and how a variety of inland/interior rock art and archaeological sites are integrated within the Chumash region. Robinson (2011) argues that pictograph sites are strongly tied within the Chumash ideological, social and economic networks based on their strong spatial association to large numbers of BRMs. Women's processing of foodstuffs would have taken place at these large associated BRM sites, referred to as taskscapes (Ingold 1993; 2000). Through Robinson's (2006; 2010a; 2010b; 2011; 2013; In Press) spatial analyses, pictographs are well within view of these taskscapes making them an area of inclusion for the people who used the BRMs for their subsistence practices. In addition, it may represent the supernatural interjection into taskscapes (Robison 2011). The co-occurrence of BRMs and pictographs has been found throughout the Chumash geographic region and shows that (*ibid*, 47), "…rock art should be seen as an important ideological media imbricated within subsistence economies, gender dynamics, and perhaps even the development of differential status and control".

Cache caves are also being introduced into the narrative and their role within the study of material culture and as places of importance within the Chumash landscape (Whitby 2012). Further research of their importance within the Chumash landscape networks is ongoing. While this work is further discussed in the proceeding chapters, it is important within the review of Chumash research as it has been able to integrate the voices of the people that lived outside of the island and coastal populations into the over networks within the Chumash interaction sphere.

2.4 Conclusion

As described in the first section of this chapter, I have highlighted the intricate and complex Chumash society in order to establish a strong understanding of the people who created the rock art central to the study in this thesis. Secondly, I have discussed the various theories that have been used to study the cultural complexities using some of the main published literature. I have argued, that there are important aspects of Chumash society that have been left out of the overall theoretical discussions and arguments, such as the inland and interior geographic areas and the complex rock art that is located in these areas. However, these discussions are still important to the overall narrative on the Chumash interaction sphere and do provide the necessary background to the dialogue.

Rock art represents a very distinct and important aspect of the Chumash that needs to be further integrated into the major discussions taking place through incorporation into the political, economic, and social theoretical dialogues. Rock art literature has been treated as a 'sub-genre' within the overall main bodies of Chumash literature. Furthermore, as I will show in the next chapter, in many of the rock art studies the archaeological context and other associated sites are ignored in favour of studies focusing on style and design of the rock art panel. Therefore, in the Chapter 3, I will discuss the international methodologies that are being used today to study rock art. Finally, I will outline and discuss the theories that have been applied to study Chumash rock art over the past 60 years.

Chapter 3 Rock Art Research Methodological and Theoretical Applications

3.1 Introduction

As I have discussed in the previous chapter, Chumash rock art is an important and complex artefact of their society. In this chapter, I wish to first look at the various methodologies applied to rock art analysis worldwide and then focus on the more localised theories that have guided Chumash rock art research in the past. Overall, I argue that there is still more work to be completed if we are to understand the role rock art played within the Chumash's social, political, economic and ideological networks.

The main strength of rock art is that it is one of the few non-portable, immovable artefacts found in the archaeological record (Chippindale and Nash 2004). It therefore has a potential connection to both the topography and environment and a potential link to the indigenous landscape perceptions based on its geographic placement. Landscape is often defined within rock art studies as not only how past humans perceived their environment, but further described, whereby patterns of artefacts (i.e. rock art) in the environment can be used as evidence of social behaviours or ideology (Hyder 2004, 85-86). I will expand on this definition to add that a landscape is comprised of multiple networks at dynamic spatial and temporal scales entrenched within social interactions and ideologies, and I will further explore this topic in Chapter 5.

Richard Bradley (1991) pushed for the inclusion of landscape studies in the study of rock art instead of treating these features in a similar manner to portable artefacts. The foundation of this inclusion is a combination of post-processual ideas of prehistoric landscape perceptions through their art and its placement, and a study of the topographic context of rock art sites (Bradley 1991, 77). This approach has been incorporated into multiple studies (e.g. Bradley 1997; Chippindale and Nash 2004; Hartley 1992; Nash 2002; Robinson 2006; 2010a; 2010b; 2011; 2013; In Press) with success. As Arsenault (2004, 73) states, "we may define the archaeology of landscape as an approach which includes the examination of the rock art sites *per se* as well as both the natural and socio-cultural environments, that is, the totality of the physical and symbolic resources both within a specific region seemingly associated with rock art sites".

Landscape studies of rock art do not come without their critiques. Smith and Blundell (2004) critique the application of the landscape approach to the study of rock art as it creates issues and assumptions because archaeologists speculate that the prominent topographical features or landmarks would have also been just as awe-inspiring as they are to modern Western society. Whereby the large topographic features (e.g. mountain ranges) are hypothesised to have served as natural boundaries or that the landscape context would provide some insight to the symbolic meaning of the rock art. Unfortunately, the authors never discuss cases where their critiques may be invalid based on available archaeological evidence and/or ethnohistoric/ethnographic data. For example, the Chumash personified much of their environment and perceived it as supernatural where natural features, such as rock, were believed to be the 'First People' transformed into stone (Harrington, 1927, 235). Furthermore, prominent topographic features served as important mythological and ideological markers (Robinson In Press). What can be said at this point is that this critique is not necessarily applicable for Chumash society as the ethnohistoric and ethnographic evidence supports the importance and supernatural relevance of topographic features and specific landmarks (see below and Chapter 5 for further discussion). As Molyneaux (2006, 69) in his study of affordance at Devil's Tower in northeastern Wyoming, correctly states, "as topographical descriptions embody meaning and function, they provide an ideological veneer over the landscape that may inform and complement the archaeological record."

Another issue with rock art is the chronological or the temporal aspect. Most of the research is weak in this area as dating pictographs is impossible without destroying the integrity of the motif, and petroglyphs are engravings in rock that often would not have organic material to radiocarbon date. In regards to California rock art, Whitley (2000) describes various ways that chronologies are established. These include: the examination of the subject matter (i.e. does it depict an animal that is extinct or a time marker such as an atlatl), the deterioration of the rock art could potentially be an indicator of its age, or when the motif or panel of art is covered by sediment then direct chronological dating can be used with geochemical or nuclear testing (Whitley 2000, 40-43).

This chapter, therefore, covers the new approaches in methodology that have become important within rock art studies in the past 10 years internationally and are also part of the methodological framework used in this thesis. Specifically, I explore and discuss the theories currently used in the study of rock art, with an overall focus on the rock art created by the Chumash. The current leading theories about the function and meaning of rock art as described and reviewed by Ross (2001, 545) include:

1) Trance shamanism and entoptic/phosphene phenomena (e.g. Blackburn 1977; Hyder & Lee 1994; Lewis-Williams 1995; Lewis-Williams et al. 1988; 1998; 2000);

2) Shrines (e.g. Grant 1967);

3) Archaeoastronomy (e.g. Hudson and Conti 1984; Hudson and Underhay 1978; Hudson et al. 1979);

4) Trade markings (e.g. Hartley and Vowser 1998);

5) Hunter (e.g. Taçon and Brockwell 1995);

6) Puberty and other communal rites (e.g. Applegate 1975; Grant 1965; Heizer 1953; Kroeger 1925; Lee 1979)

7) Riverine, territory and trail/path markers (e.g. Hyder and Lee 1991;Hartley and Vowser 1998; Robinson 2006; 2010a);

8) Biographical and narrative (e.g. Klassen 1998);

9) Vision quest/non-shamanic trance (e.g. Whitley 1992);

10) Event/mythical/historical markers (e.g. Hudson & Lee 1984).

For the purposes of this chapter, only those that have been used in the past to study Chumash rock art studies will be discussed and include: trance shamanism and entoptic/phosphen phenomena, archaeoastronomy, puberty and other communal rites, riverine, territory and trail/path markers and event/mythical/historical markers (Ross 2001, 545). Some are not described in-depth as they overlap with the following chapter that covers GIS and spatial analysis in rock art studies. While the overall methodology remains similar internationally, theoretical approaches vary based on the available data for the area of study.

3.2 Methodological Approaches to Rock Art Studies

3.2.1 Scale

Scale is an important methodological framework for rock art research and also plays an important role in any archaeological analysis whether the approach is qualitative, quantitative or a combination of both. In the last decade, the issue of scale in rock art research has become more recognised, so that applied methodologies have arisen as a result of the movement towards a more landscape approach to rock art studies (e.g. Hyder 2004 and Chippendale 2004). For the purposes of this discussion scale will be defined as the "…'grain' of the unit of analysis relative to the matrix as a whole; *effective scale* is any scale at which pattern may be recognized and meaning inferred" (Marquardt and Crumley 1987, 6, emphasis original authors). This definition, therefore, encompasses the variety of scales that archaeologists confront during their research whether it is a midden assemblage, a pictograph panel or the distribution of rock art sites over a large region.

Traditionally processualists used an analytical scale to interpret data in their quantitative analyses, but this application of scale has evolved to also encompass qualitative analysis that entails describing the meaning of temporal and spatial processes (Lock and Molyneaux 2006, 1). Today this research is most often combined to provide a more comprehensive and dynamic analysis such as the one outlined later in this thesis. Scale, therefore, is highly complex and difficult to define whether as a methodological framework, a part of human perceptions and experiences or both. Additionally, as almost all archaeological material has a spatial element (Marquardt and Crumley 1987), including rock art, defining scale becomes an important decision for each archaeologist as they are developing their methodological approach to both fieldwork and subsequent analysis (Lock and Molyneaux 2006). As Lock and Molyneaux (2006, 2, emphasis original authors) state:

> ...the essence of the scale issue is the confrontation between the archaeologist and the array of information identified as archaeological, from material objects encountered directly to the host of representations in different media at different degrees of removal from the physical environment. Consider, for example, the difference in engagement between artifacts capable of being held

> in the hand and those too large or too small. We obviously find it difficult to conceive of the outsized things *as* artifacts: we give the larger ones different names, such as features or structures, and we treat the smaller ones, tiny flake residue from tool manufacture, for example, as subjects of somewhat arcane specialties. Similarly, we have a better understanding of local environments -- the places we can explore in an hour or two -- than regions that may require a lifetime to cover.

Problems are created for many archaeologists when confronted with the concept of scale in their methodology. Issues with standardisation become highly complex when trying to adapt similar scales between analogous research projects. Culturally and temporally comparable sites may not have similar sized features or artefacts or similar methods of collection and classification. Scale remains an important explanatory method when dealing with dynamic past societies that is visualised through the archaeological record.

Within a GIS framework, scale also becomes both problematic and useful. Scale can be easily used but not necessarily easily understood, yet users can analyse multiple scales with relative ease. Furthermore, how does the archaeologist know when their analytical scale is merely arbitrary or when it represents ancient cultural perceptions? Marquardt and Crumley (1987,7) discuss that when dealing with a spatial region this area should be defined based on the extent of the cultural context and where patterns can be visually detected. Hyder (2004, 87) argues that this can be problematic because it is highly dependent on a researchers ability to identify these spatial patterns, and while this can be useful, it can also prevent other patterns from being detected. Researchers also run into issues with sample bias when determining a scale. Such biases are a reflection of the survey efforts of a particular archaeologist or project, and they will show up in a GIS framework as clusters of sites. This is the case with the project analysed here as I will discuss in more detail later in the thesis. Levels of data-gathering efforts were done within specific community scales of analysis (e.g. Horne and Glassow 1974; Robinson 2006, 2010a), and therefore, in the overall Chumash region show up as specific areas of clustering.

In order to tackle these problems, archaeologists have come up with certain approaches to dealing with analytical scales that can be useful within both quantitative and qualitative analyses. Additionally they have long recognised the importance of spatial research at multiple scales in order to promote a better understanding of the dynamics of past societies. Butzer (1982) first introduced the three levels of scale: the micro-, meso- and macro-environments. Marquardt and Crumley (1987) argue that most social scientists have focused most of their research at the meso-environment or -scale but have been slowly moving towards incorporating the macro- and the micro-scale. Adler (1996) more usefully and descriptively defines these scales as intrasite, the local community-scale and the regional or macro-regional scale and recognises that a static scale of analysis used for any archaeological research will never be adequate in a full understanding of society. Community-scale refers to a scale of analysis determined usually by the researcher based on some aspect within the full distribution of the information (i.e. clusters of settlements or artefacts). The regional scale would then refer to the full distribution of archaeological data of a defined group pertaining to a particular analysis (i.e. all known settlements for a particular indigenous group). These definitions of scale are relative to what is being analysed. For example, a macro- or regional-scale could also refer to the full distribution of artefacts within a settlement while the meso-or community-scale could refer to the clusters of these artefacts or the extraction of a particular artefact type (i.e. pottery types).

The discussion of scale within rock art research is comparatively new, but is based on a push for a more holistic approach to rock art analysis within the landscape (Chippendale and Nash 2004, 1). This is because the main strength of rock-art is that it is one of few non-portable or immovable artefacts found in the archaeological record and has a potential connection to the topography of its location. Unfortunately very few studies to date contribute focused research questions using rock art and its relationship with the natural terrain (Chippendale and Nash 2004) (see Chapter 4 for studies that do explore this relationship), so they do not recognize a community or regional scale of analysis. As Hyder (2004, 85) states, the existing studies focus more on the design motif or style of the rock art panel and its chronology (e.g. Hudson and Conti 1984; Lee 1984). This removes the artefact completely from its setting on the rock and does not explore its potential relationship with the surrounding topography (Bradley et al. 1994; Hyder 2004).

Two main articles based on the concept of scale in rock art research have been published. Hyder (2004), similar to the scales described above, has pushed for a move away from simply using the micro-scale to adding both the meso-/community-scale and the macro-/regional-scale based on the works of Butzer (1983) and Adler (1996) within location analyses. He calls for the renaming of the community-scale to the 'topographic environment' because this "…might reveal patterns in the relationship of specific landscape features to habitation and limited-activity sites, to differential distributions in subject matter, or to styles" (Hyder 2004, 91). The topographic environment should also be useful in addressing questions that reveal patterns that reflect a potential shift in cultural practices, chronological changes or a possible reflection of social identity (*ibid*, 91). This is under the assumption that topographic boundaries will reflect a particular society's boundaries, which he does recognise is not always the case (Hyder 2004, 93). Defining such a boundary would therefore become dependent on the recognition of patterns as described earlier. A macro-scale of analysis, that moves away from boundaries based on style, would also aid in answering questions based on social and economic relationships and systems and sub-systems such as trade (Hyder 2004, 87, 94).

Chippindale (2004) calls for a more precise methodology within the study of rock art that is not just concerned with location analysis. He (Chippindale 2004, 102) describes and orders these scales as:

1) The individual lines and/or dots that make up a figure (millimetre scale)
2) The actual figures themselves or the accumulation of the individual lines and/or dots (centimetre scale)
3) The relationship of these figures to one another within the motif and how these figures relate to the surface (metre scale)
4) The surfaces in relation to the landscape (kilometre scale)

(Table 3.1). While his example is more concerned with petroglyphs, it can be used as a methodological approach for most rock art sites. For example, pictograph panels may be considerably larger than many petroglyphs, so these scales can be applicable, but also can be adjusted based on judgment by the archaeologist. While this study is highly useful for its attention to a much finer scale, especially for recording rock art, it does little to define or push for a larger regional or macro-regional analysis which can be useful as noted above by Hyder (2004). Furthermore, questions arise when analysis is performed using a GIS that allows for such large scales where visiting every individual sites due to the sheer number across hectares of land, is not feasible.

Scale	Name	Aspect Addressed
thousandths of a metre	millimetre	technique
hundredths of a metre	centimetre	figure and motif
metre	metres	surface of panel
thousands of metres	kilometre	place in a broader landscape

Table 3.1: The four scales of rock art study as defined by Chippindale (2004, 115, Figure 5.1).

Within the studies of Chumash rock art, the idea of scale is predominantly used at the site-/micro-scale to the metre-scale of analysis as defined by Chippindale (2004) (e.g. Hudson and Conti 1984; Lee 1979; 1981; Lee and Horne 1978) although studies exist that allow for the inclusion of the community-scale and the regional-scale of analysis. For example, Hudson et al. (1979) present a literature review of what they interpret to be recorded summer and winter solstice rock art sites for the macro-region (macro-region also includes other indigenous linguistic regions within the state of California). They (*ibid*) further map areas where the solstice is known to play an important role within the Chumash, the types of observations (direct or indirect) and where these types of sites were recorded. The scale is arbitrarily defined because it is based on a modern political boundary, which could be argued as less effective because it has little to do with cultural perceptions. Oftentimes, though, arbitrarily defined scales are all the researcher can construct based on available data. The authors then move to a more micro-scale for sites, specifically within southern California, and present more localised information from ten sites where they had observed the solstice phenomena (Hudson et al. 1979). These sites include those recorded as Chumash including Condor Cave (CA-SBA-1633), Window Cave (CA-SBA-0655), Painted Rock (CA-SLO-0079) and Honda Ridge (CA-SBA-0550) amongst others (Hudson et al. 1979).

Hyder (1989) presents what he called a regional study of 17 rock art sites along the San Marcos Pass in Santa Barbara County. This analysis was based upon topographic areas, so was an example of the community-scale of analysis or the topographic environment. He discusses the association of rock art sites and environmental features such as ecotone transitional areas and their context compared to other Chumash site types (*ibid*). He further compares and contrasts this region with another, the Sierra Madre Ridge (collected by Horne and Glassow 1974), and also includes a functional assessment at the site-scale that includes the sites' visibility, their correlation to other site types and the description of the type of art present (Hyder 1989, 35) (See Chapter 4 for a specific review of the quantitative analysis performed).

The argument, that the choice of scale must be based on the research being conducted and the availability of data, needs to again be stressed. Scale for any archaeological research project, including rock art studies, will be highly dependent upon the following: the type of fieldwork and subsequent analysis, whether the research questions involve a comparative analysis with other analogous sites, where patterns are detected and are effective, how the archaeologists manipulates the scale to suit his/her needs, how the scale reflects cultural perceptions, and finally, how many scales are being applied and why. This highlights a more fluid and adaptable use of scale as an explanatory method that must be chosen with extreme care concerning the research questions being asked and the context of the overall project.

3.2.2 Informed Methods

In 1998 Taçon and Chippindale outlined two relevant methods that were already quite prevalent within the study of rock art at the time. These ideas were now putting specific names to two already established methodological frameworks. The first to be discussed is the use of "informed methods" (Taçon and Chippindale 1998, 7). Informed methods entail "those that depend on some source of insight passed down directly or indirectly from those who made and used the rock art - through ethnography, through ethno-history, through the historical record, or through modern understanding..." (Taçon and Chippindale 1998, 7; Chippindale and Nash 2004, 6). In most cases, the tradition of rock art creation no longer exists, for example, in North America, and this is directly a result of colonialisation and missionisation. Therefore, this method is reliant on the accuracy and integrity of those that conducted rock art studies or documented information directly or indirectly relevant to rock art creation– oftentimes this type of knowledge is very rare (Chippindale and Nash 1998).

As is often the case, ethnohistoric documentation concerning a society's rock art tradition does not exist, and archaeologists must rely on another method of analysis outlined below. An example of an informed method that includes Chumash rock art was studied by Whitley (1992, 89), who continues to study the rock art of the geographic area that he calls “far western North America”. The area covers what I would consider a macro-region that includes South-Central California, southern California and the Great Basin (see Figure 3.1). Where ethnographic literature is scarce or does not exist, Whitley (1992, 91) extrapolates the information for all groups located in the macro-region to make generalisations that cover the entire geographic area. By applying the knowledge from past ethnographers and the ethnohistoric record, he states that rock art was created only by shamans or initiates in ritual cults and the rock art depicts induced hallucinations (Whitley 1992). His hypotheses, therefore, represent all societies within far western North America that created rock art. He does admit to slight regional variations within South-Central California yet still postulates that only shamans were creating the rock art based not only on direct stylistic evidence, but also by what he says is revealed metaphorically in the ethnographic evidence (Whitley 1992, 91). The paper further compares the motifs at two rock art sites and interprets their meanings based upon ethnohistoric accounts and argues that, while the motifs vary in design, both are comparable based on same "symbolic system"; that of the shaman (Whitley 1992, 107). Furthermore, he argues that these sites were then considered sacred and places of exclusion for the general population where they were not allowed to access (Whitley 1992).

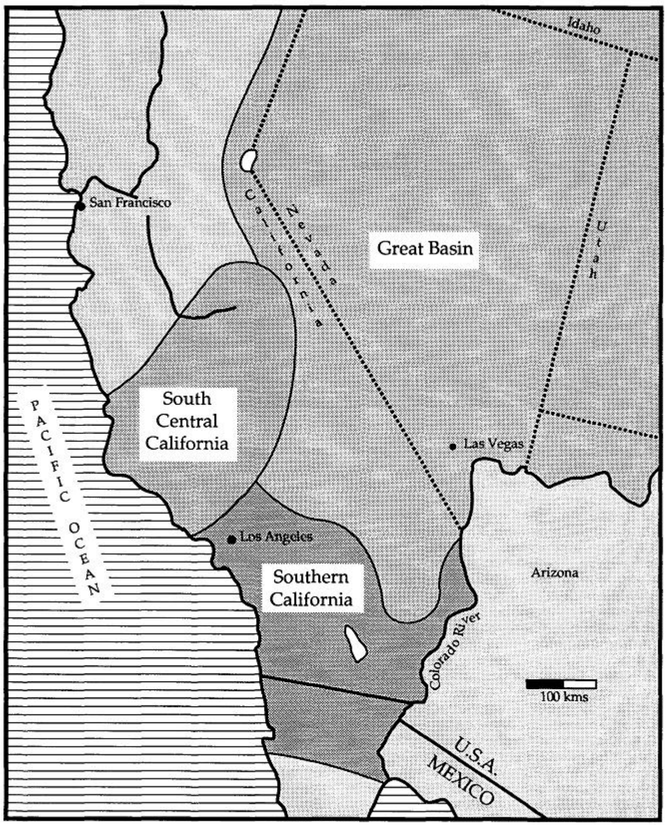


Figure 3.1: Far western North American macro-region as defined by Whitley (1992, 90, Figure 1).

Chippindale and Nash (2004) incorporate the definition of informed methods into the theme of a monograph that entails a look at rock art studies within their landscapes. Their definition further combines the knowledge of a society's perceptions and views on landscape (Taçon and Chippindale 2004, 17). Again, the data would come from ethnographic or historical data and incorporate the topographic environment, but also how the group being studied viewed this environment in relation to the rock art. Another example of this study again comes from Whitley (1998) and focuses on South-Central California, where he applies the ethnographic evidence to again support the idea that shamans and initiates of various cultural rituals were creating the rock art through trance. The rock art was a reflection of their visions during an altered state of consciousness (*ibid*). Landscape is then incorporated into the study using information gathered from ethnographic and ethnohistoric sources which purport that rock art sites were portals into the supernatural world allowing the shamans access between this world and the other (Whitley 1998, 16). The idea is similar to what was described in Chapter 2 from Hudson and Underhay's (1978) ethnographic and ethnohistoric description of the Chumash worlds, where shamans were the only people in the group to circumnavigate the many worlds. The motifs or elements that were on or near natural cracks within the rock are often interpreted as rock art entering or exiting through the gaps or fissures within the rock. The hypothesis is that they are symbols representing the shaman's transformation into their spirit helper during their vision and represent as their passage between the two worlds (Whitley 1998, 17-18). Finally, gender and sexual symbolism is applied to rock art sites through inversion where rock art sites are inherently female (based upon the fact that rock art sites were considered to symbolically represent vaginas or wombs) so were used only by male shamans (Whitley 1998, 18-19). Therefore, the distribution of rock art sites represents those places within the landscape that are symbols of importance because they are portals to the supernatural world, and represent the iconographic inversion, where the various parts of the landscape were a part of society's perceptions (Whitley 1998).

A critique of Whitley's research, in both of his articles outlined here and above, is that he studies the rock art outside of the archaeological context so, therefore, ignores other information associated with rock art sites such as middens, BRMs and association to other site types. As was stated in the previous chapter, there are specific reasons to use the ethnohistoric and ethnographic literature with caution, so research should also require the incorporation of the archaeological record. Extrapolating information over contextually varying topographic and archaeological landscapes can be problematic, and while he does admit to cultural variations, such things should not just be briefly mentioned in passing. The groups of what he refers to as 'far western United States' were each culturally rich in their traditions and perceptions of their landscape. The two examples above show how simply using the ethnographic and ethnohistoric information excludes the contextual data that can be gleaned from a more holistic approach by combining the various methodological frameworks. In other words, archaeologists and rock art researchers alike should not become overly dependent upon on a particular avenue of research but use as many tools as possible within a strong theoretical framework to guide their research. Robinson (2010b, 97) succinctly describes some of the issues with over-reliance on the ethnographic and ethnohistoric record in rock art interpretations:

> …I wish to stress here the very difficult problem of working with ethnographic texts. Specifically, when delving into the vast ethnographic information on indigenous California in order to address a specific question, one must

> necessarily hone in on specific references having to do with that question. For instance, anthropologists rarely asked their informants specifically about rock-art, so that many quotes related to rock-art are found in larger narratives or select sections on mythology, paint, or cache sites. Each quote is a node or knuckle linking multiple aspects of indigenous culture. In extracting quotes, information can become decontextualised from the very complex cultural situation within which that information emerged…This methodological approach of searching out only those nodes that are of interest has the effect of particularising and isolating the cultural element being looked at rather than seeing how it may be a strand within the larger cultural system.

3.2.3 Formal Methods

The final method as applied to rock art studies is that of “formal methods” also introduced by Taçon and Chippindale (1998, 7). This method is used when there is a lack of ethnohistoric data to study the rock art sites, which is, unfortunately, often the case for most archaeological research. It is defined as "those that depend on no inside knowledge" but which work with the observable features (*ibid*, 7). Formal methods are also used at times, as one would hope to expect, with informed methods, especially to supplement and create a more holistic analysis. When no such documentation exists then the researcher is left with only formal methods of analysis to apply their own approach to rock art analysis. Formal methods are again slightly modified to incorporate a push towards including the landscape into rock art studies in the subsequent edited monograph on landscape (Chippindale and Nash 2004). The methodology highlights the features that one can observe and/or measure within the rock art panel or site and also those features within the landscape and/or the associated environmental context (*ibid*, 20). Therefore formal methods, especially with the association to landscape and terrain, include most quantitative and spatial analyses.

For example, Horne (1976) looks at 12 Chumash rock art sites in the Sierra Madre Ridge of California, which he admits to being a small sample size, to study the variability in the rock art and whether choices in colour were non-random. He also looks at the presence or absence of rock art associated with other archaeological features present in the sample area (*ibid*). By using five style classifications of Chumash rock art (animal, human, rectilinear, curvilinear and circle and dot) and recording the colour of the elements (red, black, white or bi-chrome), he found that there was no preference for a certain colour in any of the five styles and red was the most favoured colour for all types (*ibid*, 121). The variability of style types was shown to be completely random using a *chi*-squared statistical analysis. Results for his test on associations of rock art with other site types found that while most were too small of a sample size to show any significant results, the bedrock mortars associated with rock art sites were found to be statistically significant (*ibid*, 123). Obviously a much better analysis would have resulted from a much larger sample size including more style and site variation, as Horne (*ibid*) was only looking at known sites within an area of less than 3 square miles. In this article, Horne includes a quantitative analysis through the extraction of specific elements from the motifs and by also incorporating parts of the associated landscape. He does not include any ethnohistoric data in his analyses that could have supplemented his hypotheses. Again this reduces the society being studied to only numbers and leaves out discussion on how the Chumash people potentially viewed their environment and its various attributes and associations.

Looking at the three methodologies of scale, informed and formal methods, and the various examples presented in this section, an argument can be made that a more holistic framework would benefit from using all three methods, especially due to the idiosyncratic and variable nature of society. Only with a complete lack of ethnographic information would it be necessary to exclude the informed methods, or where there is no data available that can be explored statistically or spatially would it be necessary to exclude the formal methods. Fortunately for this thesis a wealth of information exists to apply all three methods including both ethnohistoric/ethnographic and spatial data. As Chippindale and Nash (2004, 28, original emphasis) state:

> And the proven way of developing archaeological method is this: first, look at those cases and conditions where we do have some insight on which to base *informed methods*. Then, see the systematic patterns and regularities that emerge from those informed studies taken collectively. If any patterns and regularities do emerge, and they always do, even though there is no *a priori* reason why they must exist -- then use those to build robust uniformitarian *formal methods* which are broadly applicable.

3.3 Theoretical Approaches to Rock Art Studies

The following section deals with the various theoretical approaches that are currently being applied to rock art research. In Schaafsma's (1985) review of rock art studies, she shows that the main areas of study in the 1980s were concerned with chronology and interpretation with research predominantly based upon style and meaning. While her research is almost 30 years old, I believe that many of her ideas are still relevant to current rock art research. At the time, there was a large push in collecting descriptive and locational information concerning rock art sites, and oftentimes, there were very few research questions guiding this documentation (*ibid*, 239). Proper documentation is still currently important to rock art studies in terms of conservation and preservation. Furthermore, she shows how ideas of both function and symbolism, as they relate to the group creating the rock art, were becoming more prevalent in rock art research (*ibid*). One point to note is that ideas of scale, informed and formal methods were already established in the research at that time; they simply had not received explicitly defined terminology.

Rock art researchers have come a long way since the 1980s in developing a more comprehensive approach, partially as a result of the descriptive and locational information that was collected in an effort to preserve such sites. While it is true that perhaps these past records did not have a fully developed methodology nor were they theoretically orientated (*ibid*, 239), the result is that there are records available for sites that may no longer exist due to development, erosion, extreme vandalism or, simply due to the sheer size of their distribution, only a sample can be visited. That is the case for this thesis that would not exist without such efforts from past archaeologists and volunteers. Unfortunately, past research focusing on chronology, style and motif distanced itself from the potential cultural perceptions and ideology of the people creating the rock art by ignoring its placement in the overall landscape or context in which it is found (Bradley 1997).

As with the Chumash research, style and motif were studied and often included ethnographic information, but this was sometimes at the expense of the archaeological context (e.g. Hudson et al. 1979; Hudson and Conti 1984). The idea that shamans created this rock art was first introduced by Kroeber (1925) and further perpetuated by Steward (1929) and Grant (1965). With the incorporation of J.P. Harrington's information through research by Blackburn (1975) and Hudson and Underhay (1978), this ethnographic research was brought into both the public and academic world (Hyder and Lee 1994). Unfortunately, the associated material culture of the Chumash was oftentimes left out of the discussions, although some studies by

Horne (1976), Hyder (1987; 1989) and Robinson (2006; 2007; 2010a; 2010b; 2011; 2013; In Press) have remained focused on a more comprehensive and holistic analysis using the three methods described above. The ethnographic and ethnohistoric information promoted the idea that rock art creation was only by the shamans of the *'antap*. This created a rigid framework that persisted for over three decades that purported rock art sites were only used by shamans and that any sort of domestic activity (nearby associated archaeological context such as middens and BRMs.) was never temporally associated with the rock art. Since such rock art sites were considered direct portals into the supernatural world, they were considered very dangerous for the rest of the Chumash society and concluded to be places of exclusion for the general populace. Also, because rock art sites still are very difficult to date without compromising the motif, this argument was used as a way to disregard material culture as not contemporaneous. Robinson's (2006) PhD thesis brought this contextual association back into the Chumash rock art research and discussion when he looked at the associated archaeological features, activity areas and permanent settlements of the Emigdiaño Chumash in the interior. His research (*ibid*) is the beginning of a new type of rock art research that includes a more holistic approach through the three methodological frameworks to the discipline of California rock art studies.

The existing theoretical approaches to Chumash rock art studies outlined here are based on review of rock art studies by Ross (2001) and are refined to only those theories that are being pursued by academics studying Chumash rock art research both present and past. Some of the theoretical approaches outlined earlier are not included in this review because they are not known to be applicable or have not been pursued in discussions of Chumash rock art research to date. Some of these approaches outlined below have held fast over the years and have continually been updated as new information and/or technology becomes available, while others have become more prevalent within the last few decades.

3.3.1 Trance shamanism and entoptic/phosphene phenomena (the neuropsychological model)

This theoretical framework is based on the ideas that any form of trance-inducing activity creates an altered state of consciousness that cross-culturally produces similar geometric images that can be found in rock art produced by shamans on vision quests (Lewis-Williams et al. 1988). These entoptic/phosphene phenomena are considered universal, and variations in rock art happen as a result of different culturally specific influences in the creation of the images and motifs (Whitley 1992). The elements themselves would be geometrically similar, but the meaning each society placed on these elements or motifs would be drastically different. Lewis-Williams (1995, 6) uses this neuropsychological model, first introduced by Lewis-Williams et al. (1988), in studying the origin of rock art of the San in South Africa by linking it to shamanism. Whitley (1992; 1998; 2000), as was previously discussed, uses this as one of his theoretical approaches to studying the rock art of far western North America including that of the Chumash. As with many of these studies, this theory is backed up with ethnohistoric data concerning shaman's vision quests and with religious ceremonies involving the ingestion of hallucinogens. Ross (2001, 544) states, "…a loss of information and bias during the ethnographic information gathering and cognitive processing is inevitable. Shamanistic societies do not provide deep information even to their own members until certain cognitive thresholds are met by initiatory experiences". I am not saying that this theoretical approach is incorrect; it is simply to state that it may only be a piece of a much larger story as was also discussed above by Robinson (2010b). Again, there is a lack of incorporation with the archaeological context in these types of studies.

Whitley (1992; 1998; 2000) was not the only researcher to apply this type the neuro-psychological model to the Chumash. Blackburn (1977) first purports this idea of cross-cultural phenomena brought on by Chumash shaman's ingestion of *Datura inoxia,* but he also recognises the social variability that would be universally inherent based on complex cultural variation. His ideas were based on anthropological fieldwork of the South American Tukano where various symbols seen during hallucinogenic experiences were given cultural meaning that was understood by the whole tribe (*ibid*, 90). After this publication and outside of studies by Whitley (1992; 1998; 2000), the neuro-psychological model was little used in Chumash research until Hyder and Lee (1994) used the study by Lewis-Williams et al. (1988). They came to the conclusion that *many* but *not all* of the Chumash rock art sites were produced from visionary images because of the role that hallucinogens played in Chumash religious practices. Their conclusion is also based on Hyder's (1989) previous publication, were he applies quantitative analysis and purports that shamans did not create all Chumash rock art sites because of rock art's association with the archaeological context (Hyder and Lee 1994).

3.3.2 Archaeoastronomy

Archaeoastronomy is the study of how past groups understood or viewed astronomical phenomena. It is a study of indigenous cosmology. This topic became quite popular with Chumash researchers after Hudson and Underhay's (1978) collation of J.P. Harrington's notes and hypotheses relating to astronomy and Chumash mythology. Based on informants' references to the cosmos, the winter and summer solstices and further supplemented by ethnographic information from both the Yokuts and the Gabrieliño, the book describes the significance of roughly 25 constellations and stars to the Chumash. For example, Hudson and Underhay (1978) make note of a reference from Blackburn (1975) of paintings being created during the time of the winter solstice. Hudson further promotes archaeoastronomy in a series of supplementary articles (e.g. Hudson et al. 1979; Hudson and Conti 1984; Hudson and Lee 1981) and his theories were the inspiration for other researchers to pursue this specific approach for some of the Chumash rock art sites (see below).

For example, Hudson et al. (1979) presents a literature review of recorded summer and winter solstice rock art sites for the macro-region and include other known culture areas within the state of California. The authors create maps of areas where the solstice is known to play an important role within the society, the types of observations and where these types of sites have been recorded. They state (Hudson et al. 1979, 40) especially concerning the Chumash that:

> As outdoor people, Native Californians were well attuned to closely watching rhythmical cycles of nature around them. These people realized that earth's natural changes were directly related to celestial changes taking place above them. Although they did not come to theorize that the earth's seasonal changes were produced by its axial tilt and revolution around the sun, they understood that when the sun could be seen rising or setting at a certain location on the horizon, or when certain stars appeared in a dawn or twilight sky, certain seasonal changes were about to take place on earth: rain would come, leaves would dry, seeds would ripen, deer would migrate, and so forth. In short, they perceived a cosmos in which seasonal changes on earth were caused by cosmic forces above, and it was this basic concept that no doubt transformed celestial object into celestial deity. The magnitude of these

> changes, produced by untouchable and distant objects, supported the conclusion that these celestial deities were immensely powerful.

They further present a table that shows direct evidence of how important the solstices were to each of the California tribes, including representations of those with no known data. It is much more intuitive though to understand their thesis through a map of the California groups that observed, most likely observed or denied knowledge the different solstices (Figure 3.2).

Figure 3.2: Map of California showing geographic areas based on the ethnohistoric and ethnographic evidence of different societies information on solstice observations (Hudson et al. 1979, 44, Figure 1).

For the Chumash, the authors state that the sun was an important deity and observation of the solstices by watching the position of the sun was further celebrated through rituals and offerings (*ibid*, 43). Their study includes ten sites that demonstrate how rock art was being used by the Chumash to document the solstice. One of their sites, Window Cave, is a small rock shelter containing a single sun disc (See Figure 3.3). The solstice sun at sunset shines a beam through a hole or 'window' within the small rock shelter's wall that frames the disc. At sunset, the sun slowly rolls down the northern slope of Tranquillion Mountain when viewed through the hole in the inside of the shelter (*ibid*, 49). In archaeoastronomy, there is a lack of understanding within these studies of how the palaeo-environment was constructed and how possible vegetation would have prevented such phenomena from taking place. Perhaps in the past there were boulders blocking the views of the sun that have shifted due to earthquake activity. The article then goes on to discuss that due to their observations of these ten sites to measure solstice documentation, the shamans who created the rock art were also observers of the cosmos (*ibid*, 52).

Figure 3.3: Photo of the winter solstice phenomena, December 2011, during a visit by Michelle Wienhold, Jon Picciuolo and Marcello Di Bonito to document the process. The sunlight shines through the natural 'window' in the rock and starts to narrow and frame the sunburst-like petroglyph. Photo by Marcello Di Bonito.

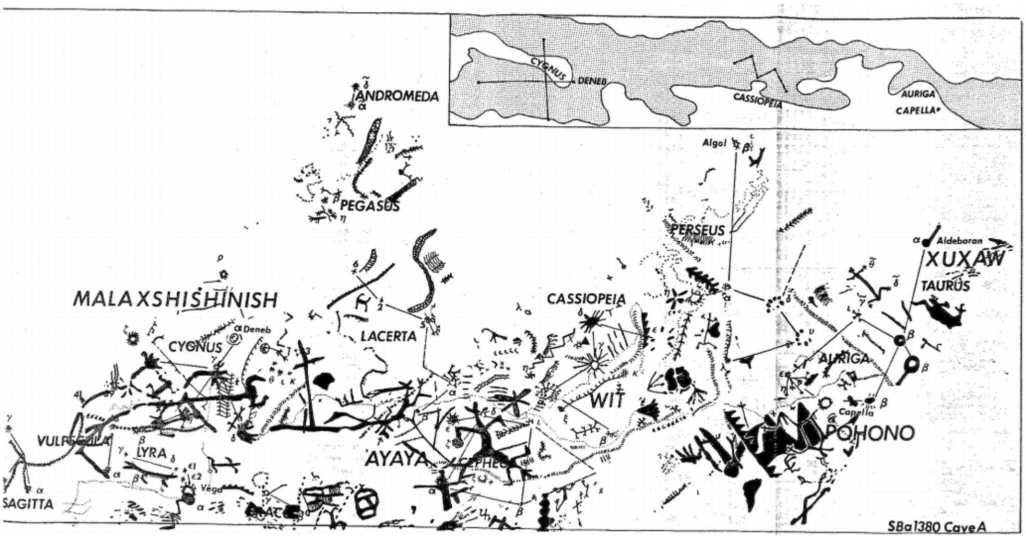


Figure 3.4: The pictographs of Indian Creek Cave A showing their relationship to stars in the winter sky (Hudson and Conti 1984, 82, Figure 29).

Hudson and Conti (1984, 49) use a specific site, Indian Creek (CA-SBA-1380), where they argue that the pictographs found here are a "map-like depiction of what may be stars in a winter sky". Their fieldwork consisted of surveying Indian Creek resulting in the discovery of new caves with rock art, bringing the total to six total caves for this specific site (*ibid*, 52). Using the archaeoastronomy approach, they purport the site to be a Chumash interpretation of the winter sky including symbols of characters from the Chumash supernatural world found in the ethnohistoric literature (Figure 3.4) (*ibid*). This site has an associated midden that they conclude is a seasonal camp and would have been occupied by the Chumash only during the summer and autumn in this area because of a lack of resources available for gathering during the winter months. Since their study found that the pictographs were of the winter sky, they conclude that it was painted during the winter months. Therefore, the rock art site was not contemporaneous with the midden, and they conclude from ethnographic information that domestic activity was not a part of the supernatural world or that of the shaman's rock art (*ibid*).

Since Hudson's work in associating pictographs to that of Chumash astronomers, archaeoastronomy, especially in its role during the summer and winter solstices, has become an important theoretical framework within Chumash rock art studies. Further studies have looked at other rock art sites within the Chumash landscape focusing on solstice phenomena by directly observing the play of shadows and light with the various pictograph motifs and petroglyphs (e.g. Spanne 1985; Krupp and Wubben 1990; Sprague and Gasse 2001; Hammond 2003). Further discussion can be found in Robinson (2004) and Robinson et al. (2012).

3.3.3 Puberty and other communal rites

Very little research exists concerning rock art creation and other communal rites outside of shamanism. In this section, the brief references found in the literature will be mentioned. The discussion so far points to the theory that only shamans were creating rock art during an altered state of consciousness in order to establish an affinity or manipulate any malevolent or benevolent affairs attributed to the supernatural. There is little discussion about the potential of rock art being created during puberty rites, but the argument has been made based on the ethnographic literature of other indigenous communities throughout California. For example, Applegate (1975, 7) in his article about *Datura* use within the Chumash, states that groups on the southern coast of California, for example, the Gabrieliño and Luiseño, used this hallucinogen as part of their large ceremonial puberty ritual referred to as the *Chingichnich* cult. Kroeber (1925, 67) states that the puberty initiates made paintings after a ritualistic run signifying the end of the ceremonial process. Grant (1965) mentions this in his book on Chumash rock art and states that it could have also been applicable within Chumash society. This is a logical conclusion as the Gabrieliño were the Chumash's southern neighbours and also due to the high use of *Datura* within Chumash society. Also, the neighbouring southern Yokuts and the Western Mono held a ritual *Datura* drinking ceremony every spring (Applegate 1975, 8). Applegate (*ibid*, 8) states that for the Chumash drinking *Datura* was acceptable year-round and was allowed for all genders after puberty. The main purpose was to contact one's spirit-helper, especially for the initial experience, but could also be used to contact their supernatural guide at any time or to obtain another helper (*ibid*). Due to the whole community having such visions, all members at some point in their lives would have been exposed to the entoptic/phosphene phenomena.

Another idea is that the cupules found throughout the Chumash geographic region were the result of certain communal rites. Unfortunately, information does not exist for these types of petroglyphs within the Chumash ethnographic record. Yet, Lee (1979, 302) states, "in other areas of California it has been suggested that cupules were associated with fertility, weather control, boundary markers, or puberty rites". Heizer (1953) shows ethnographic evidence of cupule use for fertility among the Pomo and for weather control among the Tolowa, Karok and Hupa. More research is needed for these enigmas because, as Hector (2009, 70) states, there is very little literature or attention to them because oftentimes they are difficult to identify and almost invisible in certain lighting.

3.3.5 Riverine, territory and trail/path markers

Another thesis defines rock art as the markings on the landscape that are a medium of communication, whether for internal or external social groups, to relay a message to the observer. This has been another rock art theory presented in the literature (e.g. Hartley and Vowser 1998; Robinson 2006; 2010a). While Robinson (2006; 2010a) also discusses rock art as a boundary marker for the Emigdiaño Chumash, that is further discussed in the following chapter on GIS and spatial analysis.

Instead, we will look at Lee and Hyder's (1991) study that used similar stylistic presentations to study rock art at the boundaries of six ethnic groups near permanent settlements and major trails at the time of Spanish contact. These sites were also highly visible, so they hypothesise that these sites support the assumption that they were well known at that particular moment in time (*ibid*). Lee and Hyder (*ibid*) suggest that the styles presented at the territorial boundaries for different societies were an indicator of complex cultural interactions and also reflect a way to uphold these boundaries for warring tribes or to indicate alliances. Interestingly, the groups being investigated (Yokuts, Tubatulabal, Kawaiisu, Kitanemuk, and Tataviam) all have some overlapping ideological beliefs (*ibid*). An example of their findings (*ibid*, 22) along the Temblor Range, one of Kroeber's (1925) acknowledged topographic divisions between the Chumash and the Yokuts, states:

> It is clear from the rock paintings at the sites in or near the Carrizo Plain that both tribal groups used or shared this area. Some of the motifs at Painted Rock are virtually identical to paintings in Yokuts territory; others are of sufficient size to indicate Yokuts influence if not actual Yokut artistry. In some cases, panels clearly in Chumash style are adjacent to panels with Yokuts style-motifs.

While their findings for the whole area of study were not conclusive they did find some examples, such as the one above that did show promise. They state that more work needs to be done with a greater sample size for a more conclusive analysis. The authors found the greatest support of cultural interaction in areas of ethnographically recognised boundaries where documented interactions took place (Hyder and Lee 1991, 25).

Hyder (1989) also touched on this idea of sites as boundary markers. He found that there are four archaeological site types associated with rock art in his comparison of sites along the San Marcos Pass and those sites found in the Sierra Madre Ridge. He states that this allows one to make inferences on the function of the rock art sites or whether they are private or public (*ibid*, 18). He suggests that public rock art would be those associated with permanent settlements and seasonal activity areas and their function could point to an indication of ownership, shrines or boundary markers (*ibid*).

3.3.6 Event/mythical/historical markers

The theory of rock art as event/mythical/historical markers in Chumash rock art is closely tied to the theory of archaeoastronomy (see above) where the art itself represents mythical creatures from the supernatural world represented in the cosmos and further incorporates the discussion of Chumash ideology. As Hudson and Conti (1984) purport at Indian Creek, the rock art created a map of the western sky with mythical creatures being represented within the art itself. Another study not mentioned above is also based on archaeoastronomy but also focuses on such a marker. It is the analysis of a Chumash arborglyph (tree carving) where elements were found similar to that of pictograph sites (see Saint-Onge et al. 2009 for more in formation). This theoretical framework is also closely tied to the studies of rock art as representations of Chumash ideology especially focusing on the notion of power.

Hudson and Lee's (1981, 44) work was original in attempting to discover how rock art played a role in Chumash ideology through its symbolism in a "prehistoric visual information network". In regards to Chumash rock art Hudson and Lee (1981, 31) state,

> …we believe that conventionalised symbols are present and that they represent long-term, stable, visual information elements with meanings. In addition, although the meanings of these symbols are beyond our total comprehension, we believe that some measure of understanding can be accomplished provided their functional aspects can be identified. Moreover, we believe that Chumash symbols not only were power elements which served as a vehicle of communication within the group responsible for their production, but that they also fixed certain values of ideological content.

Rock art function was perceived as a way to maintain the sacred, a way to acquisition power or to maintain an equilibrium or cosmic balance for Chumash society (*ibid*). The authors further argue that the function of the rock art was only for members of the *'antap.* The researcher would gain a stronger understanding of Chumash ideology through understanding both the function and symbolism of the rock art, the.

Rock art as mythical/event markers are further hypothesised by Robinson (2011) to also be representative of the Chumash ideology. Robinson (*ibid*) tied ideology to the Chumash landscape and subsistence practices. Instead of studying the rock art as only for the use of the members of the *'antap*, he further hypothesises that its inclusion within taskscapes makes it visually available to the rest of Chumash society. He (*ibid*, 46) describes rock art as "visual media" that is a form of Chumash expression within chosen contexts that may reflect a differentiation of power. Robinson (*ibid*, 46) states that, "…display of highly visible, vibrant media in the form of pictographs should be viewed as a projection of some form of power or authority targeting the most important locales within terrestrial south-central California." Thus ideology can be gleaned through more theoretical approaches to rock art as it is fixed at significant areas within the Chumash landscapes and taskscapes.

3.4 Conclusion

Overall this chapter has outlined the three main methodological frameworks that provide a more holistic analysis for rock art studies. As I argued, these three methodologies: scale, informed and formal methods are necessary as they utilise all available information to study rock art, its interrelationships to other archaeological data within the Chumash interaction sphere and its relevancy to the ethnohistoric/ethnographic literature. It is further important to pursue a theoretical discourse as a basis and structural guide for any archaeological analysis. Therefore, in the second section, to further understand past Chumash rock art research, I have outlined the variety of theories that have been used both in the past and within current discussions to understand the theoretical frameworks used by past Chumash rock art researchers. The research focuses on interpretations of style, function, symbolism, distribution and connections to the mythological and ideological belief systems. Therefore, I argue for a push to include the archaeological context associated with the rock art sites as it provides important information relevant to the rock art discussion. Finally, rock art research and more formal methods of analysis are further expanded upon in the next chapter through the use of quantitative and spatial analysis to statistics and geographic information systems/science (GIS).

Chapter 4 Geographic Information Systems (GIS), Spatial Analysis and Quantitative Analysis in Rock Art Studies

4.1 Introduction

As discussed in the previous chapter, I will outline the various methodologies that utilise GIS or quantitative analyses through the formal methodology for rock art research. Due to the limited number of studies using GIS, quantitative and spatial analysis within rock art analyses, I have written this chapter as a more in-depth literature review of the studies themselves. As no such extensive review exists in the published literature, this review can point to the areas of formal methods of rock art research that need to be further explored. The review also highlights the overall lack of a theoretical basis for many of these studies, although theory is not necessarily applicable to those that focus specifically on conservation and preservation. Finally, this chapter serves to highlight how my research is presenting a more complex analysis on the study of rock art within the landscape especially over a very large region by also applying a theoretical framework.

Efforts and technological advances in rock art recording and image or style analysis are more prolific within the literature (for North America see Mark and Billo 1999, 2002; Harman 2008; for Europe see Cruz Berrocal and Garcia 2007; Ling 2008; Rogerio-Candelera 2011; for Australia see El-Hakim et al. 2004 and Paterson and Wilson 2009). This is partially reflective of a push in the 1980s as described by Schaafsma (1985) for more recording within rock art studies through Cultural Resource Management (CRM) that is still prevalent today. Schaafsma (1985, 239) states in specific reference to North American rock art research that:

> In the last 20 years the emergence of and pressures associated with contract archaeology have not necessarily been conducive to the development of a problem-oriented approach and a theoretical structure with accompanying methods for analysis and interpretation. To "get it recorded before it is gone" is the all too familiar goal inspired by the destructive aspects of development as well as by an increasing infringement upon this cultural resource by vandals, as access to remote areas steadily increases. In response to accelerating need, efforts have focused on technical advances in field procedures and the development of standards for recording in order to establish guidelines for adequate documentation of rock art sites.

This also reflects a worldwide effort of archaeologists to maintain the rock art record as a cultural artefact/heritage site fixed in place and potentially at risk to destruction. Such recording efforts are very important for the preservation and conservation of such sites, but efforts cannot simply stop at the recording. Geographic and information databases can be a starting point to construct analyses to empirically and theoretically interrogate such a wealth of information that has been collected. While recording of these sites for conservation and preservation is very important, a push for more spatial analysis can enrich the understanding of the role rock art played in past populations, and support the building a more theoretical framework in which to study rock art. As was stated in the previous chapter, incorporation of ethnographic /ethnohistoric literature, if applicable, can be an important supplement to enhance the cultural understanding of the placement of the rock art within a landscape and social context. As I highlight in the following, these types of analysis efforts in rock art research have been slowly making an appearance within rock art studies and archaeology with positive results. Their aims may not be similar, and they may oftentimes lack a theoretical basis for their analyses, but the studies are showing a correlation to these extraordinary artefacts fixed and immobile within the cultural landscape. Furthermore, the Chumash rock art analyses that were introduced in the last chapter (e.g. Hyder 1989; Robinson 2006) have also been included within this chapter and highlight the potential ties rock art has to the cultural landscape and environment.

4.2 Quantitative Analysis and Spatial Statistics in Rock Art Studies

Archaeological data are, inherently but not necessarily exclusively, both quantitative and spatial in nature. Archaeologists at some point within their analysis quantify data through measuring, counting, sampling and classifying. Documentation of the spatial location of an artefact or feature, whether it is *in-situ* or not, is standard practice for fieldwork through plan or profile mapping and the use of GPS and the suite of GIS programs available today. Quantitative analyses in archaeology first became popular in the 1950s with the publication of Spaulding's "Statistical techniques for the discovery of artifact types" in 1953. During the 1960s and 1970s these types of analyses were reflected in publications (e.g. Clarke 1977; Hodder and Orton 1976) or the beginning of the Computer Applications and Quantitative Methods in Archaeology

Conference (CAA) in the United Kingdom in 1973. The methodologies highlighted were often borrowed from the disciplines of geography or ecology. Spatial archaeology, firmly rooted in the positivist approach and New Archaeology, applied a variety of statistical and quantitative methods to archaeological data. Originally the concepts of spatial analysis focused on general human processes and used quantitative methods to identify patterns reflected within the environment (Conolly and Lake 2006). This positivist approach was extensively critiqued and rejected within the post-processual movement during the 1980s (e.g. Hodder 1982, 1986) and further critiqued during the phenomenological or experiential movement (see Gillings 2009; 2012 for further discussion). Regardless, the researchers applying GIS to archaeological data never fully rejected its application within archaeological analysis, despite its critiques, especially as computers became more available and computing power increased (see Lock 2003; Wheatley and Gillings 2001; Lake and Conolly 2006). As Gillings (2012, 610) states in discussing the application of GIS in experiential research today:

> Not only has experiential theory come under sustained and insightful criticism, but the widespread penetration and routine application of spatial technologies such as GIS within the discipline have been profound. Instead of seeking out a notional middle ground, archaeologists using GIS should actively work to develop new conceptual frameworks that are not only sensitive to broader currents and debates in critical thought, but also the potentials and possibilities offered by emerging spatial technologies.

Techniques are developing with a push for more integrated approaches using GIS, often and importantly within current theoretical frameworks, as a diverse tool that requires a comprehensive understanding of its strengths and critiques. While this first section focuses on quantitative methods in rock art studies, there are examples presented in this section of research that are purely statistical in nature while others encompass a more holistic spatial analysis. GIS is applied in many of the studies outlined first, but the research relies more heavily on mathematical and statistical modelling outside of the GIS software.

Human Impact on Geomorphological Features

Jiménez-Sánchez et al. (2011) uses quantitative analysis to gain better insight to the degree of human impact on different types of geomorphologic features in rock art caves used for tourism. The cave in this study, Tito Bustillo Cave in Northern Spain, is a large cave network consisting of many interconnecting chambers (*ibid*). The main tourist attraction is the polychromatic rock paintings located in what is called the "Gran Panel Room" accessed through a human-made entrance (*ibid*, 271). Located in the western part of the cave network is an associated archaeological site that is closed to the public (*ibid*). The numerous changes that have taken place in the cave to enable tourism have drastically changed the cave's structure including the human-made entrance, lighting, numerous doors to stop sudden changes in the microclimates, paths and raising the cave floor (*ibid*, 273). Their methodology studies the human impact of geomorphological features in Tito Bustillo Cave. The first step involved creating a map of the geomorphological and anthropogenic features currently present throughout the cave. The map was constructed at a chosen scale of the horizontal features and their spatial distribution and included: natural features, gravity features, chemical precipitation features, biogenic features, anthropogenic features, geomorphologic features, other features and geological features (*ibid*, 272). The hand-drawn mapped data were then scanned and digitised, using a GIS program, into attributed, georeferenced vector data to manage the database of information associated with the cave's horizontal features. What the authors title a geomorphological heritage map was then created to analyse the degree of preservation of the cave network and the human impact from tourism (*ibid*, 272). The process involved creating heritage categories or surface parameters based on the horizontally mapped natural and anthropogenic features, and from the categories, four quantitative indices were established based on the mapped horizontal measurements of each category's area (*ibid*). The results show a significant impact to the geomorphological heritage of Tito Bustillo due to tourism (See Table 4.1 for the process and results).

Surface parameters		Surface (m^2)
S_C	Surface of the natural cave	6931.10
S_T	Surface of the tunnel	509.43
S_U	Surface of present underground environment (cave + tunnel)	7440.53
S_{NGH}	Surface of natural geomorphologic heritage	3521.92
S_{CH}	Surface of cultural heritage	88.29
S_{GTU}	Surface of geomorphologic impact	3830.32
S_A	Surface of antropogenic features	3918.61

S_U: surface of the present underground environment; S_C: cave surface; S_T: surface of the artificially added structures; S_{NGH}: surface occupied by the natural geomorphologic heritage; S_{CH}: surface occupied by cultural heritage; S_{GTU}: surface affected by human impact features linked to cave opening; S_A: surface of anthropogenic features.

Index	Index name	Formule	Index value
G_{HC}	Geomorphologic Heritage Conservation	$\frac{S_{NGH_i}}{S_C}$	0.51
C_H	Cultural Heritage	$\frac{S_{CH_i}}{S_C}$	0.01
G_{TU}	Geomorphologic Impact linked to Tourist cave conditioning	$\frac{S_{GTU_i}}{S_C}$	0.55
T_A	Total Anthropogenic Influence	$\frac{S_{A_i}}{S_C}$	0.57

G_{HC}: Geomorphologic Heritage Conservation Index; C_H: Cultural Heritage Index; G_{TU}: Index of Geomorphologic Impact linked to Tourist Use; T_A: Total Anthropogenic Influence index.

Table 4.1: The creation of surface parameters and quantitative indices to analyse human impact due to tourism based on mapped geomorphological and anthropogenic features (Jiménez-Sánchez et al. 2011, 274 Table 2).

While the quantitative indices were quite simplistic mathematically, based on the percentage of mapped areas of different horizontal cave features, this research presents a methodology that can be applied to other caves with similar issues applicable to studying the preservation of geomorphological heritage or the anthropogenic impact. The authors found that the values from 0.51-0.57 showed a high impact of tourism and the preservation of natural features within a cave environment. Further development of this analysis to include the vertical walls of the cave and the ceilings would be useful to offer up more comprehensive results. This article is the only study that I found to be using GIS to highlight important issues with preservation and conservations of rock art sites.

Multivariate Statistics

McCall (2010) applies multivariate statistical techniques to study South African rock art in Didima Gorge, an area within the Drakensberg Mountains of South Africa. The area was ideal for this type of analysis as it contained a previously recorded high-resolution spatial dataset and report of 17 rock art sites including “precise maps of individual sites, copies of the paintings and detailed typology of individual painting elements for specific rock art panels" (*ibid*, 776). The overall goal of this analysis was to introduce a new methodology for studying rock art within its cultural and geographic landscape context, especially to recognise patterns and variability in the sites' placement, organisation and imagery at multiple scales (*ibid*). Due to the ethnographic interviews from the turn of the 20th century of the *!Xam*, this information has been used previously to study the cultural and social meaning of the rock art with an overall emphasis on shamans and their altered states of consciousness (*ibid*, 776). Critiques of these previous cultural and social studies of South African rock art include a lack of regional scales of analysis showing the variability of the imagery and little focus on the chronology (*ibid*, 777).

The overall multivariate analyses were focused on 14 of the 17 sites based on the number of elements present at each sites; sites with more than 20 elements were kept for the study (*ibid*, 777). First, the inspection of the data showed a distinct difference between the numbers of small rock art sites (those with a low number of paintings) and large rock art sites (those with a high number of paintings) and a correlation between the sites and the landscape context (*ibid*). Large rock art sites were found predominantly in low elevation rock shelters found near the base of Didima Gorge (*ibid*, 778). Further exploration of the data was done to study whether these low-lying shelters that contained a high number of paintings were potential habitation sites. This is based on the idea that such easily accessible sites would have been ideal locations for domestic activities, which would then be reflected in the archaeological record. High-resolution documentation of the sites allowed for surface artefacts to quantifiably represent these domestic activities associated with habitation.

The first multivariate analysis, a regression analysis, was applied to understand the correlation between the number of surface artefacts collected and the number of rock art elements at each site and showed a low but statistically significant correlation (*ibid*, 779). McCall (*ibid*, 779) suggests that some of these large sites were not related to habitation sites or economical activities because "three of the four sites with the highest number of rock paintings were the most extreme outliers in the regression". One of these sites though is located in a high elevation area and more hidden location that could point to the potential of selection based on its isolation. Other sites did exhibit this correlation that leads to the conclusion that there were probably different site types associated with the rock art: large sites used for habitation and those that were not.

The next analysis from McCall (2010) involves pattern recognition and utilizes the substantial catalogue of rock art element recorded for this area. Research questions explore the spatial variation and patterns of coincident elements types at the sites. The data included 3,909 elements with 66 categories that were generalised into 15 categories for easier analysis and also included the frequency of lithics and ceramics (*ibid*, 781). Data was further reduced using principal component analysis (PCA) to compare and explain the frequencies of the 17 total variables (*ibid,* 781). Outputs from the PCA were used as input into a cluster analysis, which showed co-occurrence of specific element types throughout the sites (*ibid*, 782). Associations were found between the lithics, ceramics and specific elements types, which indicate that these elements were found at habitation sites and also shows the associations between elements in the other principle component variables (*ibid*, 783). Other specific elements associated with entoptic imagery were also only found at non-habitation sites. Further cluster analysis calculated the principal component regression scores for the different sites and found three distinct site types indicating that the rock art was created at varying landscape locations for a variety of purposes that include: large domestic, large uninhabited and small isolated sites (*ibid*, 783). The author further explored this idea by utilizing a spatial analysis that further supported the spatial variation of the rock art sites at the regional scale. Overall the most interesting finding was that the elements most associated with altered states of consciousness were found at isolated, non-habitation sites and in association with the imagery of children. Furthermore, McCall (2010) argues that this entoptic imagery was not predominate compared to other image categories which is surprising considering the theoretical importance of this theory within the area as prescribed by Lewis-Williams and Dowson (1988). Overall, the paper stresses that rock art was created in a variety of contexts within the landscape and also opened up a new way of looking at rock art besides just applying ethnographic information.

McCall (2010) presents a well thought out methodology for exploring rock art sites through both quantitative and spatial analysis. Two different scales are applied here, that of the rock art element or micro-scale, and that of the regional or macro-scale of analysis. Further analysis can prove interesting by rerunning some of these analyses at a site- or community-scale. The article would have benefited from a more in-depth discussion of the algorithms applied to the data and further explanation of the figures. It proves robust in developing a strong argument towards applying such methods to further explore the variety of contexts that potentially gave rise to rock art creation. As stated previously, this research is important to this area because it creates new ways of studying rock art within its archaeological context instead of simply discussing it in terms of its creation during a shaman's altered state of consciousness. After the publication of McCall's research, a rebuttal to this study was produced by Lewis-Williams and other researchers who interpret this rock art as entoptic phenomena (see Challis et al. 2012) and to which McCall (2012) responded. One of their biggest critiques was that they claimed McCall had a lack of knowledge of this landscape that they (Challis et al. 2012) have with their many years of research within the area. Even so, McCall's (2010) study points out that research should not use one static example of society (i.e. the ethnographic record) as their only direction of analysis. Rock art research should incorporate the archaeological context of rock art sites including the landscape by applying a variety of heuristic methods to help understand potential distinctions of site types. Societies are dynamic and as such an open dialogue should be present in order to have a more open mind about new directions of research.

<u>Quantitative Analysis in California Rock Art</u>

In California research, there have been a few applications of quantitative methods to rock art research. Garfinkel et al. (2010) researches rock art depicting bighorn sheep in the Coso Range of eastern California, a part of the culture area referred to as the Desert West. The area contains an extensive number of petroglyphs, around 100,000 well-preserved images, and it is estimated that about half of these represent bighorn sheep that are exceptionally realistic in nature (*ibid*, 42). The rock art is attributed to the Pre-Numic populations that are hypothesised to have been later replaced by the neighbouring Numic populations, although there is evidence that these occupations may have overlapped. The purpose of this study was to utilise a timeline from regional archaeofaunal data to quantitatively simulate the possible depletion of bighorn sheep populations from human predation after 1500 B.C. (*ibid*).

Potentially, competition for resources increased by pressure from neighbouring Numic groups over the Coso Range. The authors hypothesise that as a direct result of this human predation and resource depletion, that there was a correlation to increased production of rock art depicting bighorn sheep. This article attempts to understand the presence of an abundance of bighorn sheep rock art images found in this region.

Rock art site dates were obtained through their content (i.e. datable hunting adaptations such as hunting dogs and the use of the bow and arrow) and associated archaeological context. The simulation models themselves are temporal, not spatial and based upon "standard ecological competition and predator-prey modals" to monitor population sizes (*ibid*, 43). Four separate simulations are used to predict populations during 1500 B.C. – A.D. 1500: Numic, Pre-Numic, bighorn sheep and rock art (*ibid*, 47). First the authors cover their basic assumptions: that bighorn sheep populations were depleted during this time, the Numic replaced the Pre-Numic populations, both populations utilised bighorn sheep for resources and that rock art was created for the purpose of hunting magic (*ibid*). Overall the models were used to establish a potential correlation of increase in petroglyphs within the Coso Range during a period of time where there may have been resource depletion (*ibid*). The input variables for each of the simulations, such as beginning population sizes, were researched and considered accurate based on ethnographic data and studies of human forager populations. Potential bighorn sheep populations for this area were based upon studies of herd animal populations. Three different outputs are presented in this paper. One presents a complete depletion or extinction of the bighorn sheep within the area during the time period being studied. The other increases the birth rate of the sheep and the rock art production in order to prevent a total depletion of sheep populations. Finally, rock art production was found to be more prolific in times during resource depletion when compared to the outputs of the other two simulations (see Figure 4.1).

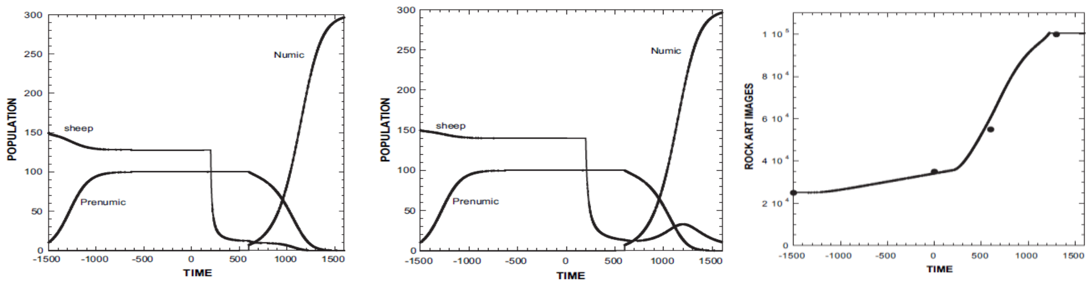


Figure 4.1: Predictions of populations of Numic, Pre-Numic, Bighorn sheep and rock art images within the Coso Range in California showing an increase in rock art creation during times of resource depletion (Garfinkel et al. 2010, 47, 49, 50, Figure 6-8).

The authors in this study admit to the simplicity of the simulations that they present in the paper, but also demonstrate that this model can be applicable, albeit with a host of assumptions, to interrogate available data. It is interesting to note that, considering bighorn sheep were herd animals, there is no mention or inclusion of the fact that neighbouring herds would have or could have entered this region at any point during the time period of study. Herd populations are only based on the original population input into the model. Furthermore, a question that could be asked is, did the Prenumic populations follow the herds outside of the study area when resources were scarce? It is an idea that could be further explored in future research within the area, which could include a spatial component. Also, this model assumes that the main resource is bighorn sheep due to the petroglyph images but excludes any other resource types. Were these elements perhaps based on other societal meanings beyond just hunting magic?

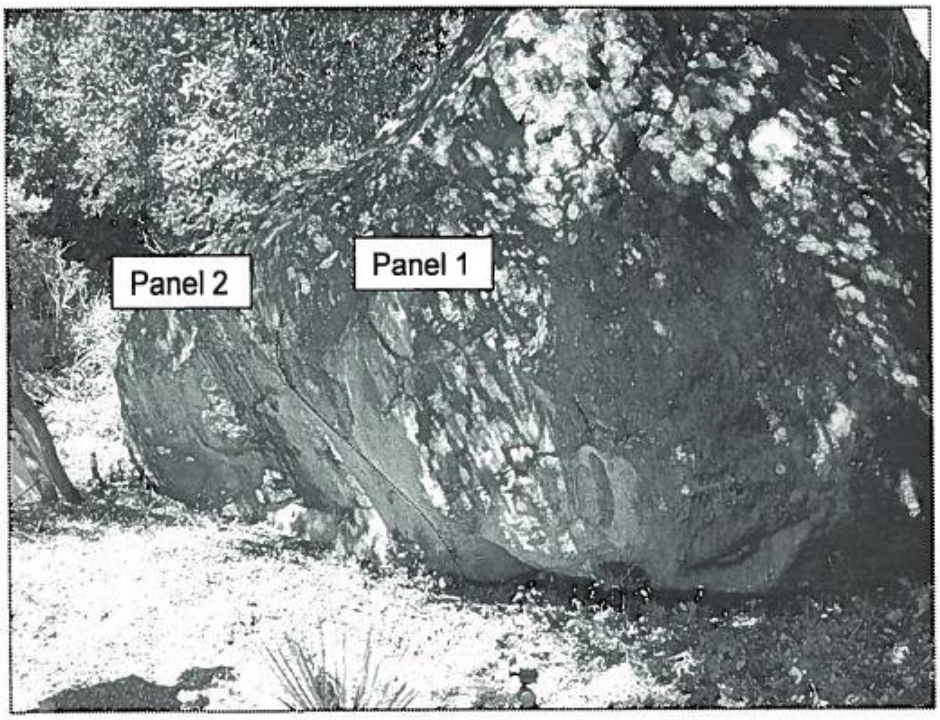
Further research on Coso rock art by Eerkens et al. (2012) studies digital images to understand how information may have potentially been transmitted through variation in rock art styles. The authors are some of the few to focus on the distribution of motifs styles at Chippindale's centimetre-scale and how the motifs are distributed at the regional-scale. Furthermore, the study uses a theoretical framework to construct their hypotheses. Theoretically, this analysis focuses on cultural transmission and innovation employing the hypothesis that the variation within rock art panels or motifs produced by the same person would be less than those produced by multiple people over the wider region (*ibid*, 241). They further state that variation within smaller community areas/clusters of rock art sites would also have less overall variation because of the potential for different artist's exposure to the nearby sites (*ibid*). Finally, motifs or panels that would have been created for the use of conveying information would also potentially contain less variability between sites as the message would need to be consistent and recognizable to the observer (*ibid*, 242). Finally, they argue that more variation would be apparent with abstract images when compared to more identifiable anthropomorphic images that are based on recognizable real-world subjects (*ibid*, 242).

Quantitative measurements were taken for four ubiquitous motifs found over the Coso region to study these hypotheses and included: "two representational (sheep and anthropomorphs) and two abstract (shields and rakes), were arbitrarily selected" (*ibid*, 242). Overall they used samples of the motifs from three site clusters positioned at different geographic- or community-scales and obtained measurements from the numerous selected motifs (*ibid*, 243). Results found that the sheep motifs had the most consistent quantitative measurements that pointed to less variation when compared to the other motif styles that had marked variation. The authors state that this may have been important for the audience to understand the representational image as sheep for conveying information (*ibid*). Overall the area of study did not show distinct spatial differences between the three site clusters and all of the present variations were represented within each of the clusters (*ibid*). The authors suggest that this may point to the high mobility of the groups within the area and that rock art was not being used to mark territories. Furthermore, these variations did adhere to a regional style potentially reflective of their cultural ideology. Finally, the quantitative data was compared to other similar data gathered for the material culture for the area. Results show that there was more variation in rock art than with the various artefact classes, so artefacts were more standardised likely due to their specific functions. Overall, except for the sheep motifs, the rock art styles did not reflect any transmission of information on how to create specific styles such as a template for their creation (*ibid*).

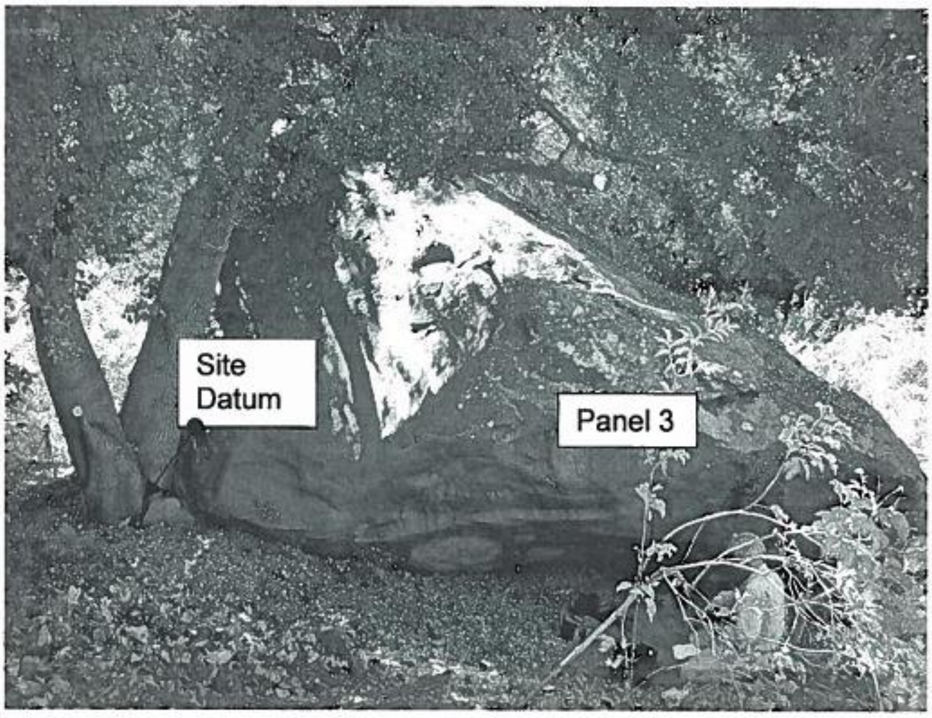
<u>Quantitative Methods in Chumash Rock Art</u>

Quantitative methods in Chumash rock art studies exist, and they are very prolific in terms of the published literature on quantitative analysis of rock art. The first quantitative analysis was performed by Horne (1976) outlined in the previous chapter, but the application became more popular in the 1980s by Hyder (1987, 1989). It is quite surprising because at this time, as this review has shown, these types of analyses in rock art were almost non-existent in the published literature. The following briefly shows the content of these studies and how they have contributed to quantitative analyses in rock art studies.

Hyder's (1987) analysis involves two relatively unknown Chumash rock art sites, Diablo Canyon (see Figure 4.2 and Figure 4.3) and Morris Cabin Creek (no photos exist within the site records), within the central mountain region of Santa Barbara County, California (*ibid*, 45). These two sites are further compared to the well-researched site of Indian Creek discussed in the previous chapter. Analysis between the three sites is used to stimulate discussion on regional variation in Chumash styles over the multiple linguistic boundaries. It is based on ethnographic information showing marriage and familial ties between associated villages on the coast and further into the interior. Hyder (*ibid*) first studies the frequency of element types at each of the three sites and then compares the element frequencies of these sites with sites previously studied in the Sierra Madre Ridge. The outputs show what Hyder (*ibid*, 48) states, "in analyzing similarity matrices computed from the site data, it became apparent that I had only a weak statistical argument for regional variation." Further analysis, explores archaeological and environmental context associated with the rock art sites between the two regions. Results show that sites in the San Marcos Pass area did not have a strong archaeological context, especially occupation sites, whilst the sites in the Sierra Madre Ridge area have a strong archaeological context (*ibid*).



View southwest of Panels 1 and 2.



View southeast of Panel 3 and Site Datum. Photographer Rick Bury at lower right.

Figure 4.2: Photographs from Diablo Canyon (CA-SBA-2015) site taken from the Los Padres National Forest site record. Photographs by Dan Reeves and Rick Bury.

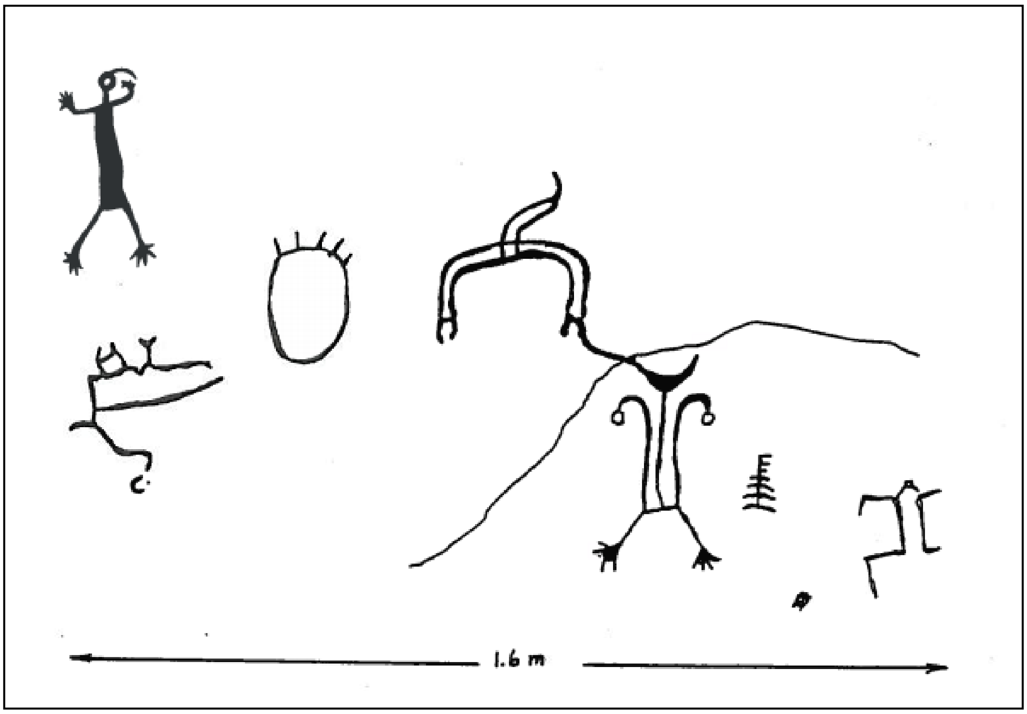


Figure 4.3: Drawing of Diablo Canyon Panel 1 (CA-SBA-2015) by Dan Reeves taken from the Los Padres National Forest site record.

Overall this paper is exceptional as it presents the initial use of quantitative methods to stimulate conversations on its application in rock art research. Furthermore, Hyder (*ibid*) includes both an environmental and archaeological context to his analyses that reaches beyond the typical stylistic and chronological studies of the 1980s. Unfortunately Chumash rock art researchers did not follow Hyder in his quantitative analyses until almost 20 years later when Robinson (2006; 2010a) applies spatial analyses to study the Emigdiaño Chumash (see below).

Hyder (1989) further expands the research presented above by comparing the rock art variability between San Marcos Pass and the Sierra Madre Ridge. In this analysis, 17 sites from the former were compared to 11 sites from the latter for a functional analysis (not quantitative) and a classification analysis. Therefore, he incorporates more sites from the San Marcos Pass area to make the research more robust than found in Hyder (1987). For the functional analysis, Hyder (1989) analyses the different site types found within the two Chumash regions. The site types include: occupation sites, limited activity camps, limited activity sites, storage caves or no associations and missing data. Site types were then documented as to the presence or absence of pictographs. The analysis points to a variety of site types that are associated with rock art that differs from the dichotomous public versus private (*ibid*, 15). Hyder (*ibid*) admits that the sample size is still too small for significant results, but he found that there is enough of a correlation between large occupation sites and rock art (public rock art sites created to send messages to the population) to warrant further future analysis. In looking for evidence of private sites (sacred or ritual rock art sites), he found very little evidence to support this site type between the two regions.

Hyder's (1989) quantitative analysis researches how the elements changed in accordance with changes in material culture or the ideology of a society. Classification of elements was done to show variation in technique into three types: chalked or drawn, monochrome and polychrome (*ibid*, 19). Application of further classification to distinguish motif types at a smaller scale created groups based on design, so a discriminate analysis was then applied to test the element categories and to adjust for misclassification and misrepresentation of the motif variations based on different erosion rates of pigments. Next, a seriation analysis was used on the existing data. Similarity measurements using the Brainerd-Robinson coefficient were used to group the element counts in order to similarity (*ibid*, 27). To seriate the data, multidimensional scales (MDS), an exploratory analysis, was applied, which is "a quantitative technique that seeks to find the best placement of points in *n* dimensional space such that similar points are closer together, and dissimilar points are farther apart (*ibid*). The analysis looks at both areas separately. The San Marcos Pass data show a potential correlation to time with the element classification while the Sierra Madre Ridge showed no real correlation. Linear drawings were older while the polychromatic designs were seen to be more recent in the San Marcos Pass area.

Hyder (*ibid*, 28) further explores the possibility that time may have not been a functional factor but that more cultural attributes could have played a role in rock art. The areas of study were combined, analysed through MDS and separated by site type. The results of this show no functional pattern for the rock art. Finally, regional patterns were studied to see if they might show dimensional correlation where styles vary between the two areas. The outputs of the MDS show a pattern of differences between the coastal and interior sites although Hyder (*ibid*) is quick to point out that the results oversimplify the cultural dynamics at play. Again as was stated earlier, Hyder (1987; 1989) was a pioneer in quantitative analyses for Chumash rock art. He used the results of his analysis to create new hypotheses for further research and to create a dialogue about the rock art chronology, function and landscape association.

4.3 GIS and Rock Art Studies

Applying GIS, and particularly spatial analysis, to rock art studies is not common within archaeological research or in the published literature. While studies on the application of advanced technology within a GIS framework (i.e. 3-D scanning, GPS, photogrammetry) to *record* and *document* rock art sites are more common, as described above, analyses of the collected data through GIS are not. This section discusses the few studies available within the published literature that use a form of spatial analysis to study rock art and its association to the landscape. Throughout these studies, a trend of the use of modern elevation or environmental data as input to study prehistoric or historic landscapes is apparent, with the exception of the virtual reality study by Winterbottom and Long (2006) and analysis by Ridges (2006) and Aubry et al. (2012). While it is problematic within GIS studies, as will be seen below, using the modern environment as an approximate representation of past topography can obtain results to be used as a heuristic that can further the understanding of past human behaviour and rock art. Often the availability and time needed to reconstruct palaeo-environments or palaeo-topography are not feasible nor are they usually present at high resolutions for finer-grained results (see Wienhold 2013).

4.3.1 Viewshed Analysis

One of the most common spatial analyses used in GIS and rock art studies is that of the viewshed analysis. Viewshed analysis is the process of identifying the cells in a raster that are visible and are not visible from an identified observation point (cell) (see Wheatley and Gillings 2002 or Conolly and Lake 2006 for further discussions). It is most often used as a bridge between phenomenological research and GIS analysis as it works with a human's perception of their landscape. In this section, a brief discussion of the few studies that incorporate this particular spatial analysis will be synthesized.

The first published viewshed analysis using rock art sites was by Gaffney et al. (1996). The article presents two case studies to support their argument for a push towards more cognitive GIS studies in archaeological spatial analysis to avoid an environmentally deterministic approach (Gaffney et al. 1996). The first is a study of burial cairns, and the other, a study of rock art and monuments. Cognitive use, therefore, is applying spatial data to explore past societies without the use of imposed values that the user assumes to be important (*ibid*). Prehistoric rock art and other ritual monuments in mid-Argyll Scotland, in the area of Kilmartin, were used as the input observation points to study their relationship with the landscape and the inter-visibility between the rock art and monuments themselves (*ibid*, 132). The rock art in this area consists of typical cup marks but also includes more elaborate designs such as rosettes and spirals (all petroglyphs)(*ibid*, 145). Viewshed analysis allows the authors to study areas where visibility overlapped to create an index of perception that varied spatially (*ibid*). The authors (*ibid*) found mostly low intervisibility between their input data, but one particular area, around a stone circle in Kilmartin Glen, had the highest inter-visibility between the monuments and, therefore, a cognitive focus. While this study only uses a single, static scale and lacks the reconstruction of vegetation (Winterbottom and Long 2006), it was groundbreaking by the incorporation of rock art sites into the archaeological landscape.

In 2006 Winterbottom and Long published another viewshed analysis within Kilmartin Glen to study the effects that contemporary vegetation, especially woodland, would have had on two of the rock art sites used in Gaffney et al.'s (1996) study: Cairnbaan and Glasvaar. Their argument was that the previous study did not take into account the past placement of woodland surrounding the rock art sites and did not explore how this could have affected the output of the visibility studies (Winterbottom and Long 2006). Two petroglyph sites were chosen based on specific criteria required to accurately reconstruct contemporary vegetation and were dependent on quality peat deposits adjacent to the rock art sites. First, the peat deposits provided pollen data for a palynological analysis that was then used to indicate the types of vegetation that were contemporary to the petroglyphs. Analysis reveals that from 3500 BC the surrounding environment consisted of woodland with a closed canopy, while from about 3000 BC to the present, there is an indication of more open woodland further comprised of grasses and sedges (*ibid*, 1359). Based on previous studies, these dates coincide with the time period that the rock art sites are believed to have been utilised. The authors conclude "the landscape in the immediate vicinity was wooded with a closed to semi-open canopy and subject to low levels of disturbance" (*ibid*). Second, the information on the spatial distribution of woodland for the areas adjacent to the rock art sites was created for input in the viewshed analysis. A spatial distribution map was produced using elevation, saturation maps (created from hydrological analysis) and data on geology to pinpoint probable areas of vegetation in the landscape within ArcGIS (Winterbottom and Long 2006, 1360). Height of the woodland was taken into account by using specific height estimates for different species of woodland, which was then added to the elevation data (*ibid*). Finally, the areas within 20 metres of the rock art sites were assumed to be cleared (*ibid*).

Viewshed analysis was run for both the base elevation data (i.e. without added height for the woodland) and the elevation data including the added woodland height. The outputs, therefore, create two examples showing the effects of no vegetation surrounding the rock art sites and the effects of maximum vegetation surrounding the rock art sites. Results show that the woodland that is contemporary to the rock art sites can affect viewshed studies (see Table 4.2). The authors state that the reality of the actual viewshed would most likely fall somewhere between these two extreme cases and be affected by seasonal changes in vegetation (*ibid*). It is especially informative for those studies that do not take into account contemporary vegetation and had previously hypothesised that sites were chosen based on the vistas (e.g. Gaffney et al. 1996). This further leads to the hypotheses that these rock art sites may more likely be markers along known routes or that nearby natural features were used as the markers for the sites themselves (Winterbottom and Long 2006). Due to the nature of viewshed analysis, where the landscape is either "seen" or "unseen", the analysis pursued procedural geometry techniques in virtual reality to further study visibility to explore other possible interpretations (*ibid*).

Area visible from rock art locations

Location	Vegetation status	Area visible (km^2)
Glasvaar	Without vegetation	8.46
	With contemporary vegetation	0.22
Cairnbaan	Without vegetation	11.67
	With contemporary vegetation	0.01

Table 4.2: Table from Winterbottom and Long's (2006, 1362 Table 1) viewshed analysis showing the visibility results before and after the addition of contemporary vegetation to the elevation data.

In order to further explore the hypotheses outlined above, the study created virtual environment reconstructions to aid in the visualisation of the surrounding landscape from the two rock art sites randomly and with varying degrees of woodland density to study different scenarios (*ibid*). The results show that there are multiple interpretations that can be reached using this method, and "it also enables us to take a more phenomenological approach to site interpretation whilst still retaining the ability to quantify landscape parameters" (*ibid*, 1365).

One critique with both of the analyses discussed above is that there is no incorporation of different scales in the GIS viewshed analyses. The studies only maintain the research at the landscape scale. The addition of the woodland reconstruction in the second study through procedural geometry techniques was novel and enabled the study to look beyond the landscape scale. Unfortunately, there was no discussion on dynamic scales in the article, and ethnographic or ethnohistoric record exists for these areas to further supplement the analyses. The next viewshed analysis discussed in this section does incorporate known ethnohistoric evidence.

Hartley and Vowser (1998) used least-cost path and viewshed analysis to explore the relationship between rock art location and its potential to communicate information to other people moving within the landscape. The research was originally presented in 1994 (Harley and Vowser 1997), but this article provides what the authors state as a version that “employs a revised method that we believe better addresses the relationship between demographics, resource structure, economic decision-making and the location of rock art” (Hartley and Vowser 1998, 185). Therefore, this article was chosen for inclusion instead of the previously published version. The area of study is in southeastern Utah, USA, which is a part of Glen Canyon National Recreation Area. Rock art of this area consists of both abstract and representational pictographs and petroglyphs (*ibid*, 188).

Data for this analysis was chosen based on its quality of locational information and specific drainage characteristics (*ibid*, 189). Other archaeological sites included in the study are storage structures and habitation sites found within this landscape. The authors postulate that the "positioning of much of the rock art was the result of decisions at the individual level, rock art offered raw 'information' about the presence of past human activities to observers moving about the landscape and it was assigned some meaning relative to the social environment and the activities that took place there" (*ibid*, 189). Spatial orientation and spatial friction are hypothesised to have been two of the most important issues in deciding where the storage structures were placed within the area of study (*ibid*, 190). Spatial orientation is the ability of a person to determine and maintain his or her spatial position and movement in relation to the surrounding environment. Spatial friction is defined as the cost of movement that would affect decision making during both travel within an environment and transportation of goods (*ibid*, 192). Overall, this article argues that some of the rock art in this landscape associated with storage of foodstuffs were media that may have prevented the risk of theft (*ibid*, 194).

To explore this argument, the authors ask two specific research questions. First, they examine whether the position of the storage sites was associated with the rock art sites, and second, if there was an association, they wanted to understand the rock art assemblages (*ibid*). The authors apply two different methodologies to explore these research questions. First they use quantitative methods by applying the Shannon formula to calculate the rock art assemblages and then apply least-cost path analysis and viewshed analysis to clarify the association of storage facilities and rock art. The Shannon formula represents the measure of redundancy within the rock art sites, where the lowest value represents only one element, or piece of information, present at the site while a higher number represents a greater number of elements (*ibid*, 195). This section focuses on the viewshed analysis while the least-cost path analysis is discussed in the next section. The two different GIS analyses are used to explore both spatial orientation and spatial friction to rock art and storage facilities.

Rock art sites were digitised using the United States Geological Survey's (USGS) 1:24,000 topographic maps and a 30-metre Digital Elevation Model (DEM) was used to represent the topography (*ibid*). Viewsheds were calculated for each rock art site and several of the storage sites in the study area and the visibility of rock art from the least-cost paths. The analysis was applied for a person of 1.75 metres in height and with a viewing distance of 500 metres (*ibid*, 199). As the results of the viewshed analysis were combined with the results of the least-cost path analyses, it is further discussed in the next section.

Robinson's (2006; 2010a) analysis of the Emigdiaño Chumash rock art found at the Wind Wolves Preserve in the San Emigdio Hills, California, also applies viewshed analysis. The overall research uses various GIS applications, viewshed and least-cost path analysis, to study rock art and its association with other archaeological deposits and environmental features at two scales. Robinson's (*ibid*) research expands on the idea that rock art is created within a landscape where both the rock art and landscape are tied together as a reflection of the social and ideological beliefs. It further looks at past California rock art researchers' hypotheses that many of the rock art sites in the western United States were either public, near other archaeological deposits, or private spaces, not associated with any known cultural areas (*ibid*). Robinson states that "a methodology addressing the visual presence of rock art in relation to individuals and their activities is needed, moving beyond general concepts of correlation into specific spatial dynamics, worked out at varying scales in order to understand past human experiences" (*ibid*, 794). The two scales of analysis are the taskscape or micro-scale and that of the landscape or meso-scale. Viewshed analysis was applied to study the scale of the taskscape. A taskscape is defined as the cultural activities that took place within the immediate vicinity of the rock art and is based on Ingold's (1993) definition of a taskscape as being socially imbedded within the landscape (*ibid*). All of the rock art sites are considered important ensembles of cultural features often containing middens and bedrock mortars associated with natural features as will be seen later in this thesis. Rock art sites and their adjacent taskscapes are considered to be seasonal occupations, late summer and autumn, where food was prepared. This section focuses on his viewshed analysis at the site or taskscape scale, and the least-cost path analysis at the landscape scale is further explored in the next section.

First, a total station was used to map the eight chosen sites. Next, a detailed viewshed analysis was run using ArcGIS software for seven taskscapes to study the visibility of the rock art or natural feature used for its setting (*ibid*, 202). Second, field verification was used to check the accuracy of the viewshed analysis, and third, cumulative viewsheds were created to represent the total on-site visibility (*ibid*). Table 4.3 shows the results of this analysis.

Analysis results reflect how people utilised the sites and how the natural features located adjacent to the rock art were exploited (*ibid*). The first analysis shows that there was intervisibility between the defined taskscapes surrounding the rock art or its setting showing "that many activities were so positioned that they occurred under the visual scope of the rock art and its host feature, and in a number of cases, pounding took place literally right on top of or immediately adjacent to the pictographs" (*ibid*, 223). Furthermore, the path to the nearest water source shows intervisibility to the rock art and/or the rock shelter so that people collecting water to aid in the processing of acorns would have visually interacted with these sites. Robinson (2006; 2010a) states that the seven rock art locations, based on this analysis, were not located in private areas, but are public taskscapes that are integrated into daily activities. Based on ethnographic literature concerning daily activities, the conclusions support the idea that women, among the other members of the Emigdiaño Chumash society, would have spent considerable time at these sites processing food (*ibid*, 224). All of the conclusions presented by Robinson (2006; 2010a) are in direct contrast to the hypotheses that rock art sites were only used as private spaces for male shamans (e.g. Whitley 2000). Finally, this affirms the idea that the rock art was intertwined with the social and ideological beliefs of the Emigdiaño Chumash as it was intervisible to both cultural and natural features, and it was therefore visible to most of the individuals that utilized these taskscapes (Robinson 2006, 225).

Site	Number of BRM stations intervisible with pictographs	Number of BRM stations intervisible with shelters with pictographs	Midden or isolates intervisible with pictographs	Midden or isolates intervisible with shelters with pictographs	Path to water intervisible with pictographs	Path to water intervisible with shelters with pictographs
Pond	1	19	No	Yes	Yes	Yes
Pleito	1	2	Yes	Yes	Yes	Yes
Los Lobos	1	4	No	No	No	Yes
Santiago	7	7	N/A	N/A	Yes	Yes
Chimney	6	N/A	Yes	N/A	Yes	Yes
Pinwheel	0	3	N/A	N/A	N/A	Yes
Three Springs	0	3	No	Yes	N/A	Yes
Total	**16**	**38**	**2**	**3**	**4**	**7**

Table 4.2: Table from Robinson's (2010a, 814, Table 1) viewshed analysis showing the visibility results of seven sites located at the Wind Wolves Preserve, California.

4.3.2 Least-cost Path Analysis

The second most common analysis performed by rock art researchers utilising GIS is that of least-cost path analysis. Least-cost path analysis refers to the creation of the shortest path from a source point to a destination point derived from a cost-surface raster measuring the cost of movement from the source point (Conolly and Lake 2006). The analysis is often used in archaeology to replicate known routes of travel or predict routes of travel, but can also be problematic in their application due to less effective algorithms used by some GIS programs (see Conolly and Lake 2006, 252-255 for further discussion).

Hartley and Vowser's (1998) study, one of the first analyses to explore least-cost path analysis with rock art, explores two different ways of producing cost surfaces. The first cost surface relies on the creation of a friction surface created by converting the DEM into a slope surface and then squaring the values to represent the steepness of terrain (*ibid*, 197). Least-cost paths were then calculated from the storage facilities and ending at the lowest part of the study area (*ibid*). The results show the conduits that utilise drainages as the paths of low friction. The second type of cost surface was produced using GRASS GIS and measures a specific value of human movement; that of the speed of human travel across the landscape measured in time through the application of Tobler's Hiking Function (*ibid*).

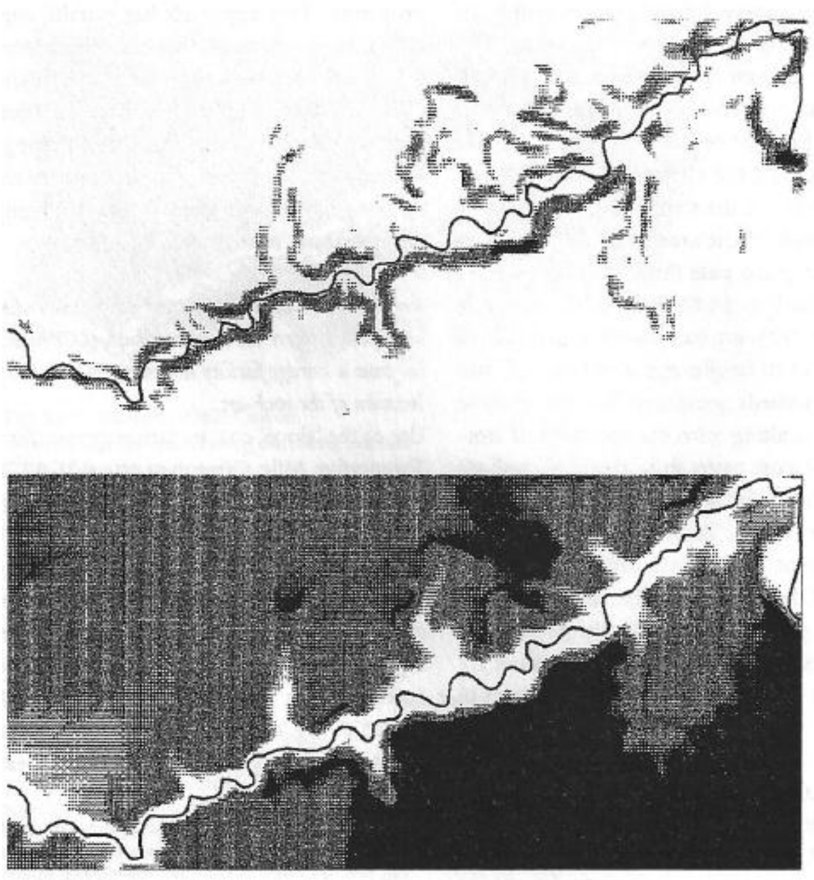


Figure 4.4: Examples of the two outputs of the difference least-cost path analyses in Twentyfive Mile Canyon, Utah, USA from Hartley and Vowser (1998, 198, Figure 11.6). The top represents the output from the cost surface created using the slope-squared while the bottom figure represents the output from the final cumulative cost surface created using the hiking algorithm.

Measurement of movement, therefore, is more intuitive and quantifiable than the least-cost path analysis measuring expended energy as it is measuring a realistic variable. Furthermore, as Hartley and Vowser (ibid, 199) state “calculating the least-cost paths across this cost surface also resulted in paths that were less likely to follow natural drainage patterns” (See Figure 4.4).

Results show that three rock art sites from the slope-squared least-cost path with high levels of information intersected with viewsheds from rock art sites (*ibid*, 199). Alternatively results from the Tobler’s hiking function show that one rock art site was located within the viewshed of the least-cost path (*ibid*, 200) and found that rock art was not found within the viewshed of many of the storage facilities nor along the routes from the least-cost path analysis (*ibid*, 201). The authors contend that this was related to population density and competition between groups although not much is discussed about the different outputs of the two analyses. They suggest that it is because there are two different types of behaviour taking place within the study area (*ibid*). Both conclusions concern population density, group mobility and risk of a threat to the stored resources. When there is a low population density and higher mobility, storage facilities would be located away from other cultural activity areas and not require rock art as media to prevent the pilfering of resources. Areas with multiple storage facilities that are located within close proximity to large habitation sites have these storage facilities within their viewsheds as well being within the visibility of storage facilities located on prominent topographical landmarks (*ibid*). This reflects that a much higher density population may have had more problems with competition for resources. Overall this research study concludes that "rock art in prominent topographical situations functioned as one medium of information available for coping with the mobility demands of this environment" and that "the location of some rock art was determined by threats to resource patches and by a need to assert proprietary rights" (*ibid*, 206).

While this study is interesting, there are a few potential shortcomings that should be considered. Firstly, Hartley and Vowser (1998) do not seem to make a distinction for time in their analysis. Based on the information available in the paper, the authors seem to be able to have general dates and cultural affiliations for the rock art, but instead sites of multiple periods are grouped together and placed on the landscape as input (e.g. Fremont, Anasazi). Multiple analyses selecting out specific contemporaneous sites may have made the study more robust and perhaps led to conclusions that were more specific to the various time periods. Second, by using two separate least-cost path analysis algorithms, the authors also did not fully expand how the different analyses affected the results. Finally, as with many of the early GIS studies, there is a lack of multiple scales of analysis. Areas with high cultural activity could have been further explored at a smaller scale to see how the viewsheds and least-cost path results would have changed in the high-density population areas. Cultural information is dynamic and not static; therefore the application of a variety of scales will potentially reflect the cultural dynamism.

As was discussed previously, Robinson (2006; 2010a) further explores his archaeological data of the Emigdiaño Chumash by using least-cost path analysis as a heuristic to study both the internal and external movement of the Chumash at the landscape scale and, as compared to the analyses presented later, at the community-scale. The analysis includes the input of known rock art site locations, ethnohistorically documented village sites, cultural activity areas, K-locales (sites with 18 or more BRMs), BRM sites and a 30-metre digital elevation model (DEM). The term K-locale is based on Jackson's (1991) research in the Sierra Nevada Mountains where he defined K-sites as places were multiple family groups came together to process/pound acorns. Robinson (2006; 2011*)* further defines the term as K-locales as the term 'site' is insufficient towards understanding the use of local environments. The morphology of the Emigdiaño landscape possibly facilitated the movement of the Emigdiaño Chumash*,* other Chumash linguistic groups and the neighbouring Southern Valley Yokuts to the north. Ethnohistorically, the trails are documented to begin within three major drainages and contributed to a variety of relationships through travel (e.g. trade, inter-marriage) (Robinson 2004; 2006; 2010a).

For the first analysis Robinson (2006; 2010a) studies the landscape movement externally and explores the hypothesis that rock art served as boundary markers to demarcate the Emigdiaño Chumash territory from that of the Yokuts to the North. Furthermore, he analyses whether or not pictographs served as ideological media at trade centres (i.e. *entrepôts*) to external populations between major sites along territory boundaries (Robinson 2010a, 798). Ethnohistorically known drainages that were used as starting points for external movement include: Quatal Canyon, Lockwood Valley and Grape Vine Canyon (*ibid*, 798). Cost surface analysis and the subsequent least-cost path analysis were run from each of the three 'trail heads' to each of the three known village sites and a final cumulative cost analysis was combined to show the results (Robinson 2006; 2010a) (See Figure 4.5).

The results show nine potential routes using the three historically documented entrances to the canyons, which are assumed to be applicable in prehistoric times as well (Robinson 2006, 188). Only two rock art sites are located along these paths, while the other pictographs are found elsewhere in the landscape (*ibid*, 188). Therefore it can be concluded that the rock art sites were not present along the potential trails nor were they used as ideological media for external groups travelling through the Emigdiaño Chumash territory. Furthermore, upon inspection of the rock art site distribution, Robinson (2006; 2010) states that many of the rock art sites are present along the southern boundary of the Emigdiaño linguistic boundary perhaps suggestive of a boundary role related to southern Chumash groups.

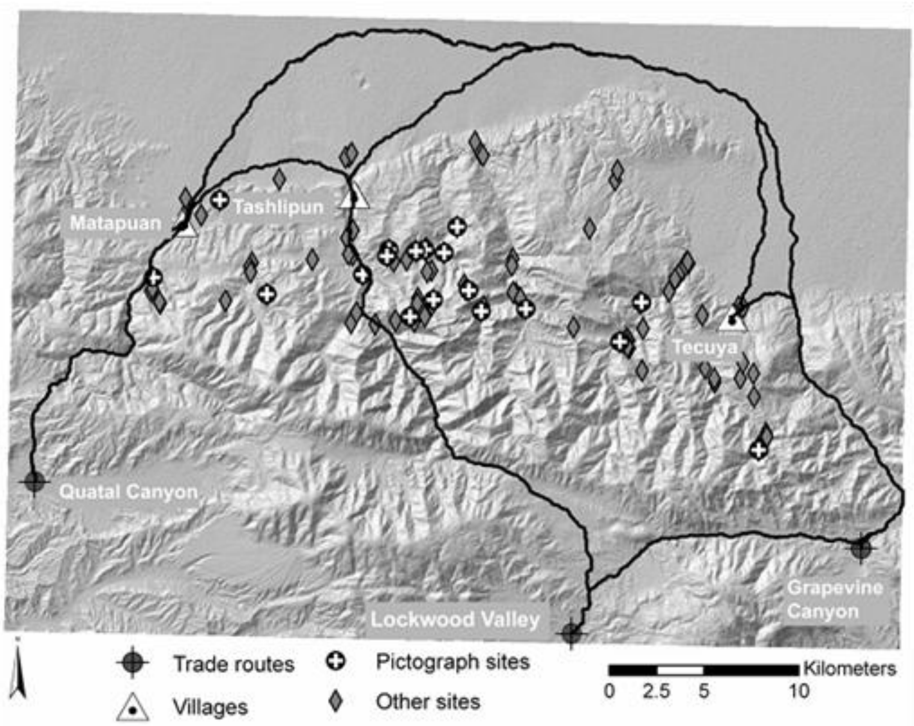


Figure 4.5: Figure 4.5: Cumulative least-cost paths of three village sites and three known ethnohistorical primary 'trail heads' within the Emigdiano landscape (Figure Robinson 2010a, 799, Figure 3).

The second least-cost path analysis in this research explores the hypothesis that instead of the rock art being media for external groups, the pictographs were used internally for other Chumash linguistic groups to the South (Robinson 2006; 2010a). This analysis also looks at the potential internal conduits between various cultural sites, such as seasonal camps for food procurement, where travel within the territory would require intimate knowledge of the landscape. Therefore, this movement would not be through the landscape to an external destination but a network of places with cultural importance throughout the topography. The analysis looks at traversing the landscape from every pictograph site to all other archaeologically documented sites.

The cumulative results of the second analysis of internal movement (Figure 4.6) create a network of routes that traversed through particular landforms and archaeological sites (Robinson 2006; 2010a). The trails also include rock art along these internal conduits that indicate a strong presence within internal travel through the Chumash landscape. At the landscape scale, Robinson (*ibid*) concludes that due to its placement along travel corridors, rock art sites were public and play a role in internal landscape movement especially in association to the k-locales found at the pictograph sites for food processing. One problem with this study is that the outputs are dependent upon an isotropic algorithm within ArcGIS that only uses the D8 search algorithm (described further in Chapter 6).

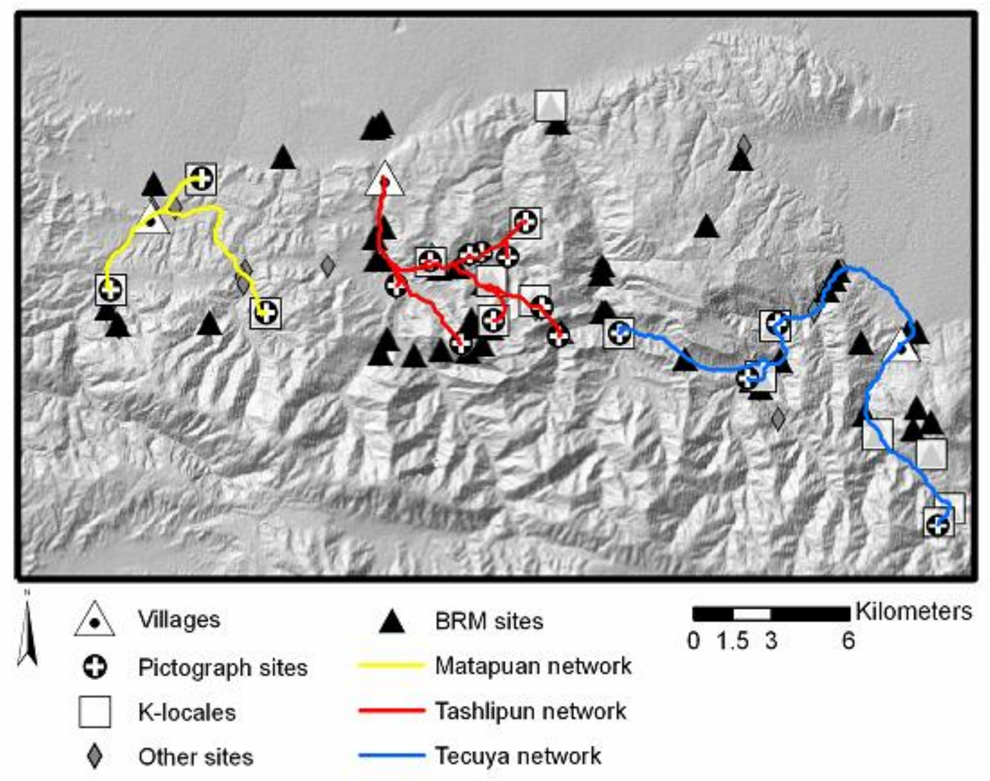


Figure 4.6: Cumulative least-cost path analysis of all *Hool* rock art sites to the ethnohistorically documented village sites (Robinson 2006, 196, Figure 5.16).

4.3.3 Spatial Patterning

The study of spatial patterning of rock art sites, first published by Ridges (2006), applies a multi-scalar analysis to 180 sites in northwest central Queensland, Australia. The region was populated by hunter-gathers who had a low population density, were highly mobile and occupied the area for about 15,000 years (*ibid*, 147). The archaeology of this region consists of stone tool production, trade and rock art production. In order to understand past perspectives on the economic and social dynamics of society, the author argues that the use of a multi-scalar methodology within an environmental context is needed (Ridges 2006). The first part of the analysis entailed the use of predictive modelling to understand the context of site placement at the regional scale and two smaller meso-scales. Stone tool manufacturing sites were used as input for the predictive model to study which environmental variables have an association with these activities. The second analysis, described in-depth in this section, involved studying the spatial patterning of rock art motifs and the patterning of a particular design element, the anthropomorph, which is most common in this region (Ridges 2006). While this analysis was performed at a single spatial scale, the region, the use of different categorical scales was applied through the centimetre-scale. One analysis studies the distribution of the various types of motifs while the other focuses on the distribution of the anthropomorph element (*ibid*, 150).

Pattern analysis explores the differences in spatial pattern distribution of the motifs and anthropomorph elements, and secondly, through link analysis. Three different design motifs were chosen, bars, circles and linked arcs, for the first categorical analysis while varying styles of anthropomorphs were studied for the second category. To obtain the input points for both analyses, average x- and y-coordinates were produced for locations of the motifs and elements as sites may contain multiple rock art panels.

The first analysis compares the distribution of the two categories by using the overall average x- and y-coordinates for all rock art sites to plot the motif category. The average coordinates of the sites containing anthropomorphs were then used to plot the axes for the second category (Figure 4.7). Therefore, points near the centre of the two x- and y-axes represent a distribution similar to the overall average distributions (*ibid*, 155). The results of the three motif types showed a distribution much different than that of all rock art sites within this region. Bars were located in the northeast, while circles and linked arcs were located in the southwest, and the author concludes that, "there was a southwest to northeast distinction in the distribution of these three major motif groups" (*ibid*, 155). Anthropomorph elements had a very different distribution pattern and were located in the centre of the axes showing a similar distribution to all of the sites containing anthropomorphs. Ridges (*ibid*, 156) states, "there are two groups of anthropomorph design elements that tend to occur in either the northwest or southeast of the anthropomorph site distribution". He concludes that these anthropomorphs follow the opposite of the motif distribution and follow a northwest to southeast trend. Unfortunately, this part of the analysis is not as clearly written nor does the figure the author uses help the reader fully understand the methodology, and more importantly, the results. Questions such as which program was used to perform this analysis, or how did the author come up with this type of analysis, would have potentially clarified some of these issues. Finally, how the results reflect the outputs and figures of the analysis would also better present this analysis to the reader.

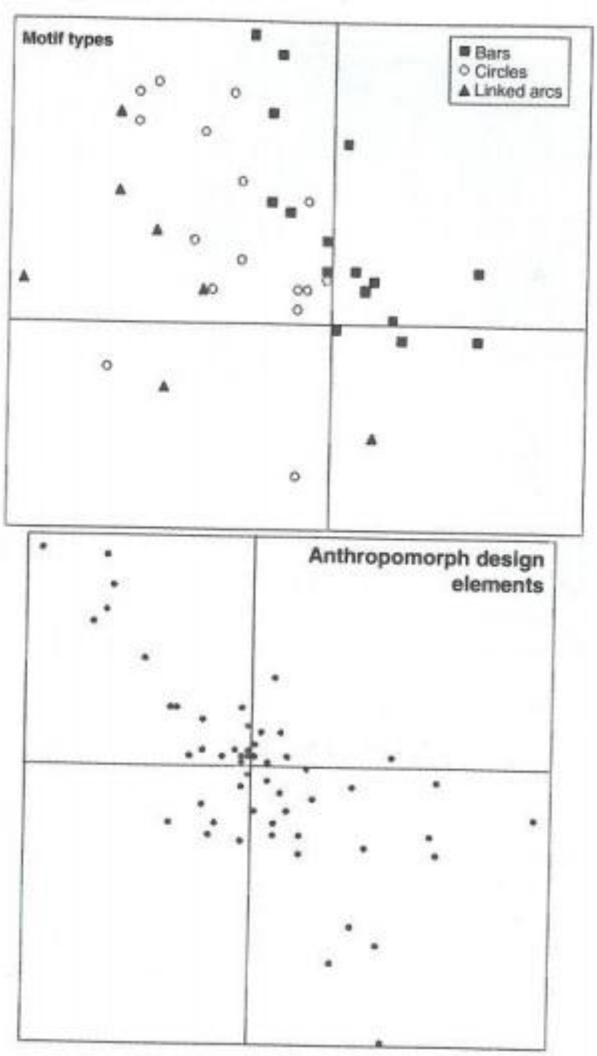


Figure 4.7: The average coordinates of anthropomorphs and motifs from Ridges (2006, 156, Figure 10-6).

Next, link analysis explores point distributions of the two categories. This analysis studies the relationship of each site containing a motif or anthropomorphic element to all other sites also containing that particular motif or element type (*ibid*, 156). GIS was applied to build lines or links in a network to connect each site to all other sites with the same motif or element. Sites linking motifs had 18,000 lines while sites linking anthropomorphic elements had 15,000 lines (*ibid*). More than one line or link would be possible between two sites if there were more than one motif or element in common between them. The results for motifs show no apparent spatial trend and very few lines with more than one shared motif between two sites. Anthropomorphic elements show a "strong northwest-southeast trend, reinforcing the pattern" in the previous analysis (*ibid*, 157).

Ridges (*ibid*) concludes that the results of both analyses reveal the social dynamics of what he defines as the regional scale. The Motif category distribution results, with its northeast to southwest distribution, reflect the location of a large drainage in the topography of this region (*ibid*, 157). The drainage would have potentially been one of the main conduits of people entering and exiting this study area (*ibid*, 157). The same motifs are also found in the neighbouring regions which suggest that the lack of firm results in the link analysis may reflect a need for a larger or inter-regional scale of analysis (*ibid*, 157-158). The anthropomorphic element distribution results show a northwest to southeast distribution pattern reflecting two distinct upland areas representing two sub-groups of the population within the study area (*ibid*, 158). Previous studies state that the anthropomorphic elements were unique to this region and could be a reflection of group identity (*ibid*). Overall this second analysis is more robust but ideally more information would be useful to the reader as discussed earlier. Very little is mentioned on aboriginal oral tradition or any ethnographic analysis that could be used to supplement this analysis. Furthermore, the link analysis could have been used at more than one scale by focusing on those areas that were strongly correlated the first distribution analysis. It may have further supported the results of the sub-populations in the upland areas and the intra-group identity.

4.3.4 Spatial Analysis and Habitat Association

The next study applies spatial analysis to a specific element type to explore habitat association in the Dolores River Valley in southwestern Colorado, USA (Davey 2006). Four separate Anasazi rock art sites containing a total of 11 bighorn sheep elements were analysed to explore their potential association to specific habitat requirements for bighorn sheep (*ibid*, 104). This association is based upon bighorn sheep remains in the archaeological record, ethnographic accounts of bighorn sheep hunting by cultures in the Great Basin and the identification of the petroglyph element as representing the species (*ibid*, 107). Further information is based on the association of the rock art element near historic hunting blinds used to hunt bighorn sheep (*ibid*, 108). Bighorn sheep prefer habitats that include steep rock terrain on southern facing slopes during the winter months (*ibid*). The relationships of the rock art locations, the bighorn sheep elements and the bighorn sheep habitats are therefore assessed through GIS.

Input variables were constructed using ArcGIS and include: point data of all rock art sites, point data of all bighorn sheep elements, slope, aspect and distance to bighorn sheep habitats. Bighorn sheep habitats were defined as areas that had an aspect facing south, southeast and southwest, while slope values greater than 51% were also selected (*ibid*, 111). Unfortunately for this analysis, a reservoir is located in this landscape and no DEM was available showing the previous topography (*ibid*). The author had to discard those sites that fell within this area from the analysis. Further analysis was performed analysing the distance of rock art sites and the bighorn sheep element to village and hamlet sites. The results show “most rock art sites in the Dolores River Valley were located on steep southerly facing slopes and that bighorn element sites appear to be located on average greater distances from habitation sites than other rock art sites” (*ibid*, 114). Therefore, the author states that areas used for acquiring resources, such as bighorn sheep habitats, show a potential spatial correlation to the context of the rock art sites (*ibid*). Finally, this research recognises the flaws in the study with a small area of analysis and a low number of rock art sites, but rightly points out that there is potential for a larger study as data becomes available.

4.3.5 Predictive Modelling

The final study discussed here focuses on using GIS to create predictive models. Predictive modelling is defined as the procedure that predicts the probability of occurrence of a dependent variable in an unknown environment using independent variables (Conolly and Lake 2006). The study area, managed by the Côa Valley Archaeological Park, is located in the Côa River Valley in northeastern Portugal, an area of around 200 km^2 (Aubry et al. 2012, 848). The rock art consists of petroglyphs that are dated to the Iron Age but roughly extend from the Upper Paleolithic to the 20th Century (*ibid*, 848). The preservation and conservation of the rock art sites is an important aspect of this analysis and the geological, weathering and human impacts are explored in reference to the known distribution of rock art and non-rock art panels. Overall this paper's main objectives in reference to predictive modelling are "to develop a general method to integrate GIS tools with a pair-wise comparison matrix and frequency-probabilistic procedure to compute a predictive model for the study area, aiming at the identification of areas where it is probable that rock art panels were exposed, are still preserved and thus, were possibly engraved during the Late-glacial and after" (*ibid*, 850). The outputs of these analyses are to guide in ground survey and aid in the preservation and conservation of rock art in the study area and other settings with similar environments (*ibid*).

An inductive approach was used in the predictive modelling and refers to a model that relies on empirical analysis. The aim was to create an output that determined the Côa panel formation and preservation (CFPF) (*ibid*, 853). The dependent variable in the study, the rock art panel, was created as a point file and converted into a 5-metre resolution raster with over 400 sites (*ibid*, 853). A subset of the rock art site data was not put into the model, but retained and used later to validate the final prediction output. As in the Davey (2006) study discussed above, there was again a presence of a reservoir within this topographic setting that prevented a part of this area to be included in the model. A DEM was created with the same resolution and used to create a number of the independent variables: slope, aspect, solar radiation and cost-weighted distance to water (Aubry et al. 2012). A cost-weighted distance to water is a friction surface created to show the cost of movement to and from a watercourse. In other words, the authors simply use the cost surface but did not create least-cost path as their final output. The dependent variables were weighted according to their importance to explaining rock art distribution. Categories or classes of the dependent variables were weighted based on their spatial relationships to the rock art locations (*ibid*). Analysis of the geological setting was also performed to understand rock art panel formation and interpret geological lineaments using Landsat imagery at multiple scales (*ibid*, 852). Weathering of panel surfaces was also explored, and more specifically, biodeterioation through lichen and bryophyte covering of the panels was recorded (*ibid*).

Results of the geological analysis found major fault lines and fractures located within the study area also backed up by previous literature and some field verification (*ibid*, 858). Geological setting indicated that there is a NNE-SSW fault and fracture system that crosses the study area that corresponds to the locations of the preserved rock art panels (*ibid*). Differential weathering also exists where the highest degradation occurring happens to rock art sites with a northwest exposure (*ibid*). Predictive modelling results show the areas of high probability, those areas where a rock art panel would likely be found and preserved, "near the left banks of the Côa and the Douro rivers, as a logical consequence of the tectonic fracture framework and the organisation of subsequent Quaternary hydrographic downcutting" (*ibid*, 863). Verification of the model results in an 80% prediction rate (*ibid*). Based on the model results, the authors conclude that the similar spatial patterns found for the rock art sites of different time periods point to a geological bias and do not reflect human decision making (*ibid*, 865). Results of the field verification present a discovery of further rock art sites. This study shows that oftentimes what archaeologists perceive as the archaeological record could be heavily biased through its geological setting. Analyses such as these are important for areas with heavy tectonic activity.

4.3.6 Landscape Association/Factor Model

Cruz Berrocal et al. (2012) use GIS and quantitative analysis to study landscape associations and Levantine rock art in the Spanish Mediterranean. The research was very reliant on the spatial statistics, but the predominant use of GIS environmental variables to create those statistics put this paper within the GIS and not the quantitative section. It is perhaps a good mixture of both approaches and shows how they can complement each other in the analysis. The paper argues that rock art in what they call a "macro-region" of 370 rock art sites was the first indicator of economic activities and resources associated with the landscape beginning in the early Neolithic (*ibid*). Pollen analysis for this area points to a similar time period for the first anthropogenic modification of the landscape supporting the idea that rock art was an economic marker in specific environments (*ibid*, 1). Cruz Berrocal et al. (*ibid*, 2) states "…we observe rock art as a very relevant kind of archaeological evidence for the understanding of landscapes, mainly because it allows us to observe a territory as a meaningful cultural or social spatial entity". The authors argue that certain cultural attributes within this landscape were continuously maintained such as the use of rock art sites and particular land-use strategies.

Rock art sites were digitised as points in the landscape and constrained them to a 50-km² buffer around these sites as the definition for the macro-region of study (*ibid*, 7). The Euclidean distance served as a measurement of roughly 2 days walking. Furthermore, 370 random points were created within this macro-region of study as a control group with which to compare to the rock art sites. It is unclear if this whole area was surveyed so that the control group of random points represent actual non-site locations. Surrounding each of the rock art points and random points were 1-km² buffers that served as the areas with which to analyse associated environmental variables. Relevant environmental input variables were chosen by the authors for input and included (both continuous and categorical): elevation, slope, annual rainfall, average maximum temperatures, bioclimatic levels, soil types and land use (*ibid*, 8-9). From the buffers surrounding the rock art and random points, the mean and standard deviation were calculated for the continuous rasters while the percentage of area was calculated for the qualitative rasters (*ibid*, 9). Significance testing was done using the Student's *t*-test and the Mann-Whitney test for percentages, differences in frequencies were studied and finally, the Kolmogorov-Smirov test was run to ascertain if the studies were statistically significant (*ibid*, 10). The study found that there were significant differences between associated landscape features for the rock art sites and the random sites. Factors that correlate to the rock art sites were (*ibid*, 14-15):

1) "Wild" landscape with a clear predominance of rough terrain and extensive lands uses.
2) Viability and stability of vegetation formations, thanks to relatively developed soils and softer climatic conditions.
3) Diversity in potential resources for economic activities, in environmentally heterogeneous zones.

4.4 Conclusion

This chapter provides a comprehensive literature review and critique of quantitative methods and spatial analyses of published rock art studies. A more holistic review was presented here to understand the methodologies that have been utilised in rock art research not only for conservation and preservation, but to also understand how rock art is integrated within the landscape through statistical and spatial interrogation. As technological advances have enabled high-resolution recording of all types of archaeology (i.e. 3D scanning, GPS), and also due to the push for documenting rock art sites for preservation and conservation beginning in the early 80s, there is a potential wealth of rock art information available for incorporation into spatial analyses. This chapter has shown that there are only a few studies that have utilised the available data to explore rock art's potential association with other archaeological sites and/or the landscape. In addition, rock art research has been slow to fully incorporate its potential in empirical and theoretical analyses. As can also be seen in this chapter, with the exception of Robinson's (2006; 2010a) use of Ingold's (1993) taskscapes, there is also a general lack of theoretical applications as a basis for these analyses. Finally, it further expands those studies applied to the Chumash rock art sites, not only highlighting how Chumash rock art analyses have been very innovative in their use of quantitative analyses, but identifies positive correlations between the rock art and the terrain.

Overall this thesis is attempting to further expand on the incorporation of GIS in landscape studies and also incorporate a sound theoretical basis for these analyses. While this chapter has focused on the methodologies used in spatial analysis of rock art, in the proceeding chapter, I discuss and outline the theoretical basis for the analyses presented in this thesis; that of actor-network theory (ANT). I further expand on how it can be useful in interpreting the rock art and its placement within the Chumash landscape and their interaction sphere. Using a theoretical background, I can begin to understand the social networks involving multiple spatial scales and including the economic systems and subsystems to further understand rock art, the landscape and Chumash ideology.

Chapter 5 Actor-Network Theory and Chumash Rock Art Analysis: Towards a Refined Theory

5.1 Introduction

The past chapters have outlined the complexity of Chumash society, the variety of their systems and subsystems that structure their society, their rich mythology and ideology and the importance of rock art research and spatial analysis within the overall cultural and rock art discussion. In this chapter, I present a theoretical perspective that can be used with GIS and spatial analysis to bring this information together. That theory is actor-network theory (ANT). While this theory has been applied within archaeology (e.g. Knappett 2008; Watts 2008; Yarrow 2008), it is important here to discuss and redefine it so its applicability within rock art studies can be applied.

ANT took shape within the sociology of science and technology studies between 1978 and 1982 in Paris with the term *acteur-reseau,* originally coined by Michael Callon (Law 2007, 2). Translated into actor-network in English by Callon (1986), theory was later added, and in the 1990s, the acronym ANT was used within the literature (Mol 2010, 254). From the beginning the main protagonists of ANT were Michel Callon (1985), Bruno Latour (1988) and John Law (1986). One of the most comprehensive definitions and one that is used for this thesis is from Law (2007, 2) where he states:

> Actor-network theory is a disparate family of material-semiotic tools, sensibilities and methods of analysis that treat everything in the social and natural worlds as a continuously generated effect of the webs of relations within which they are located. It assumes that nothing has reality or form outside the enactment of those relations. Its studies explore and characterise the webs and the practices that carry them. Like other material-semiotic approaches, the actor-network approach thus describes the enactment of materially and discursively heterogeneous relations that produce and reshuffle all kinds of actors including objects, subjects, human beings, machines, animals, 'nature', ideas, organisations, inequalities, scale and sizes, and geographical arrangements.

Its origins were a direct move away from classical French sociology (e.g. Emile Durkheim and his belief that everything in the world is hierarchically ranked in terms of importance), especially for Latour, who wanted to shift the paradigm from what he perceived as its problematic dichotomies such as human/non-human; where material culture is treated as passive or ignored within a hierarchical ontology. Latour (2005) called this the 'asymmetry of actors', where sociologists have an anthropocentric view of agency, in which it can only be ascribed or belong to humans. This anthropocentric view is further perpetuated within the theory of agency itself with the debates concerning the agency/structure dichotomy (e.g. Bordieu 1977; Giddens 1984; for archaeology see Dobres and Robb 2000). The world of the social is human while the world of material culture is often ignored or symbolic (Dolwick 2009, 22). Latour (1999, 16; original emphasis) states that the original idea was not "…to occupy a position in the agency/structure debate, not even to *overcome* this contradiction." ANT, therefore, moves past these debates as it creates a flat ontology where both humans and non-humans are all actors, where the social is made up of associations or heterogeneous networks. It moves beyond the *a priori* framework and against the dualist paradigm of classic sociology that gives primary agency to humans. Latour (1999, 19; original emphasis) succinctly states about the beginnings and the main protagonists of ANT:

> For us, ANT was simply another way of being faithful to the insights of ethnomethodology: actors know what they do and we have to learn from them not only what they do, but how and why they do it. It is *us*, the social scientists, who lack knowledge of what they do, and not *they* who are missing the explanation of why they are unwittingly manipulated by forces exterior to themselves and known to the social scientist's powerful gaze and methods.

It must be noted here though that ANT does not reduce the humans to objects but adds objects into relational heterogeneous networks (Dolwick 2009, 38). Material culture is therefore considered entangled within the social reality of society and in part helps to construct and reconstruct knowledge and power. Since its inception, ANT has been used and applied to a variety of studies ranging from economics, geography, and science and technology amongst others. A full bibliography is found as part of the Science Studies Centre at the University of Lancaster website that is maintained by John Law[2].

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[2] http://www.lancs.ac.uk/fass/centres/css/ant/ant.htm#spa Accessed 09/05/2013

As was stated above in Law's (2007) definition, it is based within the material semiotic toolkit, and I will give an introduction here. The idea of material semiotics (Law and Mol 2008, 58) evolved from linguistic semiotics that states that:

> …words give each other meaning. Material semiotics extends this insight beyond the linguistic and claims that entities give each other being: that they enact each other. In this way of thinking agency becomes ubiquitous, endlessly extended through webs of materialised relations.

Material semiotics as applied in ANT is concerned about relationality and is based upon the semiology of Ferdinand de Saussure's study of the linguistics of signs. Saussure's semiology within the discourse of sociology was the idea of a network of words based upon similarities and differences (Mol 2010, 257). Words were symbols or linguistic signs. Latour (2005, 54) further attributes the development of ANT specifically to the works of Algirdas Julien Greimas and Harold Garfinkel and even more specifically to Greimas and Courtés (1982). Law (1999, 4), therefore, refers to ANT firstly as "relational materiality", which "tells us the entities achieve their form as a consequence of the relations in which they are located". Law (*ibid*, 4) calls relational materiality the first main framework of ANT as it is the relationality of objects. Secondly, Law (*ibid*, 4) argues that with relational materiality, there exists "performativity". The framework states that if the relations cannot be supported by themselves then they will have to be performed, which, when needed, will create the stability (*ibid,* 4).

I use 'theory' in quotations as most of the founding researchers have stated that this is more of a methodology than a theory or, as Dolwick (2009, 36) states, "perhaps it is best understood as a descriptive method". Law (2007, 2) further expands on this:

> Theories usually try to explain why something happens, but actor-network theory is descriptive rather than foundational in explanatory terms, which means that it is a disappointment for those seeking strong accounts. Instead it tells stories about 'how' relations assemble or don't.

ANT therefore is empirical writing that tells the story of the relations of heterogeneous network effects especially in terms of knowledge, power and organisation (Law 1992). Theories are explanations, while ANT focuses on explaining associations (Dolwick 2009). Latour (1999,22) further expounds that ANT is not a social theory, but if perhaps one were to define it as a theory then I would agree with him (*ibid*) that it could be a "theory of the space or fluids circulating in a non-modern situation".

5.2 ANT and Its Jargon

As in any discipline, ANT comes with a specific set of jargon, but of course, the definition of these terms is often vague and abstract. As the oft quoted statement by Bruno Latour (1999, 15) cheekily acknowledges: "...there are four things that do not work with actor-network theory; the word actor, the word network, the word theory and the hyphen! Four nails in the coffin." Even Law (1999, 5) comments that ANT is "intentionally oxymoronic" that has a "tension, which lies between the centre 'actor' and the decentred 'network'". In this section, I will attempt to cover the most basic terminology of ANT, so that it can better interpreted and applicable to the research presented in my thesis.

'Actant' is usually the preferred term instead of actor/s and can be a person, idea, group, plant, animal, text, resource, etc. It can be any number of things that "modifies a state of affairs or makes a perceptible difference" (Dolwick 2009, 39). Of course it also acts or is effecting an action to other actants. The important phrase to note is an actant can be anything and everything; it is not stuck within anthropocentric theories of agency. Furthermore the actant would never have complete control over any state of affairs, which makes sense when one thinks about how objects/features/non-humans are entangled within human's social reality. This may be easier to understand if you think about how small things can change the state of affairs. For example, when you lose or break your mobile phone, lock your keys in the car, struggle to get a new program to work, etc. It cannot be understood only in terms of intentionality. The actant is analysed by the power of its associations (there is no limit to the number of associations an actant can have) with those it is connecting with and then 'mapping' or 'tracing' these relational effects. As Mol (2010, 255) states "the question ANT asks not where the activities of actors come from, but rather where they go: effects are crucial".

On the other hand, 'network' can also be a person, idea, group, plant, animal, text, resource, etc., and Dolwick (2009, 39) defines it as "an interactive assembly of actors, group, or 'string of actions' involving a number of potential mediators". The actions of these networks must be traceable, so it must leave some 'trail of activity' for the researcher to observe and document. Networks are also referred to as 'heterogeneous networks' that perhaps is a better definition or description. It supports the idea that the networks are fluid associations created by a wealth of different things that mediate the behaviour of the actants. These networks actively take part within the social. It can be noted here one very valid point brought up by Latour (1999, 15), that the term 'network' 20 years ago did not have the same definition as the 'network' of today, which is heavily influenced by the internet and social networks. He described that the original network of ANT refers to a "series of transformations and translations which could not be captured by any of the traditional terms of social theory" while, in its much more modern definition, it is refers to "transport without deformation, an instantaneous, unmediated access to every piece of information" (*ibid*, 15). In its most basic of terms, today's network is really the point and click technology, that connectedness that allows for information to be accessible 24/7 with simply the push of a button. The original definition is the one that is truly relevant to the ANT being applied to archaeology and my analysis of rock art.

A network can be an actant and vice versa. Law and Mol (2009) most accurately compare these actants and networks as almost fractal-like in their construction. The more you 'zoom in' or increase the scale the more you find another heterogeneous network to describe. It is the idea that something is just as complex a pattern whether you look at it close-up or from afar. The more you investigate the networks, the more complex relational effects you are likely to find. The idea is that actants and networks are "more than one and less than many" (Law 1999, 11). For example, one could argue that a human is "who they are because they are a patterned network of heterogeneous materials" (Law 1992, 383). Take away certain collections of material possessions, and you will have changed the essence of the person. Similar to an example made by Law (1992), I am an archaeologist, but if one takes away my publications, my computer, my degrees, then my definition of who I am as a person would have changed. The knowledge that I disseminate would have completely changed. There are also no *a priori* assumptions being made that either the networks or the actants change or stabilise the social (Law 1992).

5.3 Anthropology, Archaeology, Rock Art and ANT: A Review

In archaeology, ANT has been applied as a framework for analysis but to date it has not been fully integrated within the discipline. This is perhaps due to the debate that is still relevant within the theoretical literature concerning the agency/structure dualism. In this section, I first discuss Alfred Gell's (1998) introduction to the agency of art, an influential book that inspired researchers to view agency of non-humans across anthropology, archaeology and other disciplines concerned with analysis of material culture. While not further expanded upon here, there has been one important monograph edited by Carl Knappett and Lambros Malafouris (2008) that includes ANT and material semiotics as it is applied to the discipline of archaeology. Three chapters specifically put ANT within a specific archaeological framework (Knappett 2008; Watts 2008; Yarrow 2008). Within the discipline of maritime archaeology, ANT has been introduced and applied, including one review by Dolwick (2009) and one analysis by Tuddenham (2012).

Secondly, I will also discuss three articles that use ANT to study rock art. Allen and Lukinbeal (2010) focus on pedagogical strategies for helping students understand weathering by the application of the rock art stability index. The other two are monograph chapters written by Fredrik Fahlander (2012a; 2012b) and echoes many similar arguments made in this chapter with his work on Scandinavian Bronze Age rock art. Finally, I briefly discuss how ANT is also similar in concept to Gibson's (1979) theory of affordance and its more recently modified tenets. The suite of literature that applies ANT to archaeology is still minimal but has been gaining momentum in recent years.

To begin this review, I first refer to anthropologist Alfred Gell's (1998) *Art and Agency* where he purports that humans are the primary agents and art is a secondary agent. Art is seen as a 'system of action' rather than having symbolic meaning where art becomes part of the social processes instead of the interpretation of objects as if they were texts (Gell 1998, 6). In particular social settings, works of art or imagery can also be agents. Primary agency refers to intentional beings while secondary agents are given agency, or in other words, their agency is rendered effective by the primary agents (Gell 1998). This is not to be confused with meaning the same as primary agency, or the anthropogenic agency, described early in this chapter. Gell (1998, 36) creates a distinction between the two that focuses on intentionality, where primary agents are "entities endowed with the capacity to initiate actions/events through will or intention" and secondary agents are "entities not endowed with will or intentionality by themselves but essential to the formation, appearance, or manifestation of intentional actions". Primary agency in the past has referred to humans and only humans as having agency whilst Gell (1998) states that materials, and in this case art, has agency but not intentionality. This is different than ANT, whereby intentionality is purposely disentangled from agency and the material world is not just causal relations. In ANT, the focus is more on relational effects coming from a flat ontology with no *a priori* framework or assumptions. Intention and will are no longer assumed to be exclusively human properties (Yarrow 2008) and that releases material objects into the subject of agency. In Gell's (1998) agency, one could argue that at times the primary agent is difficult to discern. In the case of the archaeological record, especially within prehistory, the agency of the material culture can be obscured by a lack of continuity and connectedness. Within ANT, both primary and secondary agency of artefacts can both be a part of the heterogeneous networks. For example, rock art, could have both primary and secondary agency for different people within the same society in different situations. The person who created the rock art would give it secondary agency or a voice, while the person encountering the rock art could give it primary agency as it may hold power over their decisions through supernatural beliefs. Gell's approach of using both primary and secondary agency has been used in rock art research (e.g. Bradley 2009; Cochrane 2008; Nimura 2012; Tilley 2008).

Fredrik Fahlander (2012a; 2012b) applies ANT, especially its concept of a flat ontology, to study petroglyphs in northern Europe. Fahlander (2012b) uses a non-representational approach that focuses on unfinished motifs, patchworks, re-cuts and hybrids in the creation of petroglyphs and also discusses the materiality of the rock itself. Bronze Age petroglyphs were analysed from southern Sweden and the focus is on the horizontal stratigraphy of the Hemsta panel found near the city of Enköping (*ibid*, 98). He uses ANT to discuss rock art production without incorporating the symbolism or style and emphasise the materiality. His ANT approach discusses the elements as actants that he argues were entangled within the production process and integrated within the social structure to bypass traditional dichotomies within rock art studies.

In his next publication, Fahlander (2012a) again focuses on petroglyphs in Scandinavia and applied both ANT and indexicality (based on Piercien semiotics). His ideas on indexicality, in terms of agency, are similar to those discussed by Gell (1998) who uses this perspective to create his secondary agency (*ibid*, 57). Fahlander (*ibid*, 57) purports that while Peircean semiotics "may offer a way of thinking about the nested relations between materialities, practice and ideology across different scales it does not offer much guidance in how to apply a relational perspective in practice". ANT is then used to create a methodology to study relational effects. Again, he focuses primarily on the concept of a flat ontology and argues that archaeologists need to apply ANT to combine both the macro- and micro-scale in their studies, especially within prehistoric studies where the large-scale structures are most likely unknown (*ibid*, 69). More importantly he purports that ANT and indexicality within archaeology allows for a framework to use local cultural traces, or indexes, to connect with larger scale processes and structures (*ibid*). His case study illustrates two different types of Scandinavian rock art, that of the Late Neolithic and the early Bronze Age, where previous studies have neglected to study their apparent stylistic relationships. He concludes that these "shared grammatical aspects are seen as relational indices of hybridity…the emergence of something that was partly new, originating from encounters between different groups in the flux between different lifestyles and traditions…" (*ibid*, 70).

Within the discipline of geography, Allen and Lukinbeal (2010, 2) use ANT theory to challenge the "traditional, positivistic science pedagogical techniques" in weathering science within physical geography. They specifically focus on the study of rock art and weathering using a new pedagogy, the rock art stability index (RASI). RASI is argued to be an actor network as it connects task and materiality to landscape thus creating place (*ibid*). Applying the RASI specifically connects the "weathering form to weathering process" and presents a field-based learning application to engage and challenge students to explore these connections (*ibid*, 2). Landscape is placed firmly within the ANT framework as landscape here is considered a human-environment network enacted through practice (*ibid*). A pedagogical paradigm shift is suggested that puts more emphasis on the RASI actor networks that allowed students to conceptualise and engage with the landscape in their weathering science fieldwork (*ibid*).

Dolwick (2009) introduced ANT into maritime archaeology with a review of the science of the social or sociology. His article focuses on the social and how within sociology this term is still under debate because the discipline still lacks a dominant paradigm (*ibid*). From more broad definitions, such as the one found in ANT, to the much more narrow definitions focussed on social structures, sociology has many paradigms and lacks a strong, core central theory (*ibid*, 22-23). The article presented a review on the concept of the social in sociology and provided an introductory discussion on ANT, especially in its applicability within archaeology.

Tuddenham (2012) also studies ANT within maritime archaeology. His study focused on ship finds in Norwegian waters and the implementation of the Norwegian Cultural Heritage Act from the Culture Heritage Management (CHM) (*ibid*, 231). He argues that the implementation of this act created a dichotomy within archaeology between finds found on land and sea and a hierarchy of importance of underwater finds is created based on whether an object is associated with a ship find. He uses ANT to analyse the ship finds' contextual borders and overlap with other borders, its definition and the many actors that become involved in such a discussion. Ship finds were found to be hybrid relations found within the heterogeneous networks of ANT. The definitions of a ship find as defined by CHM were concluded to be too rigid and firmly maintained by narrow dichotomies promoted by the CHM (*ibid*, 242).

Finally, the relational thinking or network relations is similar in concept to Gibson's (1979) theory of affordance as a way to study perception through an ecological approach to psychology. Affordance has been used as a theoretical framework within archaeology for dissolving dichotomies and understanding scale (e.g. Costall 2006; Molyneaux 2006) and within spatial analysis and archaeology (e.g. Llobera 1996; Gillings 2009; Gillings 2012). As Costall (2006, 19, original emphasis) describes affordance as "…the meanings of things for our actions, but these meanings are not something we "mentally project" onto objects. They concern the *relations* between the agent and the world". The idea of affordance as relations was explicitly developed by Chemero (2003), who describes it as the 'relational theory of affordance' or what Best (2009) calls 'relational affordances. Gillings (2012, 606) describes Chemero's (2003) relational theory of affordance, "this approach differs in its insistence that affordances not be considered as properties (whether latent or dispositional) of either animals or environments in any formal sense, but instead relations between the two". Just as material semiotics and agency are both ingrained and described through ANT's network relations, so is affordance, all of which have been important theoretical frameworks within archaeology. I believe that this is one of the strengths of ANT, is its ability to capture relational effects for human and nonhuman features that adds and describes these relations within the much larger dynamic network relations.

5.4 Combining ANT, Landscape, GIS and Rock Art: Modifications of ANT's Tenets

A few writers within geography have looked at ANT and how its framework can be applied to the concept of landscape. Landscape within an ANT framework is perceived as the location where all participants (humans and materials) interact. Landscape is a participant, not passive, that acts and enacts. It is also the human perception of the environment, it is the anthropomorphisation in various societies and religions, it is nature, it is the social, it is context, it is a collection of spatio-temporal events and the list could go on and on. Allen (2011) argues that ANT works well with landscape studies due to its connectedness outside of the bounds of scale. When describing landscape within an ANT framework, Allen (*ibid*, 276) purports Tobler's First Law of Geography as being a part of its importance and applicability to landscape studies or models. It states that when things are nearer to each other they are more related than things that are further apart. This is a point that should not be overlooked. Allen (2011) put the spatial into a more hierarchical sense than perhaps the main ANT protagonists would have liked. Most users of ANT would argue that things further apart could be potentially more connected through the heterogeneous networks than things closer together. For example, as an academic, I would be more connected to another rock art researcher in California than to my neighbour here in the UK due to education, research interests and a shared American culture. I will discuss this further below, but would like to point out here briefly that like most disciplines that use ANT, as a theoretical framework, it will always become adaptable and modifiable to the discipline or research to which it is being applied.

Just like landscape, so therefore are space, scale and time also interwoven within ANT. That is to say that ANT looks outside of the Euclidean view of space and to that of a hypothetical topological space. It looks beyond a Cartesian interpretation of location/geo-location. Mol and Law (1994) further discuss the concept of space in ANT in terms of the social by breaking it down into three types. Their study focused on tropical doctors and their treatment of anaemia and introduced a third type of space that is relevant for analysing the similarities and differences of networks (*ibid*). They argue that the social does not exist within one particular spatial type (*ibid*, 643). The first concept of space is that of the region. A region is defined where clusters are identified and assigned to specific boundaries or bounded territories and within ANT, is considered homogenous. Next, they identify space as networks where "distance is a function of the relations between the elements and difference a matter of relational variety" (*ibid*). Networks are comprised of immutable mobiles that are a description of how networks create regions (Latour 1988). The actants are immutable because neither the objects nor their relationships change, but they are mobile because they have the ability to move from one place to another in the network or bring together two places within the network (Mol and Law 1994, 649). The final type of space is that of the fluid space where neither boundaries nor relations point to similarities or differences between two locations (*ibid*). Space then behaves like a fluid or with "liquid continuity" and "sometimes boundaries come and go, allow leakage or disappear altogether, while relations transform themselves without fracture (*ibid*, 659, 643). No one type of space is more or less important than the others, as they all exist together. Furthermore scale is seen as unbending, so there is no micro- or macro-scale. If you simply follow the actants, they will direct you through space and time by their relational effects. This is much different to the scale of archaeologists described in Chapter 3. Murdoch (1998, 360) states:

> Times, like spaces, are, therefore, folded into complex geometries and topologies by series of connections and disconnections. There is no one time or space, rather there are a number of co-existing space-times.

ANT's view of spatiality though is also where many of the critiques are found. Researchers state that ANT is apolitical and masks the variable relationships that are recognised within and through spatial differences (Bosco 2006, 143). Placing time, space and scale firmly within the heterogeneous networks creates an idea that specific, important, internal relationships lack differentiation in "both social and geographic space" (Sheppard 2002, 317). That is not to say that ANT is not useful within the field of archaeology or especially within my subsequent interpretations and discussions of the GIS and spatial analyses. Archaeology, as it is dependent upon material culture, sometimes wholly, for its interpretations into the past, can find ANT a useful methodology on relational thinking and its material semiotic framework. Just as geographers have utilised an approach where "many see ANT as a poststructural approach to power relations that can be adapted, transformed, and modified to fit their research concerns and at the same time as an approach that can be 'grounded' and made politically relevant" (Bosco 2006, 144) so can archaeologists. This is where GIS can be argued as one of the heterogeneous networks whose various outputs can be interpreted through ANT to discover more specific internal relations and differentiations. ANT provides the 'theoretical' framework with which to begin and interpret the dynamic relational effects.

Looking back on Murdoch's (1998) description of space and time within an ANT, it is apparent that with this folding of both space and time the researcher is not seeing the depth and strength of these folds and how they were created. This "topological metaphor" coined by Inkpen et al. (2007, 537), applied to the description of space and time within ANT, critiques ANT as problematic because of its simplicity in analysing the intensity of the various folds of space, time and scale. They state that the actants within ANT would need to exist before the enfolding happens, so it lacks a full description of the spaces between these actants that may play a role in the creation of the relations (*ibid*, 537). The authors introduce this new term called the "topographical metaphor" to conceptualise these important internal dynamics that may be lost within a topological framework (*ibid*, 537). They name the relations "entrenchments" and state that "as relations become more strongly connected, and more aligned, the more entrenched they become" (*ibid*, 537). The authors compare this to a watershed and river network where the stronger the relations, the more entrenched and difficult to change, while the less entrenched, the easier they are to change (*ibid*). Their idea is similar to what I am suggesting here, applying ANT as a framework to understand the internal dynamics with more of a focus on the landscape setting through relations/networks instead of ignoring what is happening between the folds of space, time and scale. In addition, within this topographical metaphor "scale is not necessarily viewed as a fixed dimension or absolute level, but as an explanatory device that is defined by its component processes and entities" (*ibid*, 539). As

Sheppard (2002, 318) states: "the internal spatiality of existing networks does shift as the networks evolve in response to internal dissent and external threats, but it also demonstrates a great deal of persistence". This persistence is what archaeologists hope to see from the material culture found in archaeological research and mitigation. Sheppard's (*ibid*) critiques are focused on studies of contemporary globalisation, a subject that has an abundance of supporting documentation and data, even then he finds that ANT lacks differentiation. Furthermore, Knappett (2008, 139, original emphasis) states, "yet despite its name, Actor-*Network*-Theory has paid relatively little attention to the spatial and organisational structures of the human-nonhuman networks and their effects upon network 'behaviour' or dynamics", which is exactly where I focus my research questions and GIS analysis. I am taking the idea of Inkpen et al.'s (2007) topographic metaphor and entrenchment and utilizing GIS as a heuristic to conceptualise the internal dynamics of the actant and network relations. Therefore, my research will use ANT as a topographical network that reflects the entrenchment of rock art and the associated archaeology within Chumash society and their interaction sphere.

The actants and networks within my spatial analysis are of Chumash rock art, its archaeological context, specific element types, Chumash ethnohistorically documented villages, the Chumash landscape, and the ethnographic/ethnohistoric accounts of their lives, mythology and ideology at a variety of scales. I will refer to everything as a network as I believe the word itself is more inclusive to both the actants and the multiple connections found within the Chumash interaction sphere. Just like the fractal-like description described above, when 'zooming-in' on the actants themselves, they are perhaps comprised of more intricate network relations. Therefore, I believe that the term network should be used for everything. While the data in my analysis are fragments of a once connected, complex society, I use the available information to explain the dynamics of the heterogeneous network relations. In terms of scale and the spatial, I use the data to define the multiple scales from the micro- to the macro-scale. Furthermore, I incorporate Chippindale's (2004) centimetre scale through ubiquitous motif extraction for the entire region to study its network relations. By using the outputs of the spatial analyses, I further explore the heterogeneous networks through the entrenchment and connectivity of Chumash rock art both inside and outside of bounded territories (e.g. linguistic boundaries) within topographical space. I am letting the various networks within Chumash society (i.e. social, political, economic and ideological) show their interconnectedness through my rock art analyses. Therefore, my analyses are concerned with understanding and describing the dynamic processes that give rise to landscapes and taskscapes through the spatial analysis of rock art and associated archaeological data. By the use of multi-scalar geographic analyses, I am taking steps to remove the static of Cartesian space, that is apparent within my dataset and create a more dynamic or fluid space. I will not look at materiality and the social in terms of large scale versus small scale. Instead, I will pursue my analysis at a variety of scales from the rock art element to the region and explore their connectedness to other forms of Chumash society to understand their placement within the overall Chumash interaction sphere.

5.5 ANT and the Chumash

As seen in Chapter 3, rock art research uses multiple theories to understand the meaning of rock art and how it may reflect the social complexity, economic systems and subsystems, the political ties and ideology of the group being studied. It can be argued that rock art can have different meanings to different people within a society through space and time. Furthermore, like Gell (1998), I want to place rock art firmly within the social processes, such as asking "How does the rock art affect the Chumash people?" or "How do the Chumash interact with rock art?". In this section, therefore, I will introduce ANT and its applicability within the Chumash rock art analysis.

Law and Mol (2007) describe how sheep in Cumbria during the foot and mouth epidemic in 2001 were enacted in different practices through ANT and material semiotics. They argue that there were different versions of sheep that both acted and enacted: veterinary sheep, epidemiological sheep, economic sheep and farming sheep (*ibid*). For example, veterinary sheep are enacted as a host to the disease, but the symptoms are not always clear, while epidemiological sheep are enacted as a collection of input and outputs of data to study, analyse and predict (*idem*). The sheep in this example acted and enacted, so are not passive. Rock art in my analysis is similar to the sheep in that it both acts and enacts. As Blackburn (1975, 66) states:

> The Chumash, in common with many other societies throughout the world, tend to personify aspects of their natural environment and attribute to the beings thus depicted the same qualities of sentience, will, rationality, and emotionality that characterize man himself. Thus plants, animals and birds,

> celestial bodies, and various natural forces are all part of the social universe to which man belongs, and their activities and interests may vitally affect the course of human events…Many have been transformed into other shapes since the Flood, or are no longer actively concerned with human affairs. But all events and phenomena are the result of actions taken by specific sentient beings, rather than the product of impersonal forces.

For different people over time, rock art could have both primary and secondary agency and within ANT both of these concepts would be interwoven within the framework. For the Chumash, a motif or element would mean something to the artist (perhaps as previously theorised that an artist would be a shaman or an astrologer), while interpretations or meaning would be different for the members of the community that are visually experiencing the art within its landscape or taskscape. In terms of ANT, the Chumash people *enact* rock art in different ways while in turn rock art *enacts* the Chumash people in different ways. Furthermore, rock art would have a different effect on people of different ages based on their social and political identity and gender. For example, within the Chumash, age is associated with wisdom and therefore power is ascribed to maturity (Blackburn 1975, 74-75) and would vary through space and time. Throughout time the symbolic meaning of the rock art or its intentions by its creator would not have remained static and could create a variety of relational effects.

The location of the rock art within the Chumash landscape would also create different effects. For example, I could suggest that rock art near springs or a body of water would mean something different than rock art that is not located near this type of environmental feature. This is because, as Blackburn (1975, 85) states, this natural element has a wealth of different meaning within the Chumash oral narratives such as "…a flood that destroys the world, rejuvenation through submersion, springs or other bodies of water that are focal points of danger or exits from the realm of the supernatural, and water as an antidote for poison". Furthermore, as was stated above, water and associated rock art would also mean different things to the different Chumash people.

Major geographic features such as mountains also enacted upon the Chumash people such as Mount Pinos (the largest peak in the Chumash geographic area), Frazier Mountain and Cuddy Valley to the north of these two peaks. Hudson and Underhay (1978, 41, all source edits were from the original author) note that one of J.P.

Harrington's informants from the neighbouring Kitanemuk (an indigenous group that lived to the east and southeast of the Chumash) knew of these prominent mountains:

> The place the *'antaps* are is [a] lagunita [tiny pond, marsh, or lake]—[this place was] in a cañada [canyon] near *'Iwɨhiɨnmu* mountain [Mount Pinos] and beyond Cuddy's [Cuddy Valley]. The water flows not *pacá* but *payá* [away from here]. You hear bullroarers and tocar [playing instruments, i.e., flutes, whistles] and gritar [shouting]—dogs barking—[There were] many people in there—it is like a fiesta. And in a cave, suterrano [underground], the *'ichunash* [sacred deer bone whistles used by the *'antap*] are kept—four of them. [The] ancients never went near that vicinity. The wind blows strong [there], [and] the earth quakes. If you get in there, you never get back [out] again. Once the soldiers from the Fort [Tejón] went up there to make shakes—lots of fine piños [pines] up there. In the night they say lumber [fires lit] in the mountains, and arrancaron [the soldiers quickly departed]. All [was] quiet again [the] next day.

Past studies have also highlighted the network nature of Chumash ceremonial and ritual society; another important aspect of the persistent relations that make up the interaction sphere. Blackburn (1976) discusses the interrelationships found within past California societies, focusing on the Yokuts, Chumash and Gabrieliño. The focus is on the reciprocal ceremonial exchange found between people of a society to maintain social interactions (*ibid*). Blackburn (1976, 242) states:

> Thus, social interaction was no longer dependent solely on irregular environmental fluctuations; instead, social factors involving the demands of an annual ritual cycle as well as reciprocal obligations of a social, economic, or political nature, became the primary motivations for social actions. Thus what began as an ecologically adaptive convenience becomes a socially catalytic necessity, stimulating the production, exchange, and consumption of economic goods, reinforcing interpersonal and intergroup relationships, and providing the context for political cooperation and integration.

As I have highlighted previously in Chapter 3, rock art has been theoretically studied as a part of these ceremonial processes and therefore both acts and enacts within the ritual and ceremonial networks.

King (1976) further pursues the hypothesis of dynamic inter-group exchange in the context of resource variability throughout the Chumash region and the regularities found within the archaeological record through the remains of foodstuffs (e.g. shells) and raw materials (e.g. chert). ANT is also highly applicable within the context of Gamble's (2008, 272) notions of power networks where she states:

> Coalitions were probably continually shifting, depending on the particular context of their formation and their ongoing management. Parallel and overlapping alliances were often formed by chiefs who attempted to maintain

> friendly relationships within their coalitions, while at the same time endeavoring to retain power, resources, territory, and partnerships. To accomplish this, they had to keep their communities happy. Any discord between individuals within these alliances could upset the balance and set off a series of discordant reactions, with some ballooning into revenge and warfare. When resources were unreliable or scarce, the likelihood of factional competition, conflict, and warfare was greater.

Underlying the studies by Blackburn (1976), King (1976) and Gamble (2008) are the notions of power and control relations to maintain the complex social systems and subsystems of the Chumash. Furthermore, Hudson and Lee (1981) and Robinson (2011) associate the role of power within the ideology of rock art as media that demonstrates or differentiates power respectively as discussed in Chapter 3. ANT embraces these varying scales of power from the rock art site to the ceremonial networks throughout the region to conceptualise the role rock art played to further entrench the various systems and subsystems within the dynamic network relations.

Finally, ANT pushes away from the dualisms that have been apparent within Chumash rock art research and rock art research on an international scale. More importantly these dualisms of non-shamanic/shamanic or public/private (inclusion/exclusion) are incorporated into its framework where one is no more important or correct than the other. They are all important and are entrenched to varying degrees within the topography creating different relational effects where the archaeological record is a reflection of these network relations within the Chumash landscape. As Law (1999, 3) states, “such divisions are understood as the effects or outcomes” and are incorporated within the framework. For example, the public versus private concept that was first introduced by Hudson and Lee (1981) for Chumash rock art can be integrated within ANT and also incorporates all of the sites’ functions expanded on by Hyder (1989) (see the review in Chapter 3). For example, analyses would include the associated archaeology, environmental features, underlying supernatural belief systems documented in the ethnographic record and recent theoretical studies. Instead it would apply a ‘sliding scale’ where the different dichotomies are not just one or the other but a network of any possible variations of the two.

5.6 Conclusion

In order to begin the discussion and analysis on rock art sites and the Chumash landscape through GIS and ANT, I argue here that this type of heuristic analysis (GIS and spatial analysis) can highlight new avenues of viewing and researching rock art sites through their network connections and relational effects at various scales to other types of environmental and archaeological information. GIS is particularly strong in this aspect as it allows both multi-scalar analysis, and through spatial analysis, I am able to conceptualise the rock art, the contextual archaeology and its relations. By incorporating both important and new theoretical applications and terminology into rock art research, such as entrenchment, dynamic networks, connectivity and the topographical metaphor, ANT has become highly applicable in understanding the role that rock art played within the underlying and interwoven structuring principles of Chumash society.

In Chapter 3, I discuss how studies of rock art at multiple scales are important to understand dynamic, heterogeneous societies, and I therefore wish to further explore this concept of multi-scalar analysis as an explanatory device defined and conceptualised by its network connections. By studying the micro-, community- and regional-scale dynamics of the network relations, I will describe how rock art both acted and enacted to give rise to social places and interrelationships within the Chumash interaction sphere. The Chumash were utilising these same places for a variety of purposes besides rock art creation (as discussed in Chapter 3 and 4), and therefore, rock art's association to other aspects of the archaeological record can reflect its importance through entrenchment, or persistent network relations, both throughout their landscape. As I have discussed in previous chapters through the ongoing research of Robinson (2006, 2010a, 2011), the Chumash interaction sphere, including the rock art, was not only a landscape, but also a taskscape. Both landscape and taskscape were entrenched in the cultural, socio-economic systems and sub-systems, political structures and ideology of its inhabitants. The surrounding environment was also another important feature interwoven within their rich and nuanced society. Understanding rock art within the networks can be further studied and incorporate the ethnographic/ethnohistoric record and the ideological hypotheses outlined in Chapter 3 by Hudson and Lee (1981) and Robinson (2011).

ANT further allows the incorporation of multiple, similar theoretical frameworks and offers a way to capture these relations; they include material semiotics, agency and affordance. Through material semiotics rock art therefore has agency, whereby primary or secondary agency as described by Gell (1998) is interwoven within the heterogeneous network connections as relational effects. Within ANT, the dichotomies such as primary/secondary agency or private/public (exclusion/inclusion) are expanded through a sliding scale of incorporation where different people over time found different symbolic meaning at rock art sites that resulted in multiple versions and reconstructions of these dichotomies. Furthermore, the relational thinking or network relations is further supported by Gibson's (1979) theory of affordance and the adapted relational theory of affordance by Chemero (2003). ANT is a network of multiple theoretical ideas and frameworks creating further relations into the larger network.

The aims of this chapter were to understand ANT and further refine its tenets so that it is applicable to the study of Chumash rock art and its placement or location within the overall Chumash interaction sphere. Therefore, the Chumash landscape was full of connected networks at a variety of scales entrenched to varying degrees within the topography, and through ANT, I will be able to further conceptualise and contextualise these relational effects within the internal dynamic folds that make up the interaction sphere. Specifically, the application of ANT to the data inputs and outputs of the analyses performed in the following chapters provide the theoretical framework to aid in the discussion, interpretation and description of the research questions and results. In order to comprehensively understand the subsequent analyses, the next chapter aims to provide a detailed outline of the methods used to gather the data important for the GIS analyses and present the results of the collation of data.

Chapter 6 Data Acquisition and Creation: Rock art, cultural and environmental variables

6.1 Introduction

As has been pointed out in the last few chapters, there is a need to understand Chumash rock art sites within a theoretical framework that helps to begin bridging the gap between the main discussions for the rise of their complex society as discussed in Chapter 2 and the theories and methods that explain the rock art highlighted in Chapter 3. I am incorporating the application of ANT as a means to begin this discussion and analysis. As Robinson (2006; 2010a) started this type of research within the Emigdiaño linguistic region, my goal is to further apply this type of analysis to the whole of the Chumash landscape or interaction sphere. In the following chapters of this thesis, landscape will always refer to the entirety of the distribution of known, verified and validated sites[3]; otherwise known as the Chumash interaction sphere. Through the application of ANT, the landscape between these sites is part of the multi-scalar network of intra-regional interactions involving all cultural and environmental activities. As pointed out in the previous chapter, the whole of the environment and landscape were important interwoven, networks comprising Chumash society. Therefore I want to move away from the boundaries that exist in the literature and study their complex network behaviour and dynamics in terms of the topographical metaphor or the topographical networks. In order to do this, an association between the rock art, associated archaeological sites, the archaeological context and the personified environment and landscape needs to be analysed. As time did not permit a whole survey and excavation of all the known rock art sites, a desk-based GIS study with correspondence and face-to-face interviews with people who had visited the numerous sites and a review of all rock art site records took place over a 6-month span of fieldwork in South Central California.

[3] In this thesis, verification involves the confirmation that the site is a rock art site that has sufficient information to put into the database, while validation requires that the site has been revisited a minimum of two or more times to prove that the original site record was accurate. During fieldwork, many sites were verified, but their exact location could never be replicated from the original site visit either due to destruction or inaccurate coordinates.

This Chapter entails a full description of the creation of the input data used in the proceeding chapters to prevent multiple descriptions of the data and to present an understanding of its creation so that this type or similar research can be duplicated in the future. Also as this database has not been created before, it can provide a means for standardisation for the various institutions and organisations that manage rock art data in the Chumash region. Next, I highlight the main research questions that have been touched upon previously in the introduction to further highlight how the data will fully support both the questions and ANT. Finally, I go over the assumptions that are made in order to perform a GIS and spatial analysis on rock art data. These assumptions needed to be established before the collation of the data and subsequent analysis in order to make sure the correct data was collected and attributed correctly.

6.2 Chumash Database Creation

The main goal of the California data collection and fieldwork was to create a comprehensive GIS database containing all of the previously recorded rock art sites located within the Chumash interaction sphere. At the beginning of my fieldwork, there was no known database that covered the whole of the Chumash region. More specifically, comprehensive is used to describe the database as it includes information to perform a multi-scalar analysis for sites with their archaeological context, an analysis for at least the distribution of one ubiquitous motif type and information on the enigmatic stand-alone cupule sites. For this study, I chose the bifurcated motif for analysis, as it is the ubiquitous motif most mentioned in the literature and will provide a more refined centimetre of analysis as discussed in Chapter 3 based on Chippendale's multi-scalar methodology. It is the centimetre scale extracted for a regional-and community-scale for GIS analysis. I also extracted information on the two style types presented in Hudson and Conti (1981), if applicable in the motif description, Type I and Type II (see Chapter 2 for the style descriptions). While this information was extracted to include in the analyses, due to the low number of either of the style types, it was not included within the main body of analyses. Only the total bifurcated motifs were therefore included. Rock art sites were also broken into three rock art types that included: pictographs, petroglyphs and stand-alone cupule sites. Associated and contextual archaeological information was added to the site if it was within roughly 10 metres of the original site. It could be argued that associated middens were located further away, but extracting this information from other site records was outside the scope of this research.

The stand-alone cupule sites were considered important as they are not often studied nor are they included in a lot of the rock art discussions, yet their distribution covers all of the Chumash linguistic areas. Stand-alone cupule sites are often found on large boulders with the presence of numerous cup marks sometimes in the hundreds. Cupules were also included in the database if they were associated within the rock art site or panel itself, similar to BRMs, middens and the bifurcated motif, and treated as *contextual* information instead of a distinct site type. While cupules by definition are considered petroglyphs, I wished to make a distinction between them and other identified petroglyphs due to their uniqueness. This distinction is in part because of their enigmatic nature within the rock art discussions, but more importantly though, I believe cupules are a distinct and unique phenomena. Associated cupules in the database are, therefore, defined as a part of the contextual information of a rock art site at the centimetre scale such as the bifurcated motif and not described nor recorded as petroglyphs. A more thorough analysis on cupules than what is presented in the following chapters should be a topic for future analysis and outside the scope of this thesis. The stand-alone cupule sites were included in the analysis as completely different phenomena as they are not found at the pictograph or petroglyphs panels but are independent sites in terms of geographic location.

The geographic starting point was the original linguistic boundary as defined by Kroeber (1925), but as discussed before, this is only a guideline and the archaeology should be used as a better indication of the Chumash landscape. Furthermore, this database is a dynamic entity as it will always change based on newly discovered or relocated rock art sites. For example, during my research, three new rock art sites were discovered and included in the database. Finally, the incorporation of other archaeological site data was also researched for their existence and permission was sought for their use. Fortunately based on previous research the inclusion of the ethnohistoric village database was allowed.

6.2.1 Rock Art Sites

As was stated above, there was no known comprehensive database that existed for the entirety of the Chumash geographic/linguistic area or for the entirety of all potential Chumash sites. The site records for this area are held at multiple locations. Each of the land-holding organizations and data-curating institutions hold information on the various rock art sites from projects administrated and reviewed under California's Office of Historic Preservation, information from institutions with responsibilities under the California Environmental Quality Act (CEQA) and National Environmental Policy Act (NEPA), academic surveys and excavations and a variety of other projects that do not fall under Section 106[4] of the National Historic Preservation Act (NHPA) (California Historical Resources Information System, 2012). The information is in the form of Cultural Resource Management (CRM) reports, academic research papers and reports, monitoring reports from volunteer site stewards, fire incident reports, photographs and drawings from previous research and spatial information or hand-drawn maps of site locations. Finally, additional information is available through local rock art enthusiasts, forest service agents and local hikers who have volunteered their time to monitor the conditions of the rock art sites through GPS data, site reports, photographs and hand-drawn maps.

To create the rock art database, the first goals I needed to accomplish were as follows:

1. Collect and collate all rock art site types that are identified as Chumash based on the style of the art through the work of the artistically educated researchers such as Georgia Lee, Campbell Grant and Dan Reeves.
2. Collect and collate all associated available archaeological databases that exist at a regional scale for a variety of site types.
3. Further explore the areas along and outside what is currently perceived as Chumash territory to represent a more accurate Chumash landscape based on known site distribution.

All of the collated data would then be used to create a GIS file to show the geographic location of each site and create attributes of pertinent site information required to aid in the multi-scalar analyses. At a minimum the site information would need to have

[4] "Tribal consultation is required in all steps of the Section 106 process when a federal agency undertaking may affect historic properties that are either (1) located on tribal lands, or (2) when any Indian tribe or Native Hawaiian organization attaches religious or cultural significance to the historic property". (See http://www.gsa.gov/portal/content/101901 for more information on the US federal laws applicable to archaeological sites).

accurate geographic information for eastings (X) and northings (Y) to create a location point within the GIS software, and to have an accurate description of what associated cultural material is found at the specific rock art site (e.g. bedrock mortars and middens) and the various elements and motifs or photographs to inspect.

The primary data source for this research study utilised site record data held at the Heritage Center of Los Padres National Forest in Santa Barbara County, California, USA a land holding organization under the United States Department of Agriculture (USDA). Los Padres National Forest is located within parts of four counties in California: San Luis Obispo, Santa Barbara, Ventura and Kern (Figure 6.1). This area is wholly within the Chumash regional landscape which was a logical starting point for the data acquisition. Los Padres Heritage Center previously had their archaeology sites (i.e. all sites types including rock art) collated into a GIS file by students and volunteers by digitising hand-drawn site boundaries from official site records that include boundaries placed onto the USGS 7.5 minute maps[5]. The attribute data for this file did not have comprehensive information as to the type of site (e.g. lithic production area, habitation, seasonal camp, rock art, etc.) nor did it have any descriptive information that could be used to extract rock art site data from the file. The main information that each digitised site was attributed was the unique number assigned by the Forest Archaeologist when the record was formalized into their files. Therefore, in order to gather a list of rock art sites, each of the 1,682 site records had to be thoroughly read through, and when it was confirmed as a rock art site (i.e. included information on confirming rock art was present), it was removed for further investigation. As each rock art site record was pulled, the site number for the Forest was recorded into a verification and validation spreadsheet that also included the California Trinomial (if applicable), formal site name (if applicable), a brief description of what was present at the site and the final decision of the site (e.g. to include or exclude it from the GIS database) (see Appendix A for this intermediate database). Secondly, after gathering Forest rock art site numbers, the GIS file was queried, and all of these sites were selected and exported from the main GIS file into a temporary rock art file for later validation. The exported file was quality controlled for errors and any of these errors

[5] For a description of these maps, please refer to the USGS website: http://nationalmap.gov/ustopo/index.html.

(e.g. duplicate polygons) was flagged in the spreadsheet. The total number of rock art sites in the preliminary data extraction from Los Padres National Forest was 193.

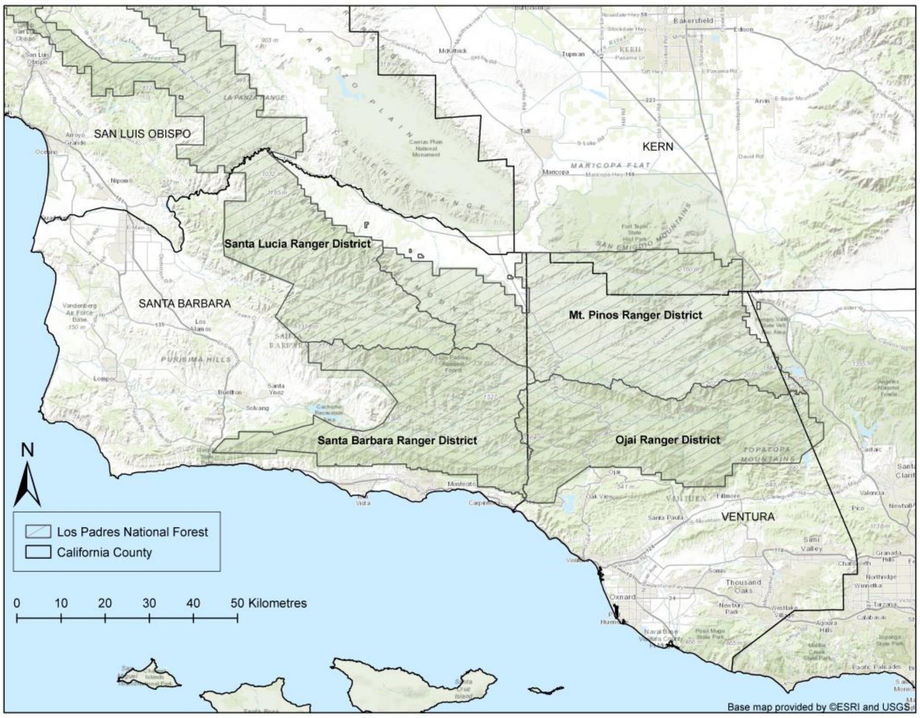

Figure 6.1: Map of California's administrative boundaries relevant to the verification and validation of rock art site data.

The secondary data sources for this study were the Central Coast Information Center (CCIC) and the South Central Coast Information Center (SCCIC), both of these centers are part of the California Historical Resources Information System[6] under the Office of Historic Preservation. CCIC is operated by the Department of Anthropology at the University of California, Santa Barbara, CA, while SCCIC is run by the Department of Anthropology at California State University in Fullerton, CA. These repositories (CCIC and SCCIC) hold records for archaeology sites in all of San Luis Obispo and Santa Barbara Counties and then Ventura and Los Angeles Counties respectively. There was considerable overlap with Los Padres National Forest, but the overlapping data allowed for further verification of site location. Additionally, the collection of Chumash rock art sites outside of the National Forest was now available to add to the rock art database.

[6] http://ohp.parks.ca.gov/?page_id=1068

CCIC held their data in digitised site records, paper site records and a GIS file of site polygons. Not all sites had been digitised from paper format or into a GIS format (dependent on availability of student volunteers), so the level of information extraction was site dependent. Again no information on site type or descriptive information was included in the attribute table at either of these centers, but paper site records of rock art sites had previously been pulled from the main archive at CCIC by past researchers. Therefore, using the California Trinomial from the site records and the Los Padres files, the digitised site records and GIS polygons of rock art sites were extracted from the main data sources. The information of extracted sites was also included in the spreadsheet (again see Appendix A).

The information on the rock art sites from SCCIC covering both Ventura and Los Angeles Counties was available through previous research efforts by Dr. Paul Cairns (2008). As a rock art enthusiast, he had gone through the literature and site records at SCCIC and compiled a list of rock art sites in these areas. Furthermore, Dr. Cairns had field verified many of these sites in the field, so information was available as to whether the sites accurately located the presence of rock art. SCCIC did not allow for GIS files to be used in research, as they had not been fully validated, so rock art site records were pulled, copied and the hard copies were used to relocate and digitise the sites. The total number of rock art sites in the preliminary data extraction from CCIC was 61. The total number of rock art sites in the preliminary data extraction from SCCIC was 26.

Data was also gathered from the Wind Wolves Preserve originally collected from Robinson's (2006) PhD thesis studying rock art sites. This data was in the form of a spreadsheet with information including the California Trinomials, site descriptions and northings and eastings. Information on the rock art sites on Vandenberg Air Force Base was also in this similar format. By using ArcGIS 10, the northings and eastings were plotted in the software and a GIS file was created. The Wind Wolves Preserve had a total of 49 sites.

The final source of data was utilized for the creation of the rock art GIS file. First, GPS data was gathered from various site stewards, in particular from Jon Piccoulo and Jim Blakely, Jr., who are volunteer site stewards at Los Padres and rock art enthusiasts. Each gave their permission to use their data, and this provided a much more accurate point location for the site as they visit many of these sites annually. This data oftentimes had a description of what was located at each site in terms of whether it was a pictograph, petroglyph or cupule site. Also available through volunteers was an accurate comparison of the current California Trinomials and the old site nomenclature that had previously been designated by Campbell Grant. This data provided a comparison of sites' descriptions from past research.

After carefully looking over the data that was available, and considering the research questions to be answered by the various spatial analyses, the format for the database was decided. The structure of the database or attribute information is as follows:

1) **Field 1:** Los Padres National Forest FS Number (if applicable)
2) **Field 2:** California Trinomial (if applicable)
3) **Field 3:** Campbell Grant Site Number (if applicable)
4) **Field 4:** Site Name (if applicable)
5) **Field 5:** Presence or Absence of Pictographs at the Site (0=absence; 1=presence)
6) **Field 6:** Presence or Absence of Petroglyphs at the Site (0=absence; 1=presence)
7) **Field 7:** Presence or Absence of Cupules at the Site (0=absence; 1=presence)
8) **Field 8:** Presence or Absence of the Aquatic Motif at the Site (0=absence; 1=presence)
9) **Field 9:** Presence or Absence of Type I Aquatic Motif at the Site (0=absence; 1=presence)
10) **Field 10:** Presence or Absence of Type II Aquatic Motif at the Site (0=absence; 1=presence)
11) **Field 11:** Presence or Absence of Middens at the Site (0=absence; 1=presence)

12) **Field 12**: Presence or Absence of Bedrock Mortars at the Site (0=absence; 1=presence)

13) **Field 13**: Formal description of the site, numbers of rock art panels or elements if applicable, numbers of cupules if applicable, etc.

The inclusion of the FS number and CA Trinomial allow the database to be joined with existing Forest Service or California Historical Resources Information System information databases and provide a full attribute table of information for these institutions and organisations that previously did not have this information in their GIS. The alphanumeric formatting standards that are currently set up by the California State Government and used for the existing information were maintained. The site name was included for easy reference as oftentimes this is how a site is described in the literature. The presence or absence of the rock art site information allowed an easy way to create a raster database in order to run spatial analysis within a GIS program. The formal description allowed for the entering of information that could not be included numerically but could be potentially extracted for use at a later date. For example, the number of bedrock mortars was included in the description if it was part of the site record. This was *not consistent* within the site records themselves but could be useful if an individual site analysis was required.

In order to create a highly accurate GIS layer for the rock art sites, all of the data were placed on both 7.5-minute USGS topographic maps and up-to-date aerial photography preferably from the autumn or winter so less foliage was present. Each site was then carefully examined using its geographic location according to the collected GIS files and the locational description and site maps found in the Los Padres, CCIC and SCCIC site records. Errors were noted in the spreadsheet. The most accurate location for the site was decided upon and either re-digitised, or if it was originally digitised correctly, the polygon was copied and pasted into the file. This often included the help of present and former Los Padres archaeologists to help determine the site's location. The most common errors found for the Los Padres and UCSB site polygons was that the site had not been digitised to scale based on the measurements from the site records. Also, the Los Padres data often had the site numbers incorrectly entered into the GIS file creating duplicate polygons. This was easily fixed because of the presence of the other GIS files from the other institutions and organisations. The attribute table was then populated with the information from the site record through data entry, and if there was associated archaeological information within 10 metres (if an accurate distance was not recorded, then I made the final decision) of the site, it was included in the site attribute. Some sites did not have enough information to be formally digitised in their geographic location. This was often because the site itself had not been visited since it was first recorded and the locational information and site maps were too vague to get an accurate position. Each available data source was exhausted before a site was formally removed from the dataset, and this information was entered into the verification and validation spreadsheet for cross-reference (See Appendix B for the final attribute table of rock art sites).

6.2.2 Ethnohistoric Village Sites

Finally, data was collected for the Chumash ethnohistoric village sites from the Santa Barbara Museum of Natural History. Information was in the form of point data with a description of the village name based on Johnson's (1988) research on Spanish Mission records. His analysis focused on the ethnohistorically documented sites along the coast and into the Santa Ynez valley to answer research questions concerning whether documented marriage ties reflected economic and political networks. Information for all of the village sites was then digitised using previous published maps of these sites and added based on site locations from previous studies (e.g. Fu 2007; Neal, 2007) and with permission from Dr. John Johnson (pers comm. 2011). The locational information for the sites on the Northern Channel Islands was not included in this research. This was partially due to the fact that no rock art information was available for the research and also due to the lack of landscape continuity because of the Pacific Ocean. Such information would be difficult to model through a GIS.

6.2.3 Database Creation Results

All of the rock art data and village site data were converted into points, as polygon data did not exist for all of the GIS data (refer to Figure 6.2 and 6.3 for the geographic distribution of each database) nor were consistent site boundaries measured or mapped for all of the sites. For the number of sites, this was the most practical for managing and processing the data within a GIS program. The Los Padres and CCIC information was in the form of polygonal data, but since this was not consistent for all of the information collected, points were used as an indicator of site location. Also, the polygons were oftentimes not to scale for the actual site boundaries and were difficult to determine based on the descriptions in the site records. Sites with numerous rock art panels were not given a single point per panel or weighted based on the number of panels present as again this was not consistent throughout the data collected and is further work to be pursued in the future. Also, it must be noted that what one archaeologist may consider one site with multiple art panels or loci another archaeologist may interpret as multiple sites and record it as thus. For example at Burro Flats (CA-VEN-1072), the original documentation had identified multiple sites, but recent recording has now identified as one site with multiple loci. This inconsistency is dependent upon individual interpretation. Because many of the loci were more than 10 metres apart, I created a point for each locus instead of just one site point for all. Without a full survey of all sites for consistency, it was interpreted to the best of my ability, but can be updated in the future. Sites were found to have multiple types of rock art present. For this database, the point was placed in the centre of the rock formation, as identified in the most recent aerial photograph, which contained the panels, and always placed on the rock formation itself through consultation with archaeologists or volunteers who had visited the site. The total area for the rock art data distribution was 1,458,811.31 hectares or 14,588.11 km² based on creating a convex hull of the rock art sites and clipping out the coast. For reference, the area of Wales is 20,761 km². The ethnohistoric village sites (not including sites located on the islands) composed a larger distribution that equalled 1,882,486.79 hectares or 18,824.87 km². The rock art landscape falls completely within the ethnohistoric village landscape. In total, there were 254 rock art site records that were verified and validated and 135 ethnohistoric village sites.

Figure 6.2: Rock art site distribution throughout the Chumash landscape.

Figure 6.3: Rock art site distribution and ethnohistoric village site distribution throughout the Chumash landscape.

By initially looking at the rock art site database and site distribution, it is apparent that there is already a wealth of information available and there are a few initial points that first must be made. First when placing the Kroeber's (1925) linguistic boundary around both sites' distributions, it is already apparent that the archaeology does not reflect the linguistic boundary (Figure 6.4). Most likely, this is due to further survey and excavation efforts and also the extensive research that has taken place in the almost nine decades since his research. Furthermore a synthesis of the sites and associated archaeological material gives a general overview of the rock art database (Figure 6.5 and further see Appendix C for associated distribution maps). Here we see that pictographs are the most common type of rock art found within Chumash territory and associated BRMs are the most common associated archaeological material. Yet middens are not far behind in terms of counts. The bifurcated motif, while ubiquitous throughout the territory, was present at 34 different sites with 28 Type I and 12 Type II (some sites having both Type I and II present). Next, if we expand on Figure 6.6 to look at what associated data are specifically found at sites where pictographs, petroglyphs or stand-alone cupules are present (see Figure 6.6), we find that at the 170 sites that had pictographs present, middens were the most prevalent associated archaeology. BRMs were the most common at stand-alone cupule sites while petroglyphs also had associated middens occurring in the highest numbers.

Figure 6.4: Rock art site and ethnohistoric site distribution with linguistic boundary

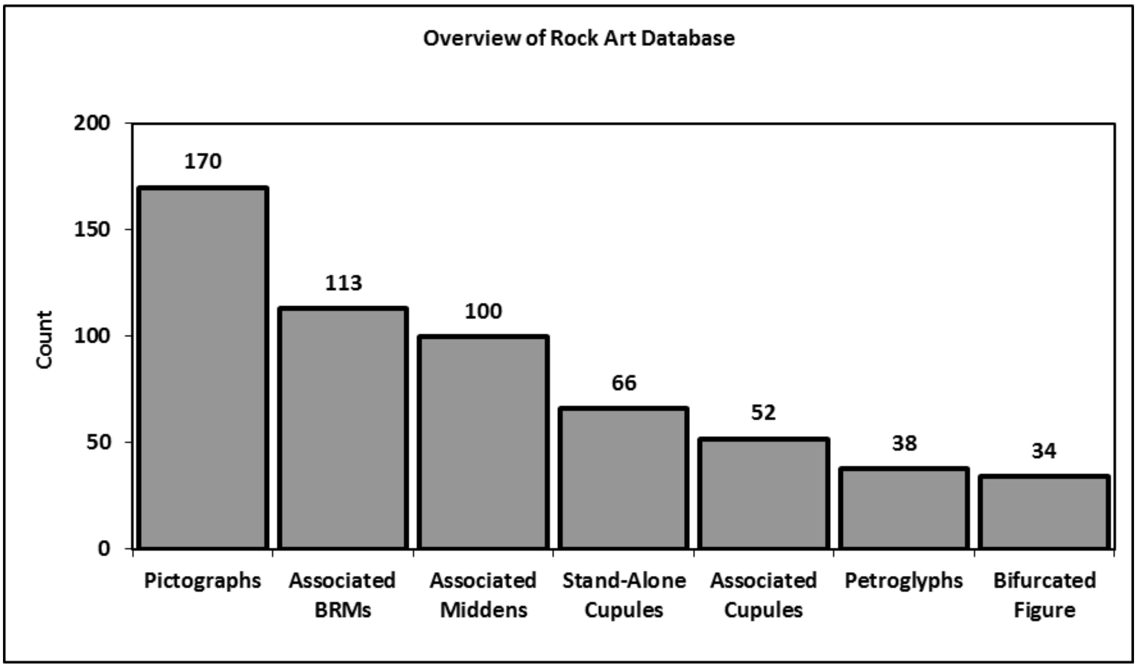

Figure 6.5: Overview of rock art database and associated archaeological information.

Figure 6.6: Associated information for various rock art types found within the Chumash landscape. This graph does not include those sites with no associated archaeology.

In total, 92 sites did not have associated archaeology documented (i.e. without BRMs and middens) at the time of writing this thesis, although as was described earlier, middens could potentially exist but due to lack of excavation there is no recorded evidence at this time (See Figure 6.7).

Figure 6.7: The presence of rock art without associated archaeology.

The amount of associated material found from the creation of this database (162 sites), or 64 % of the total rock art sites studied, is substantial. In contrast, 36 % did not have any known associated archaeological evidence. The convergence on the associated archaeology led Hyder (1989) to consider the potential of different functions for the rock art sites. Also Lee (1984, 19) describes, "private sites are in small, confined spaces and may have been associated with personal ritual activity such as vision questing", which she posits "…we would expect the private sites to display more individualistic symbolism then group sites which would display more examples of mythological motifs". More analysis on style would be necessary to further explore this hypothesis. As I argued earlier though, archaeologists have found that middens are potentially hidden beneath the surface of these sites, so unknown association does not necessarily mean that there is no apparent archaeological context beyond the art itself. While I am not debating the ideological importance of these sites as places of contact with the spiritual world or as places of mythological importance such as shown in the ethnographic literature (e.g. Hudson and Underhay 1978; Blackburn 1975), I am questioning their function as places of exclusion. Robinson (2010a, 794) states, in relation to the debates on if the general population was excluded or included in visually consuming the sites:

> Crucially, these arguments hinge on the visual presence of rock art in relation to the presence or absence of other archaeological deposits. It is for this reason that the archaeological record is an ideal medium to explore the visual presence of art within public or private realms. Correlative modeling— the listing of rock art and its association with or without other archaeological components— is a good starting point; however, correlation by its own is not enough.

Therefore, the following chapters will continue this discussion using the information created in the rock art database through GIS, spatial analysis and the application of ANT. In order to accomplish this, different environmental variables were constructed to first understand the many networks that are present, and to further explore how this information entrenches the Chumash interaction sphere.

6.3 Environmental Variables

Data was collected to create high-resolution variables for the GIS analysis in the form of environmental data in both raster and vector GIS format. The data was downloaded from the United States Geological Survey (USGS), also collected with permission from the Los Padres National Forest sets of data and other various freely available data as described in the following text. The USGS provides data for the United States and worldwide at various resolutions free of charge. The data available also enables the user to create other derived datasets relevant to the analyses outlined above and explained below. For example, an elevation raster can be used to extract the stream and drainage information and create a slope and aspect map of the area of study. This environmental and topographic information was an important aspect of the GIS analyses as it allows for a direct comparison and analysis of the rock art sites to the topography and environments in which they are located. It is discussed here to introduce the information for the next three chapters.

The area of study was expanded from the original area based on the convex hull of the ethnohistoric villages sites to prevent any edge effects. Expansion enables the sites at the edges of the study areas to increase the available raster cells or vector areas so there is more information available to provide more accurate measurements. Therefore, the original convex hull was buffered by 10 km and the total area of study increased to 3375018.96 hectares or 33750.19 km^2. The study area at a 10 metre resolution was extremely large and caused numerous computing issues due to various GIS programs inability to analyse numerous datasets over 2 GB in size. Therefore, consistent incorporation of algorithms that provide the best output for the types of analyses being undertaken at the regional scale was impossible (see more below). ArcGIS 10 was the only program that could undertake such intensive analyses, so it was used for all of the regional scales of analysis. Once the information was obtained at the regional scale, better algorithms were implemented at the smaller community- and site-scales in other GIS programs to obtain more accurate and measurable results.

6.3.1 Base Data

For the elevation dataset, the National Elevation Dataset (NED), a raster product assembled by the USGS, was downloaded. NED provides elevation data with a consistent datum, elevation unit, and projection (USGS, 2006b). The NED for the area of study has a resolution of 1/3 arc-second (10 metres). Because there was a need for multiple tiles to be downloaded, the data was mosaicked into a single seamless layer in ArcGIS 10 and the area of study was extracted. The DEM was then further used to create the slope, aspect, accumulated cost surface and hydrology datasets explained below.

The USGS allows a vector GIS layer of "geologic units and structural features in California, with lithology, age, data structure, and format written and arranged just like the other 50 States" to be downloaded free of charge from their website (USGS 2012a). The geological data had to be resampled because it was digitised at a 1:100,000 scale and was converted into a continuous raster format at a 10-metre resolution. Resampling allowed the geology dataset to be compatible with the previously described datasets, and as a result, could be used as input for the spatial analyses.

The data used to represent the habitat/vegetation regions for the study area is from the California GAP Analysis Project. GAP data was made freely and publicly accessible in 1998 by the Biogeography Lab at the University of California at Santa Barbara and is available for free download from their website[7]. The California GAP dataset was produced using a variety of collated datasets, ground survey and

[7] http://www.biogeog.ucsb.edu/projects/gap/gap_data2.html

computer applications such as remote sensing and aerial photo interpretation (Neal 2007). The vegetation communities are represented by polygons and were produced using Weislander Vegetation Type Maps[8] created during the 1930s and 1940s through ground survey (Neal 2007). In order to use this data for my analysis, it had to be resampled because it was originally digitised as polygons. It was further converted into a continuous raster format at a 10-metre resolution. Again, resampling allowed the vegetation dataset to be compatible with the previously described datasets and therefore could be used as input for the spatial analyses.

6.3.2 Derived Datasets

Slope or gradient was derived from the NED elevation dataset and is expressed as degrees of inclination from the horizontal (Conolly and Lake, 2006, 192). In other words, for each raster cell, slope calculates the maximum rate of change in elevation values from that cell to its eight neighbours to identify the steepest downhill descent (ESRI 2011d). Aspect was also derived from the NED elevation dataset and is expressed as "degrees of rotation from some origin, with a separate value for flat areas where it is undefined" (Conolly and Lake, 2006, 192). Aspect is more simply the slope direction and the output raster values will be expressed as compass directions (ESRI 2011b). ArcGIS was used to create both the slope and aspect variables for all scales of analysis.

The USGS offers a publicly available stream and river datasets for free download, although it is not of the highest accuracy according to its published metadata. It was originally digitised at various scales but usually at the 1:100,000 scale (see Neal 2007 for more information). The USGS stream and river dataset was downloaded for the area of study (USGS 2012c). The available data was not comprehensive and only represented the major rivers and streams within the area. With the availability of a 10-metre resolution elevation dataset, a more up-to-date and accurate hydrology dataset was created for input. Previous GIS information on lakes, ponds and springs from the USGS was still used and added to the new stream network that was created. These polygonal datasets were rasterised and added to the stream dataset using the ArcGIS Map Calculator tool. It must be noted that areas where there

[8] http://www.lib.berkeley.edu/BIOS/vtm/

are problematic human-made lakes are located within the area of analysis and it is reflected in the topography of the DEM. The areas are therefore not considered places where highly accurate outputs exist and must be used with caution in the interpretations. Also as was described in Chapter 2, the hydrology of the area is extremely dynamic, so the modern drainage networks are merely an approximate representation of the palaeo-networks that have changed over time.

GRASS GIS provides the most accurate GIS hydrological analysis with its terrain analyses, r.terraflow and r.watershed, because the program uses algorithms that create a multiple flow direction (MFD) output for the stream networks. r.watershed was chosen as it has been proven to produce better and more accurate results for stream networks specifically in areas with low slope values (GRASS GIS manuals 2010). Tarboton's (2013) Terrain Analysis Using Digital Elevation Models (TauDEM), a toolbox externally created for ArcGIS, was also tested for the regional scale of analysis as its algorithm is also based on MFD. MFD creates a more natural flow path output as it searches the DEM raster cells within 16 cells, instead of the 8 cells, used by the single flow direction (SFD). The SFD, also known as D8, assumes that there is only one direction of flow, that of the steepest downslope direction and creates unnatural flow paths especially in valleys (Neteller and Mitasova 2008). MFD algorithms create the flow path from each downslope neighbouring cell, or lower elevation cells, therefore, creating a more naturalistic flow path (*ibid*). Unfortunately for the regional scale of analysis r.watershed and TauDEM were not able to run such large, high-resolution input variables because of the size of the dataset and the number of rows and columns comprising the raster. The DEM was therefore cut into multiple areas that were of the correct size for analysis. Issues arose when merging the outputs together due to edge effects at the areas of overlap. It was decided to use ArcGIS Hydrology toolbox for the regional scale because even though the processing time was long, it could handle the size of the input data (ESRI 2011a). The problem is that ArcGIS runs the SFD algorithm, so the results are not as accurate or reflective of the natural flow paths. This creates a more general output for the large regional scale. Smaller scales of analysis were then run using r.watershed and are more accurate.

Outputs had to be dealt with based on the individual programs. For the regional scale, ArcGIS uses the Strahler (1952) ordering system. Raster cells that do not have any other cell draining into them are order 1, while cells formed by the "confluence of two or more order-1 flow paths are coded 2, and those formed by the confluence of two or more order-2 flow paths are coded order 3" (Conolly and Lake 2006, 258). This network was reclassified for only those cells that had a Strahler value greater than 2, so as to most closely represent the modern flow paths. As this output is already in vector format, it was converted into a raster where lakes and springs were added and then converted back into a vector file. The r.watershed outputs for the smaller scales of analysis were thinned using r.thin to create a single raster cell for conversion into a vector, the other hydrological features were added and then all data was converted into a vector.

Next, accumulative cost surfaces were created to study travel and movement within the Chumash landscape to the rock art, associated archaeology and the stream networks. Accumulated cost surfaces use a cost-of-passage raster (e.g. slope) and apply an algorithm to minimise the cost of traversing to all other points within the map (see Wheatley and Gillings, 2002, pp.151-158; Conolly and Lake, 2006, pp.215-224, 252). Oftentimes this accumulated cost surface is then used to create and trace a least-cost path to show the shortest difference to travel between two points although this will not be implemented in this thesis. There are two types of accumulated cost surfaces that can be modelled using a GIS, isotropic and anisotropic. Isotropic surfaces are independent of the direction of movement (e.g. landcover, soil properties) while anisotropic costs are dependent on the direction of movement (e.g. slope) (see Herzog 2012 for more discussions on this topic). Further issues, and similar to those discussed in the hydrological analysis, are produced based on the search algorithm being used in the analysis, D8 or D16. Again, oftentimes the D8 is the default being used by the GIS programs when a more effective algorithm would be the D16. Outputs for the D8 algorithm can be problematic when tested against flat topography, as the results will not produce the expected straight line (see Bevan 2012). Furthermore, it is often the case where the GIS program is a 'black box' when trying to identify the units that the accumulated cost surface is measuring (*ibid*). The preferred algorithm for modelling the accumulated cost surface for this thesis is r.walk in GRASS GIS which measures the anisotropic cost of travelling using both elevation and slope while applying Naismith's rule to determine cost values for hiking different slope values (see GRASS GIS manuals 2012; Langmuir 1984). Again, GRASS GIS could not handle the input of large datasets at the regional scale, so ArcGIS Cost Distance Tool was used (ESRI 2011c). r.walk was then applied to the community- and site-scale of analysis. The problems with ArcGIS are that the D8 algorithm is implemented in this tool, and the actual values being measured are unclear, so again the regional scale is not as accurate. The ArcGIS outputs are also isotropic, as effective slope was not used (see Conolly and Lake 2006).

6.4 Research Questions

In order to begin these analyses, research questions were created to drive the data collection and collation and begin to form the structure of the analyses studied in subsequent chapters. The following section outlines the research questions being asked in this thesis, which are a starting point for the development of more precise questions as the spatial analysis takes form and does/does not highlight any distinct trends conceptualised in the multi-scalar topographical networks. Specifically, I am using these aspects of ANT within a GIS framework to explore the dynamics of the internal Chumash relations: entrenchment, topographical heterogeneous networks, connectivity and the dynamic relations that give rise to the Chumash interaction sphere.

To begin the analysis we must first ask questions of the main database that is the focus of the research presented here in this chapter:

1) What is the spatial distribution of Chumash rock art sites, specific element types, stand-alone cupule sites and the associated material culture across the region?

As was stated numerous times before, no current up-to-date maps on the spatial distribution of rock art at the regional scale and its association with other material culture and the topographic context exist. Furthermore, Grant (1965), after visiting a large number of the rock art sites, with the exception of the Sierra Madre Ridge, was able to see a variation within the elements at various sites loosely support Kroeber's (1925) linguistic territories mapped within the Chumash territory. Visually this is important to see how the various rock art site types and the current archaeology are related and what places are more entrenched within the archaeological record. Furthermore, this becomes the regional foundation of the network by which to use ANT to describe the internal relations and for breaking down the distribution into subsections for multi-scalar analysis. By thematically mapping the various archaeological and environmental elements the following questions can be visually assessed:

- **How does the regional distribution of rock art sites compare to culture historian Kroeber's (1925) linguistic boundaries?**

Secondly, I can ask:

2) Are there areas of spatial clustering or disbursement of sites and the elements and do these areas relate to the ethnographic information available, the distribution of the ethnohistoric village sites or the previously mapped linguistic boundaries?

More specifically, I wish to ask:

- **Where are the gaps in spatial and archaeological knowledge within the Chumash landscape and why?**
- **Based on associated cultural material and specific element types is there a potential pattern?**

Due to the prevailing dependence on current research of using such boundaries for understanding Chumash geographies and landscape, I wish to challenge this by using previous stylistic interpretations of rock art motifs and applying analysis on the clustering and disbursement of rock art sites. First, I wish to use Kernel Density Estimate (KDE) analysis to study specific areas of intensity of sites to conceptualise where the community-scale or topographic scales may be located. Secondly, I will apply Ripley's *K*-function as a way to measure statistically significant clustering or regularity of point data at multiple scales regardless of the shape of the area being studied (Conolly and Lake, 2006, 166). This analysis aims to look beyond the polygonal modern boundaries and pre-defined linguistic boundaries and study the interwoven network dynamics that give rise to social space and scale. Ripley's *K* will look at how actual site distribution may reflect the Chumash landscape and taskscapes potentially represented in areas of significant clustering of site types and various elements. For example, the results could reflect clustered areas of entrenched relations over time while regularity could represent more underlying societal structuring principles such as competition for resources. One critique with using this type of analysis is that it was originally designed for datasets that were assumed to be homogeneous and isotropic and archaeological datasets are inherently heterogeneous or comprised of multiple underlying cultural processes (Orton, 2005, 5). Therefore specific data attributes must be extracted (e.g. cupule sites, pictographs versus petroglyphs, element types) from the dataset to study their potential clustering or regularity.

3) What is the correlation between the rock art sites, specific element types and the associated cultural material to specific landscape features? Is this reflective of what is written in the ethnographic data about Chumash ideology?

This potential correlation will be explored by the use of maximum entropy modelling, a term used to describe predictive modelling techniques that use presence-only data, based on the ecological niche concept by Hutchinson (1957). This type of presence-only model has been used previously in archaeology to model human interaction with the environment and was first introduced by Banks et al. (2006 and 2008). Maxent is one predictive modelling tool developed to study species' distribution without absence data (i.e. where sites *do not* exist) (Philips et al. 2004; 2006). While this analysis looks at the correlation with the modern environment and makes the assumption that rock art site placement was influenced by specific characteristics within the environment, GIS can be used heuristically to make inferences, create discussions and conceptualise the heterogeneous environmental characteristics and their association to rock art sites. More importantly, the analysis can point to some of the many attributes that may have influenced site location decisions. It looks at how the environment acted or enacted the rock art and its placement. One predictive model has been performed within the study area by Neal (2007) and also uses 'presence-only' data with success. His study explored the modern environmental variables applied to ethnohistoric Chumash village sites using weights of evidence to predict undiscovered village locations.

Finally, the study aims to ask questions based on travel times throughout the Chumash interaction sphere and sees if there is potential connectivity based on the energetic cost at the regional scale and at selected community scales of analysis. Therefore the main research question to be asked is:

4) What are the potential network connections between the rock art sites and other sites?

This analysis aims to study past dynamic behaviours by looking at potential movement between various types of sites and the rock art using accumulative cost surface analysis, or in other words, looking at the potential networks on a continuous surface (Conolly and Lake, 2006). More importantly it will use both isolines and isochrones to study groups of site types and travel time costs without being dependent upon specific paths that may not be representative of actual movement. It can further explore what Armstrong (2011) found in his analysis of shellfish taxa in ethnohistorically documented villages. Armstrong (2011) found that geographic distances to resources potentially played a more important role in village networks compared to other types of network relations such as marriage or economic ties. Geographic distances can be measured and studied to see if they also have the same affect on the rock art sites. The isochrone analysis will use Tobler's Hiking Function applied to slope values (Gorenflo and Gale 1990; Tobler 1993) so as to output more intuitive values to understand travel between rock art sites within the Chumash landscape. Cost surfaces converted into measurable contours can reflect the connectivity of the rock art sites with the location of other site types and open up discussions on their potential connectivity. Finally other questions can also be explored:

5) How are different types of rock art sites potentially connected?

Furthermore, I can expand on this by asking:

- **How are the different site connections related to marriage networks from the mission records and information the political and economic provinces or religious territories from the ethnographic record?**

This final research question looks at the outputs of the previous spatial analyses and makes further interpretations in the concluding chapter to expand on ANT and the idea of entrenchment and network dynamics by asking:

6) Do the outputs of these analyses reflect how rock art helped to form or was a reflection of the dynamic entrenched topographical and ideological networks?

This question will use the outputs of the spatial analyses and collate them into a comprehensive discussion on how integrating the informed methods with more formal methods of analysis helped to visualise the rock art and other archaeological sites as dynamic interwoven networks entrenched within the landscape at multiple scales. Evolving from the original research question first outlined in the introductory chapter, this integrates the application of the modified tenets of ANT.

6.5 Assumptions and Inferences

As was discussed in Chapters 2 and 3, chronology for the rock art sites is difficult to obtain and may be the reason it is oftentimes not included in the theoretical dialogues on Chumash archaeological and ethnographical studies. While this persists, new investigations are being undertaken in the dating of rock art sites (e.g. Whitley 2000), but it is not yet consistent throughout the Chumash region. More specifically, excavations at Pinwheel Cave (CA-KER-9593), a pictograph site, and BRM complex (CA-KER-9594) 500 metres away used diagnostic analysis of the associated archaeological material, and they found artefacts dating from 5,000 BP up until the Historic Period (Robinson and Sturt 2008). The results of this excavation show that there are more complex activities at this site and that further excavation is needed to provide a more holistic picture of rock art sites as taskscapes. I will, therefore, make the assumption that the rock art sites and their associated archaeology and evidence of taskscapes are broadly contemporaneous in my GIS analyses. As new ways of obtaining dates for these sites are discovered, or as more excavations are completed, this research and the data that is created can easily be updated to expand the analyses temporally.

For many of the rock art sites, most of the associated material (i.e. middens) is located only from ground survey and much of the potential context is potentially buried underneath the surface. (Even then, often the associated archaeology is not recorded for rock art surveys as it is considered secondary information, or has been placed into a different site record with no reference to its association to the rock art.) The issue would be alleviated by the full digitisation of all site records into a GIS format. Such an effort would be an intensive task with the tens of thousands of site records available for the Chumash region. What information is gleaned from site records is therefore considered a sample of the full information that is potentially available and in the future should be updated by local archaeologists with better knowledge of the sites. Using the same example discussed above, survey of Pinwheel Cave and the associated BRM site showed little evidence of surface artefacts during survey of the two sites. Robinson and Sturt (2008,39) excavated these two areas and found that while " examination of the surface around the BRM complex revealed little evidence for midden material, the quantity and range of artifacts recovered was surprising". Furthermore after also excavating Pinwheel Cave they found that "…the site was occupied to a much higher degree than surface finds alone indicated" (*ibid*, 34). While the Pinwheel Cave excavation is only the analysis for one rock art site, the evidence found here point to more extensive use of rock art sites not visible from surface survey. I must also trust the recorder of the site record and assume they surveyed the area thoroughly. Unfortunately, this is not often the case due to overgrowth during the spring and summer months and the time of day that one visits the sites.

In terms of the use of the ethnohistorically recorded village sites, again a contemporaneous relationship will be inferred. It is highly likely that if the rock had been created earlier than the village sites then the people who inhabited the village sites, or created the middens and BRMs (perhaps as hunting or gathering camps), would have known about rock art site locations through an assumed intimate knowledge of their landscape or simply from being nearby. Supporting evidence for contemporaneity can be found in analyses by Glassow et al. (2011, 54) which found that settlements within the Santa Ynez Mountains and inland into the Santa Ynez Valley were extensively occupied dating as far back as before 5,000 cal BP. It will also be inferred that the archaeological record would have been entrenched throughout time at varying degrees with their importance or use ebbing and flowing within the network. For example, Glassow (2002) found in his research of an occupation site called Punta Arena on the Channel Islands through radiocarbon dating that site occupation was not consistent, and exploitation of this area was based upon resource abundance directly related to environmental perturbations. The documented villages further represent, in this analysis, another aspect of the internal and integrated hierarchy that created the underlying structural relations inherent in my modification of ANT.

Next, while all efforts were made to create high-resolution environmental datasets reflective of past landscapes, this was not possible, as palaeo-environmental and palaeo-topographic information for this area does not exist. If it is available it is either created only for specific sites or at kilometre resolutions. As was stated before in Chapter 2, it is highly unlikely that the modern environmental variables present the whole 'picture' of the topography and environment that was present throughout the temporal scale of Chumash habitation. This thesis does not claim that these input variables are a direct representation of such a dynamic and ever-changing terrain. Therefore, as the analyses presented in this thesis are considered a heuristic tool to begin to understand the various networks the Chumash had with the rock art and their cultural landscape and geography, the modern environmental datasets are considered approximate representations of the past landscape used to open up discussions and make inferences about past, dynamic relationships.

6.6 Conclusion

This chapter outlined the methodologies used to collate the rock art site data, associated archaeological data and the environmental variables that were available. Furthermore, I outlined the various secondary datasets that were created for input into the various spatial analyses. I also covered the research questions and the analyses that will be performed for the data and presented the overall results of the database that was created. Finally, I presented the assumptions and inferences that needed to be made in order to perform spatial analyses for the rock art sites.

In addition, the data collated and described in this chapter provide the backdrop for the landscape and taskscape relations created through rock art and the associated archaeology representing the internal networks that were interwoven to create the Chumash interaction sphere. Rock art data will be interrogated through multi-scalar spatial analysis and my research questions to conceptualise and understand its relationship and potential reflection of the social, political, economic and ideological networks. Furthermore, I will study its association to Chumash landscape perceptions and how other associated features ebbed and flowed within the dynamic network structure. The environmental variables are an approximate representation used to study and compare their relationships with rock art and to compare to what has been written within the ethnographic literature about the personified environment. In the next three chapters, the research questions for each analysis type will be performed at multiple scales to further understand how rock art was entrenched within the overall cultural landscape networks of internal relation effects.

Chapter 7 Rock Art Site Cluster Analysis

7.1 Introduction

In this chapter, I begin with an exploratory and informal analysis of the rock art database at the regional scale. By using a form of intensity analysis, I begin the discussion on what is happening spatially with the rock art sites in terms of areas of clustering and pointing out areas of further inquiry and further survey. The rock art distribution is used to define space for analysis. It is the first step of understanding the Chumash interaction sphere outside of the modern and linguistic boundaries and to begin a discussion on the internal, entrenched networks that make up the Chumash landscape. A more significant analysis, Ripley's *K*-function is then utilised to show a multi-scalar analysis of the region, the various associated data and to extract a centimetre scale for regional analysis as outlined in Chapter 2 using the bifurcated motif and associated cupules. By using the outputs of the kernel density analysis to define the community scale, I begin to explore the various scales to explore the heterogeneous or homogeneous nature of the networks through the clustering or segregation of the data. Areas of clustering may point to the persistence of network relations between sites within the landscape and taskscape. In addition, the Ripley's *K* outputs may point to how rock art networks were interwoven within the interaction sphere through the extraction of the contextual and associated attributes. As outlined in the previous chapter, I wish to answer the following research questions:

1. **Where are the gaps in spatial and archaeological knowledge within the Chumash landscape and why?**
2. **Are there areas of spatial clustering or disbursement of sites and the associated data? Do these areas relate to the ethnographic information available, the distribution of the ethnohistoric village sites or the previously mapped linguistic boundaries?**
3. **How does this change at the various scales of analysis?**
4. **Based on associated cultural material and specific element/motifs types is there a potential pattern that reflects the ethnographic literature or cultural ideology and socio-economy?**

7.2 Kernel Density Estimation (KDE)

7.2.1 KDE Methodology

In order to being to spatially and visually study the areas of point clustering throughout the regional scale of analysis, a kernel density estimation analysis (KDE) (Silverman 1986) was performed on the entire rock art dataset. Kernel density estimation "…is a non-parametric technique in which a two-dimensional probability density function or the 'kernel' is placed across the observed data points to create a smooth approximation of its distribution from the centre of the point outwards" (Conolly and Lake 2006, 175). First introduced within archaeology by Beardah and Baxter (1995) and Beardah and Baxter (1997), this type of analysis has been used in a variety of ways within the discipline with positive results (see Bevan et al. 2013; Bevan and Wilson 2013). In this study, KDE was only performed at the regional scale due to its informality and used to identify patterns of reflective scale and define space for the community-scale of analyses. This analysis makes it easier for the user to interpret point clustering and visualise the gaps between the identified clusters within the chosen study area (Sayer and Wienhold 2013, 8). Baxter and Beardah (1997, 347, 351) state, especially when compared to a density analysis, that KDE provides a smooth visualisation of the data and is more reflective of real life distributions.

ArcGIS 10 KDE was used on the regional distribution of rock art site data. The analysis applies a quartic approximation of a Gaussian kernel and allows the search radius or bandwidth of the kernel to change (Sayer and Wienhold 2013, 8). The actual choice of the bandwidth is difficult to establish and can be a complicated process (see Fotheringham et al. 2000, 148-149) and in this analysis the outputs were visually assessed for their apparent 'spikes' or over smoothing that indicate an incorrect choice of radius. In order to begin to explore the data, multiple radii were chosen to explore the regional dataset at one, five, six, eight and ten kilometres were arbitrarily chosen to visually assess where the clustering of the various rock art sites were apparent. It should be noted that too large of a kernel value will cause the output to show a distribution that it too smooth, or an almost flat kernel, while too small of a kernel will cause the output to be 'spiked' and not reflective of the actual clustering of sites (Fotheringham et al. 2000). KDE is an important starting point to begin to understand the distribution of the sites and also understand the potential biases that may be reflected in the input data.

7.2.2 KDE Results

The results of the 1 kilometre KDE did not show anything of use as the radius was too small, and the output showed 'spikes' around the point locations (see Figure 7.1). Five and six kilometre results were more interesting and showed a distribution surface that can be analysed for general and exploratory patterns (see Figure 7.2 and 7.3). The distances of eight and ten kilometres are showing a more generalized smoothing that begins to cover the whole of the study area (see Figure 7.4 and 7.5). Therefore, the five kilometre outputs will be accepted as a good representation of the clustering of the rock art points.

Predominant clusters are immediately apparent on the Wind Wolves/San Emigdio Hills region associated with the Emigdiaño Chumash, the Sierra Madre Ridge/San Rafael Wilderness associated with both the Ineseño and Cuyama Chumash, the Carrizo Plain[9] associated with the Cuyama Chumash, the Santa Ynez Mountains and backcountry associated with the Ineseño Chumash and Simi Hills and Ventura County associated with the Ventureño Chumash[10]. Many of the results are likely associated with levels of past effort in rock art survey, but this is unavoidable. The Emigdiaño Chumash have been extensively surveyed by Robinson (2006), the Sierra Madre Ridge was studied in 1974 by Horne and Glassow and extended into the San Rafael Wilderness by Lee (1981), Grant (1965) covered much of the Santa Ynez Mountains and Ventura County along with many local rock art enthusiasts, Simi Hills was analysed by Romani et al. (1985; 1988) and the Carrizo Plain was surveyed by Johnson (1985) and W&S Consultants (Whitley et al. 2004; 2006). KDE potentially reflects not only prehistoric rock art patterns, but captures modern behavioural patterns present within the current landscape and is reflected through levels of effort

[9] The Carrizo Plain area was not included in this analysis as I did not receive permission to run a more localised analysis within this area. Further study should be included in future analyses.

[10] For the rest of this thesis, the community-scale areas will be mostly referred to as the geographic areas. This because of the potential overlap of these linguistic groups throughout time so that perhaps all groups at one point or another utilized these areas and the rock art.

by the archaeologists. Obviously this also presents a bias within the distribution, as areas where there are the most points have been studied for decades. I argue here though that these areas of clustering, if they are biased, present an opportunity for geographic samples to be used at the community or meso-scale of analysis.

Figure 7.1: Kernel density analysis for rock art sites at a 1 km kernel.

Figure 7.2: Kernel density analysis for rock art sites at a 5 km kernel.

Figure 7.3: Kernel density analysis for rock art sites at a 6 km kernel.

Figure 7.4: Kernel density analysis for rock art sites at an 8 km kernel.

Figure 7.5: Kernel density analysis for rock art sites at a 10 km kernel.

One of the most notable reasons for large gaps in the research is from expansion of urban areas and areas of private land ownership within the Chumash geographic area. Los Padres National Forest is an area legally protected by the US government and as such does not allow development on its lands. The Wind Wolves Preserve and Vandenberg Airforce Base also do not allow development, as currently they are protected areas because of private ownership and under US government security respectively. Therefore rock art located in areas owned by these land-holding organisations are protected and preserved to the best of their abilities and monitored by professional archaeologists and volunteers. Places of private ownership, such as the vast ranches, that are distributed across this region (see Figure 7.6) have in many instances prohibited archaeological survey. For example, in Kern County, where part of Los Padres National Forest and all of the Wind Wolves Preserve are located, was first settled in the 1840s by the Spaniards and in the 1880s by the Americans (see Shier 2011). The private ownership of the land by the same families has been continuous in many of these parts, so rights to survey are at the discretion of the landowner. Finally urban development within these areas has also subjected the rock art to destruction, especially in the past, or the movement of cupule boulders due to the inability of people to recognize them for being part of the archaeological record.

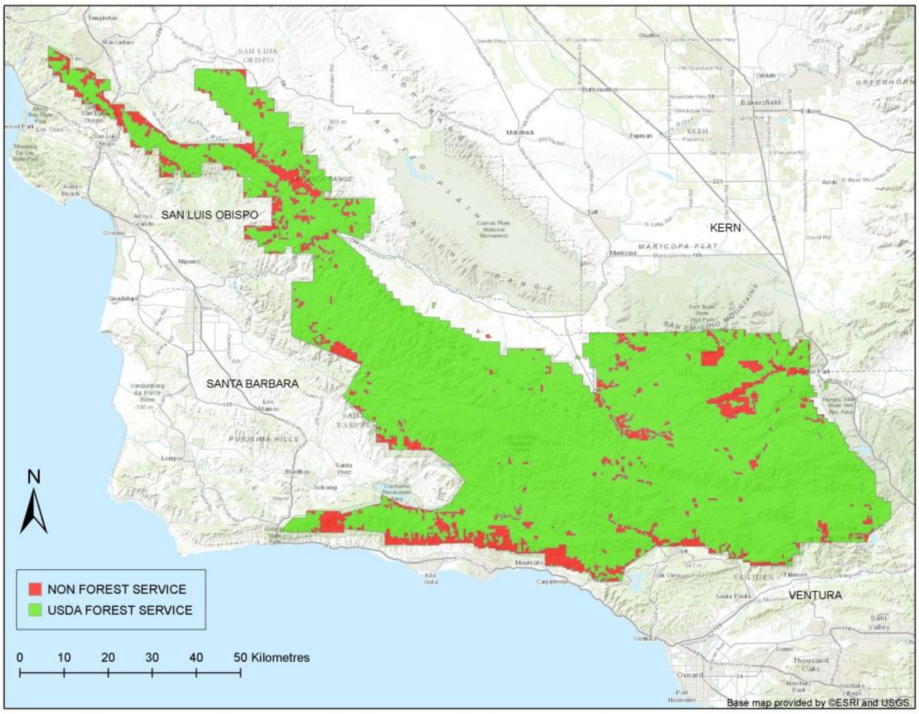

Figure 7.6: Map of areas of non-forest service and forest service land within Los Padres National Forest. The non-forest service land (in red) would only be allowed for survey through the owner's permission.

Culturally, there is a gap in this distribution that is of importance when dealing with the ethnographic record. The areas of Mount Pinos and Frazier Mountain were considered very important and sacred geographic areas within the Chumash ideology. Furthermore, the area of Cuddy Valley to the North of these peaks was also considered religiously important place (see Figure 7.7) named after the important group the *'antap*. Hudson and Underhay (1978, 40-41) describe this through data extracted from J.P. Harrington's notes as:

> Mountaintops were also locations at which power might be concentrated, and by far the two most important to the Chumash were the sacred peaks of *'Iwɨhiɨnmu* (Mount Pinos) and *Toshololo* (Frazier Mountain), for they were located near the very center of the Middle World, the sacred plain called *'Antap* (Cuddy Valley). When darkness came, it was believed that the spirits lit their fires at this sacred spot and began to dance.

Maria Solares, one of Harrington's most important informants described events of a supernatural origin *'Iwɨhiɨnmu* that frightened visitors (Blackburn 1975). She also spoke of it being "…the most sacred of all places in the Chumash country" (*ibid*, 41).

Figure 7.7: Map of rock art distribution and areas of known importance to the Chumash through the ethnographic literature, Mount Pinos, Frazier Mountain and Cuddy Valley.

If I overlay the clusters of village sites again at five kilometres, again there is a 'hole' within the data (see Figure 7.8). Here we can see that it may be an important area of exclusion based upon the descriptions above from J.P. Harrington's informants. Archaeologist Dan Reeves conducted surveys of these areas and found only hunting camps and no rock art (Reeves pers comm. 2012). Perhaps rock art was not allowed based on the religious and sacredness of this area. The areas of overlap point to the fact that the ethnohistoric villages and rock art sites had overlap in terms of Euclidean distances. While this does not take into account the cost of moving throughout this diverse and oftentimes extremely rough landscape, it begins to show potential for a connectedness of the Chumash interaction sphere. It may also relate to the connectedness of specific political provinces or religious territories described by Hudson and Underday (1978).

Figure 7.8: Map of rock art distribution, ethnohistorically documented villages and areas of known importance to the Chumash through the ethnographic literature, Mount Pinos, Frazier Mountain and Cuddy Valley.

By studying the rock art within the areas of clustering, I can begin to outline the potential these areas have for further analysis. The areas were determined using all values of the KDE output and not just the areas designated as 'hot spots' represented in the map in burgundy. This enabled me to have a large enough sample for further analysis. First, the points within the Sierra Madre Ridge/San Rafael Wilderness (see Figure 7.9) were extracted. There were a total of 63 rock art sites found within this area, and a break down of the types of rock art and the associated data are below in Figure 7.10. Thirteen of the sites had no associated archaeology making up only 21% of the total sites, and only one of sites was a stand-alone cupule site.

Figure 7.9: Sierra Madre/San Rafael KDE cluster at a 5 km kernel with rock art sites.

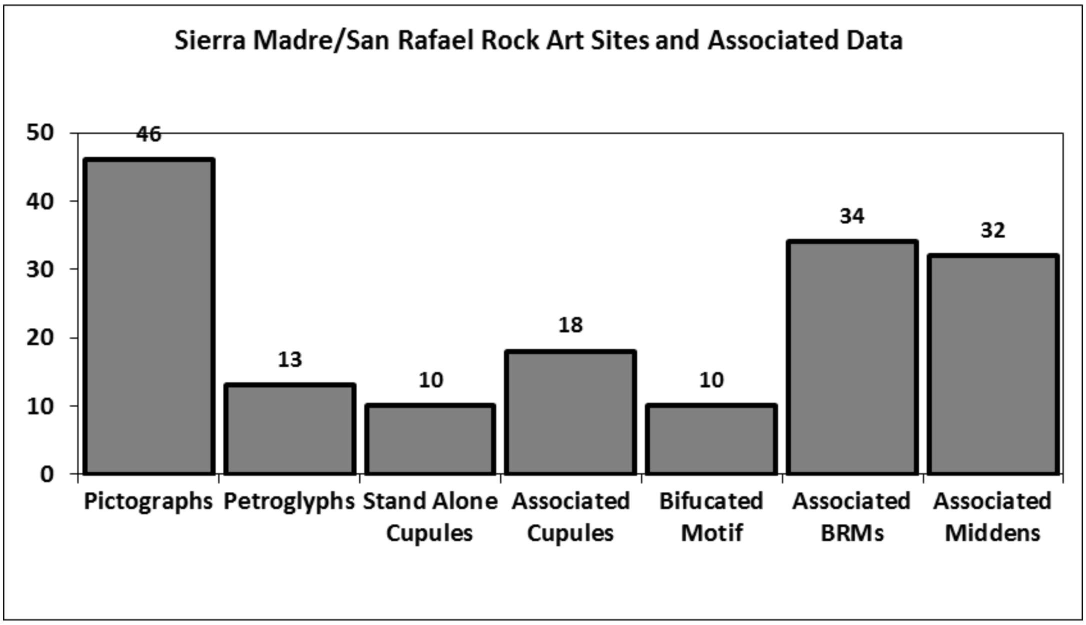

Figure 7.10.: Graph of the rock art site types and associated data found within the contour extracted from the KDE for the Sierra Madre Ridge/ San Rafael Wilderness.

As was stated earlier, the area of the Sierra Madre Ridge area has been significantly surveyed and studied by Horne and Glassow (1974) and further though associated ethnohistoric sites by Horne (1981). In his analysis he studied the catchment of an ethnohistoric village site known as *Hawamiw* (*ibid*, 124) (Figure 7.11) and described a seasonal schedule for the hunter-gatherers that lived at this site. *Hawamiw* was considered the primary base camp for the people that resided here and was home to the entire population during the winter months, depending on stored foods (Horne 1981). During the spring and summer months, the populations would become fragmented as people left to occupy different environments for other resources while others would stay behind (those that were unable to make the trek) to forage within the home radius (*ibid*). The autumn would see people gathering at specific areas within the environment to gather and process food such as acorns for winter storage (*ibid*).

The rock art sites found here fall within this catchment and beyond in what Lee (1981) found to be an area of stylistically similar Chumash pictographs with no apparent outside influences. There are six ethnohistorically documented village sites located in this KDE area, so perhaps these villages also used this area. There are six ethnohistorically documented village sites located in this KDE area, so perhaps these villages also used this area and could be an indicator of a connectedness here between the villages and rock art that needs to be further explored. Within this area, the rock art sites have a large proportion with associated middens (n=32) and BRMs (n=34) (Figure 7.10). This may point to the location of the seasonal camps discussed by Horne (1981), and in terms of the BRMs, areas of food processing or taskscapes as described by Robinson (2006). The bifurcated motif is present here (n=10) again showing its ubiquitous nature, while associated cupules (n=18) are even more common at the rock art sites for the centimetre scale of analysis. Finally *Sapaski* (or House of the Sun), one of the few more notable rock art sites, is found within this area and has the largest group of BRMs of all rock art sites within the area (see Figure 7.12).

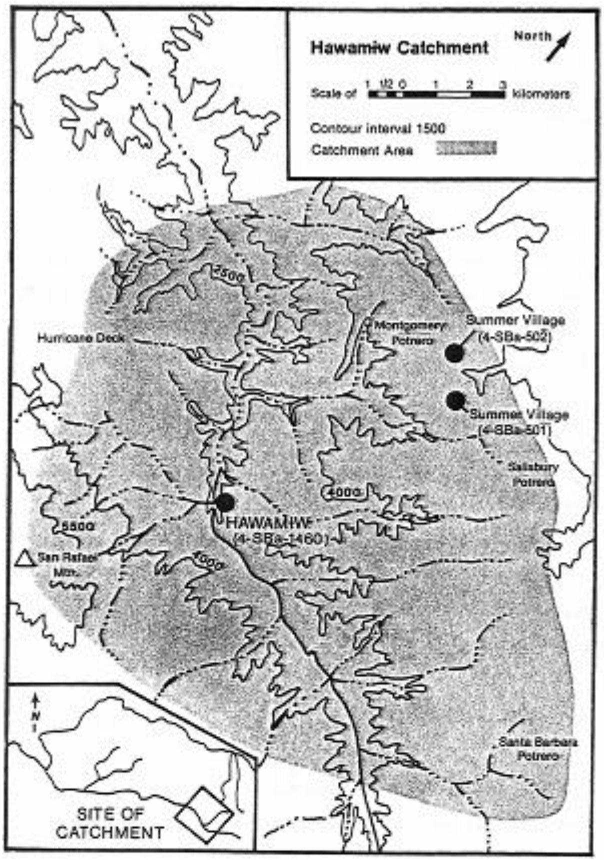

Figure 7.11: *Hawamiw* catchment area defined by Horne (1981, 139, Figure 13).

Figure 7.12: A selection of *Sapaski* rock art (Robinson 2006, 72, Figure 2.47).

Next the clustering around the Santa Ynez Mountains and backcountry showed less concentrations of rock art, and sites were mostly pictographs (n=19) out of the total of 24 rock art sites (see Figure 7.13 for an example) (see Figure 7.14 and Figure 7.15 for the results for the analysis). In total there were two sites with petroglyphs, five cupule sites, three sites with associated BRMs and five with associated middens. There were 16 sites with no BRMs or middens constituting 67% of the total sites and one of these sites is a stand-alone cupule boulder. At the centimetre scale the bifurcated motif (n=6) was found more often than the associated cupules (n=2). As was outlined earlier, the substantial coastal populations are hypothesised to be the centres of wealth within the Chumash population and were in charge of distributing the wealth throughout that network. Populations would have traversed the Santa Ynez Mountains in order to reach the inland and interior populations or coastal populations to enhance the trade networks or attend the large feastings. The networks would have brought goods from the interior and goods such as shells would have been exported out.

Located in this area is one large ethnohistoric village called *Shnaxalyiwi* that was known during historic times to have a chief (Johnson 1984). Only the largest residences had chiefs and some more than one (*ibid*). Johnson (*ibid*) also identifies another large site in the backcountry to also have a chief, but it is located outside of the KDE cluster, called *Stuk.* Its location falls to the north near the Sierra Madre/San Rafael cluster. Johnson (*ibid*) also notes though that two other villages, *Shniwax* and *Wishap,* within this cluster were documented in the mission registry to supply chiefs for the coastal villages (Figure 7.16). Johnson (1988) also ran an analysis based on a hypothesis suggested by King (1976) that stated there were stronger economic and marriage networks between areas of differing environmental variables based on demand. Johnson (1988, 261) used regression analysis to "test a tendency for marriages to fortify economic exchanges". Results from his analysis show that there was a trend for marriages between the coastal villages and the villages within the Santa Ynez Valley to have a higher frequency across different ecological zones (*ibid*, 261). Therefore, at least in historic times, this area was important not only for trade but for social and marriage alliances to strengthen the overall cultural network. This area, as was stated before, has been left out of the overall literature from studies on the coastal villages but could be argued as a central area for connectivity to the inland

and interior regions. Finally, more formal survey within the backcountry needs to be done comparable to places such as the Carrizo Plain, the Sierra Madre Ridge and the Wind Wolves Preserve to shed more light on the rock art and archaeology in this area (Robinson 2011).

Figure 7.13: CA-SBA-1652 rock art site located in the Santa Ynez Mountains and backcountry community- scale. Photo by Rick Bury from the Los Padres National Forest archives.

Figure 7.14: Santa Ynez Mountains and backcountry KDE cluster at a 5 km kernel with rock art sites.

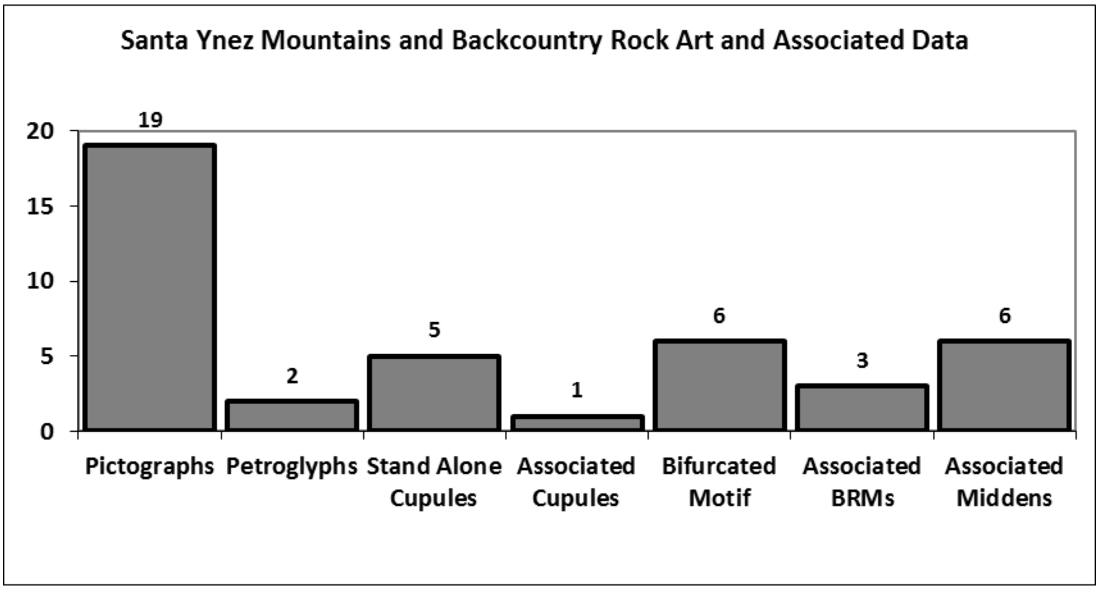

Figure 7.15: The Santa Ynez Mountains and backcountry rock art and associated data extracted through the KDE.

Figure 7.16: Santa Ynez Mountains and backcountry KDE clustering with important ethnohistorically documented village sites.

The Simi Hills and other rock art located within modern day Ventura County are the next area to be investigated (see Figure 7.17 and 7.18 for KDE results). One of the most predominant sites in this area is that of Burro Flats. As described earlier in this thesis, this area was originally 15 sites, but today is being recorded as a single site (CA-VEN-1072) with 15 loci (see Figure 7.19). Caution must be taken in the analysis at this site because recording this area as multiple panels has potentially reduced the level of information of associated material. The whole site refers to associated BRMs and middens, but their location is not always clear in the site records or maps. NASA currently owns this area and access to the site is limited. As Knight (2012, 262) states, the excavations within this area in the 1950s produced a wealth of artefacts and ecofacts (although information concerning their location/curation is currently unknown). Further research by Romani et al. (1985), and then by NASA (2010), also state the significance of the associated archaeological data. Furthermore this site was hypothesised to be of ceremonial significance in terms of archaeoastronomy (Romani et al. 1988). To the SE of this KDE cluster, there is also a large settlement called *Huwam* that was reported to be of cultural importance by Romani (1981) as a place for the winter solstice ceremonies and further tied to the coastal populations through trade with *Humaliwu* or present day Malibu (Figure 7.20).

Overall the Simi Hills and Ventura County data have 23 pictograph sites and the presence of only four petroglyphs (Figure 7.17 and 7.18). At the centimetre scale there were more associated cupules than bifurcated motifs (n=1). Associated archaeological data had 15 middens, but only 7 BRM sites. Again these sites show a similarity to the Santa Ynez sites in the fact that there are many pictograph sites but very few BRM sites. Eleven sites had no associated archaeological material making them 48% of the total sites located in this contour and only one of these sites was a stand-alone cupule site. Less evidence of processing food here could point to a more ceremonial aspect to these sites as suggested by Romani et al (1988) and may point to the Santa Ynez area as having a similar function. The presence of a considerable number of middens could reflect areas of inclusion for more of the population than just the shaman on a vision quest.

Figure 7.17: The Simi Hills and Ventura County KDE cluster at a 5 km kernel with rock art sites.

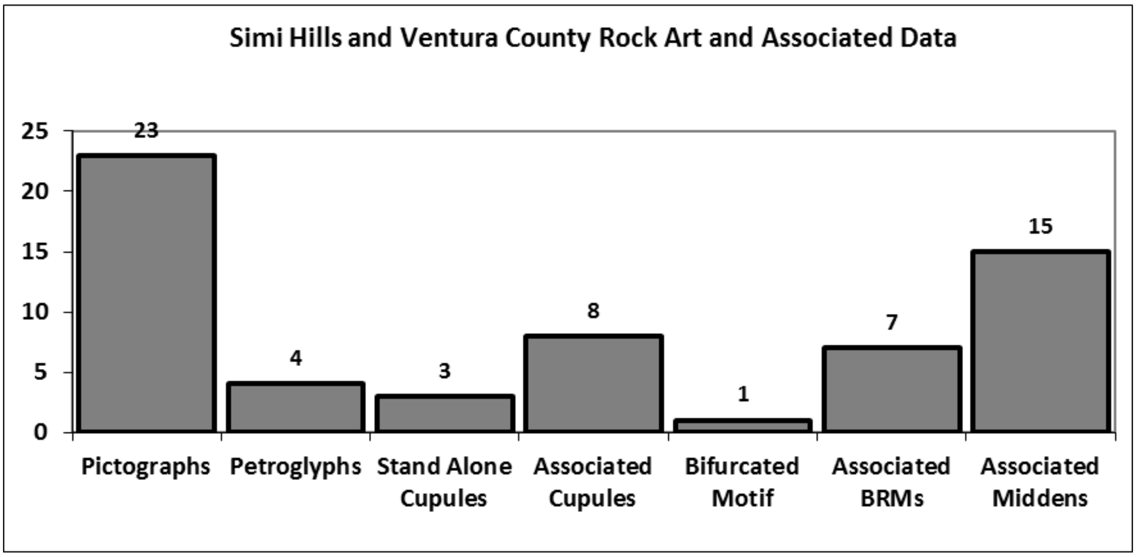

Figure 7.18: The Simi Hills and Ventura Country rock art and associated data from the KDE analysis.

Figure 7.19: Pictograph panel at Burro Flats rock art site. Photo by Clive Ruglles.

Figure 7.20: Simi Hills and Ventura County KDE clustering with important ethnohistorically documented village sites.

The Wind Wolves Preserve showed continuous clustering within the KDE results (Figure 7.21 and 7.22). This area is still being extensively surveyed and studied by Robinson (2006), and the results have proven new ways to spatially study rock art within the landscape and taskscape. Although much is already written in this thesis about the studies involved at the Wind Wolves Preserve, there are a few points that can be made here. As was stated earlier all of the major K-locales (sites with 18 or more BRMs) were associated with rock art sites. While Robinson (2006) found 55 sites containing one to 17, or less BRMs, the sites were never associated with rock art (*ibid*). Furthermore, during his survey, he was able to locate many of the major ethnohistoric village sites, none of which had associated rock art (*ibid*). The most important settlements in this area are *Tashlipun* and *Malapwen* and are included within the KDE analysis of rock art site clusters (Figure 7.23). The inhabitants of these settlements would have probably utilised these rock art areas for processing food and seasonal camps based on the high numbers of associated BRMs (n=28) and the occasional occurrence of associated middens (Robinson 2011). Overall there are 19 sites that had pictographs present, five sites with petroglyphs and 27 stand alone cupule sites. At the centimetre scale there are ten sites with associated cupules, but only three sites with the bifurcated motif present. Its presence though is duly noted in all areas of study. Finally 20 sites within this area had no known associated archaeology with seven of these sites stand-alone cupule boulders.

Figure 7.21: Wind Wolves Preserve KDE cluster at a 5 km kernel with rock art sites.

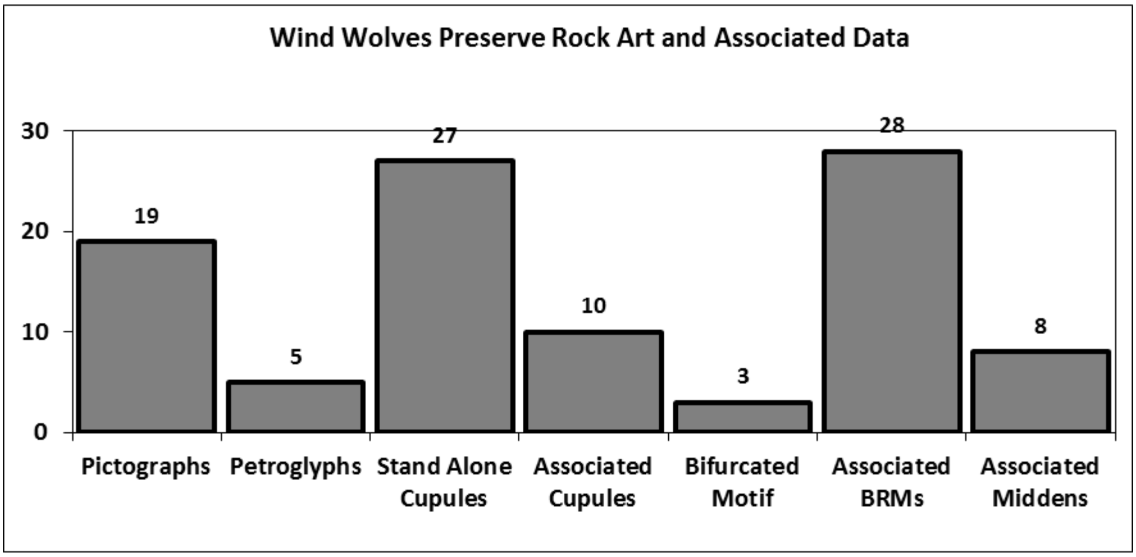

Figure 7.22: The Wind Wolves Preserve rock art and associated data extracted from the KDE analysis.

Figure 7.23: The Wind Wolves Preserve KDE clustering with important ethnohistorically documented village sites.

A more formal means of analysis, the Ripley's *K*-function, will be applied to study the inherent clustering or segregation of the rock art data at multiple scales in the next section.

7.3 Ripley's *K*-function

7.3.1 Ripley's K-function Methodology

Ripley's *K*-function (Ripley 1976; 1977; 1981) is a way to analyse the clustering or dispersal of point patterns at multiple scales simultaneously (Conolly and Lake 2006, 166) and was first introduced into archaeology by Orton (2005) and further expanded upon by Bevan and Conolly (2006). Ripley's *K*-function analysis has been applied in the past to archaeological point datasets with success (for artefact distribution see Orton 2005; Markofsky 2013; for site distribution see Bevan and Conolly 2006 and Winter-Levneh et al 2010; for burials see Sayer and Wienhold 2013). In the more commonly applied point pattern analysis, Nearest Neighbour (see Conolly and Lake, 2006), outputs are static and at a single scale, while Ripley's *K* is inherently dynamic through its multi-scalar output. Ripley's *K* is also not dependent upon the shape of the study area nor does it influence the results, while in contrast, Nearest Neighbour is highly dependent and influenced by the shape of the study area (*ibid*). Archaeological and environmental data are comprised of many scales as discussed in Chapter 3 so that as one 'zooms in' from the regional- to the community- to the site-scale different patterns emerge. Ripley's *K* is very applicable for these datasets to detect patterns that aren't visually obvious through simply plotting the point distribution or using the KDE described earlier. Furthermore, Ripley's *K* produces statistically significant results by the use of Monte Carlo simulation through the application of "repeated random samples" (Conolly and Lake 2006, 161).

The *K*-function is defined "for a process of intensity λ, where λ*K*(*d*) is the expected number of neighbours in a circle of radius *d* centred at an arbitrary point in the distribution" (Ripley 1977; Pelissier and Goreaud 2001,101). In the *K*-function the expected value for the Poisson distribution equals one, which makes the output parabolic, so that the data and the upper and lower confidence intervals directly increase (Sayer and Wienhold 2013, 7). Interpretively this can be problematic so a common translation, called the *L*-function, is often applied. In the *L*-function, the null hypothesis equals zero instead of one so the results are more intuitive (*ibid*). The *L*-function is defined as:

$$L(d) = \sqrt{\frac{K(d)}{\pi - d}}$$

(Bailey and Gatrell 1995, 94).

where $L(d) < 0$ it indicates segregation within the dataset, $L(d) = 0$ is complete spatial randomness, and $L(d)>0$ indicates clustering within the dataset (Pelissier and Goreaud 2001,102). Within this analysis, 1000 permutations were used through Monte Carlo simulation to establish the confidence intervals and test for significance for $p<0.01$. Therefore, when "$L(d)>0$ falls above the upper confidence intervals then there is statistically significant clustering, when $L(d)=0$ there is complete spatial randomness and when $L(d)<0$ falls below the low confidence interval there is segregation of the data" (Sayer and Wienhold 2013, 8).

Using both the maptools and spatstat libraries in R the following was applied after importing the rock art database into the program:

envelope (x, fun=Lest, nsim=1000,correction="Ripley", rank=1, global = TRUE) where the process is run under a simulation envelope, *x* is the object containing the database being analysed, *Lest* is the *L*-function, *nsim* is the number of permutations simulated by the program, *rank* is the envelope value among the simulated values (rank of 1 means that the minimum and maximum simulated values will be used), the edge correction called up is "Ripley" for isotropic, polygonal or square windows and *global* indicates a simultaneous confidence band (Baddeley and Turner 2005).

Ripley's *K* is robust due to its multi-scalar design, but one important issue with the analysis is the assumption that the input datasets are both homogeneous and isotropic (Orton, 2005, 5). Archaeological data are heterogeneous and oftentimes anisotropic, or based upon directional movement, so therefore specific information must be extracted to pursue both homogeneity and isotropy. Data are therefore tested for all rock art sites at the regional scale to begin, but specific attribute and associated information is extracted from the database as was presented in the previous chapter (i.e. bifurcated motif, sites with associated middens, pictographs, etc.) to being to study the potential clustering/aggregation of the dataset (as recommended by Bevan and Conolly 2006). Furthermore, using the results for the KDE, I am able to begin to break the analysis down into community-scales of analyses and extract information to study the multi-scalar patterns for the rock art. Using the areas of clustering, I am able to present the data visually to again understand rock art placement within the landscape.

7.3.2 Ripley's K-function Regional Results

At the regional scale the data was run for all of the data and extracted information presented in the methodology section:

1) All Rock Art
2) Pictographs
3) Petroglyphs
4) Rock Art with Associated Middens
5) Rock Art with Associated BRMs
6) Rock Art with Associated Cupules
7) Stand-Alone Cupule Sites

8) Rock Art with No Associated Archaeology

First the analysis was run on the whole rock art database at all spatial scales (see Figure 7.24). Results show that the observed value for *L* shows clustering immediately as it continually increases in distance (*r*) outside of the confidence intervals shown in grey. The clustering/aggregation of these sites reflect the heterogeneity of the landscape. According to Orton (2005, 7) when the outputs of the *K*-function show a "strong aggregation at large scales for all of the classes, a clear indication of spatial inhomogeneity in the data, and an indication that the space should be divided for finer-grained analysis". Considering that archaeological data are inherently heterogeneous, and the Chumash landscape covers an expansive spatial geography with complex local processes and activities, this is not surprising for the Chumash landscape. The aggregation showing heterogeneity within the data has been found to be misunderstood in the archaeological literature (see such errors in Winter-Livnet et al.'s (2010) study), so it is important to note that its output is considered a way for researchers to begin to think about the other contributing, complex processes for the spatial distribution of their data. The analysis at the regional scale but through the extraction of specific traits and associated data at the sites also shows the clustering or aggregation continues as the distance or scale increases (See Appendix D for the outputs of the first analysis). Importantly, with this set of regional data there were two classes that did deviate from the tendency to strongly cluster at all scales which I will further discuss here.

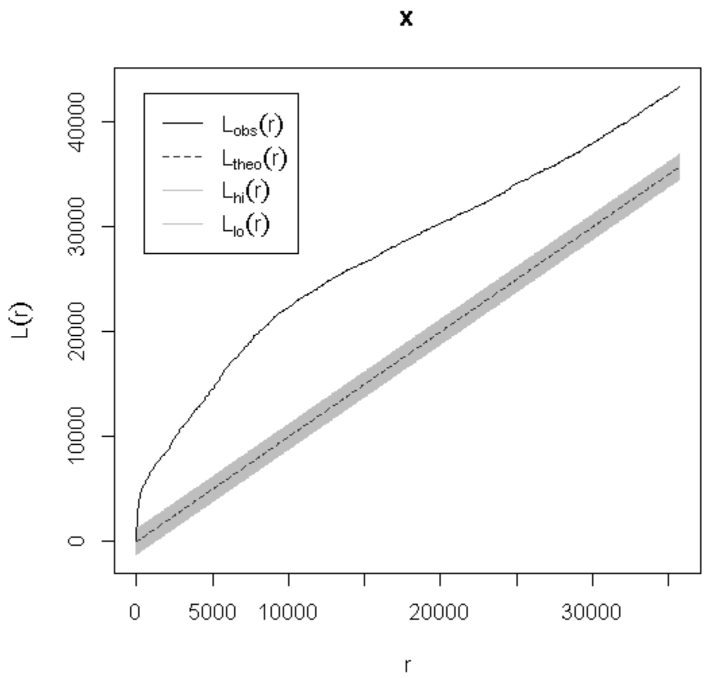

Figure 7.24: The output of the Ripley's *K*-function analysis at the regional scale for all rock art sites. The solid black line represents the observed *L* and the grey area represents the confidence intervals on either side of the dashed line that is the theoretical *L* of complete spatial randomness.

First, the bifurcated motif was found to have complete spatial randomness (see Figure 7.25). In all studies of this type, the null hypothesis would be complete spatial randomness of the data. The output is interesting as the placement of these motifs within the landscape was considered random and did not exhibit any clustering or regularity as the scale increased. It may potentially reflect that the placement of the bifurcated motif was more at the discretion of the individual artists and their mobility. Its ubiquitousness may reflect a template of a particular cultural ideology spread across the landscape, but one that was not placed in areas relative to other bifurcated motifs to create clustering nor at specific distances to show regularity. Their placement in the landscape could also be a reflection of the heterogeneity instead of the environmental context in which they are placed (e.g. geology, water) or the topography and is reflected in the analysis (Bevan and Conolly 2006). Therefore, the locations of the bifurcated motif were not as dependent on the other bifurcated motif locations, but rather their locations are a reflection of some environmental or cultural context.

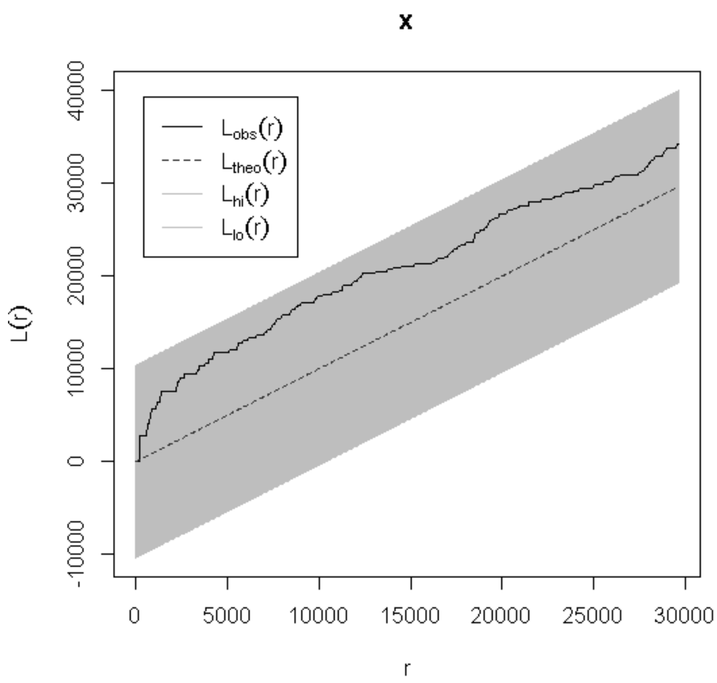

Figure 7.25: The output of the Ripley's *K*-function analysis at the regional scale for the bifurcated motif.

Second, petroglyphs (see Figure 7.26) were clustered at 2.5 kilometres until about 20 kilometres. Clustering is shown where the black line rises above the confidence intervals showing a change at that distance from complete spatial randomness. Considering that there are much fewer petroglyphs compared to pictographs, their placement within the landscape may have been more deliberate or intentional.

Finally, the ethnohistoric villages were analysed to understand and compare their distribution to rock art (Figure 7.27). The sites showed significant results for clustering after 12 kilometres. The output shows that during historic times there was statistically significant clustering of ethnohistoric village sites at scales over 12,000 metres. This clustering is important because it has been hypothesised within the literature that these sites were parts of large networks across the Chumash region strengthened by marriage ties and socio-economic alliances (Johnson 1988; Gamble 2008). There is more homogeneity for ethnohistoric village site placement when compared to rock art placement. Rock art placement therefore reflects more heterogeneous processes and a heterogeneous environment/topography.

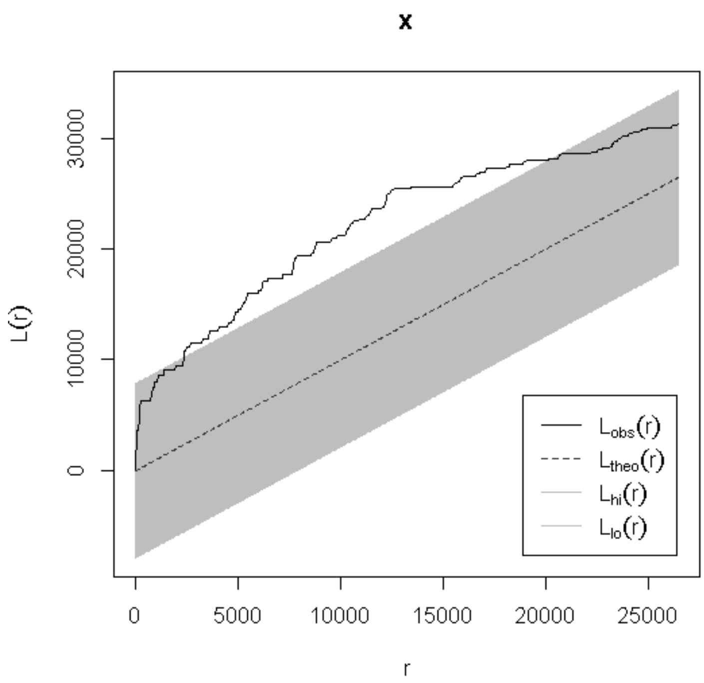

Figure 7.26: The output of the Ripley's *K*-function analysis at the regional scale for petroglyphs.

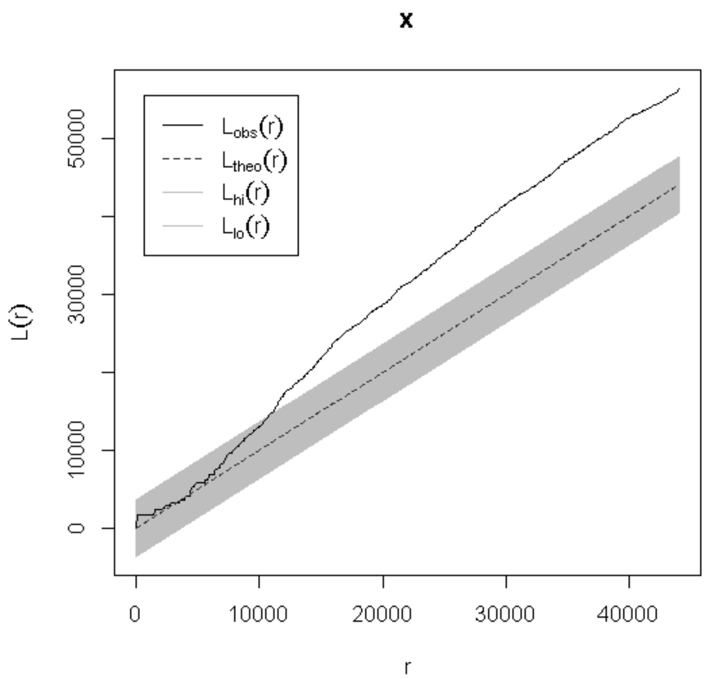

Figure 7.27: The output of the Ripley's *K*-function analysis at the regional scale for ethnohistorically documented village sites.

Overall the rock art results show that further analysis is required. Bevan and Conolly (2006, 229) make several suggestions on how to proceed when there is linear aggregation within the data such as using local density estimations or extracting out data based on specific environmental characteristics. Therefore, the outputs of the

KDE analysis will be used to extract the clusters of points that may potentially point to areas of more homogeneity.

7.3.3 Ripley's K-function Community Results

In order to extract point clusters, the KDE outputs were converted into contours and used to select out the rock art data that fell within the contour. Thus, these areas define the community-scale. While these areas do point to potential survey efforts as described above, they do provide a good set of samples for further analysis. Specifically, since many of these areas have been extensively studied, I have a more complete record to analyse and enough input points to extract associated data when possible (NB: due to the nature of Ripley's *K*-function analysis some areas did not provide enough associated data at that scale for the comprehensive list of attributes and associated data listed above to be exhausted). The survey areas were as follows, as described above: Sierra Madre Ridge/San Rafael Wilderness, the Wind Wolves Preserve, Santa Ynez Mountains and backcountry and the Simi Hills (see Figure 7.2 above).

The Sierra Madre Ridge/San Rafael Wilderness area results produced statistically significant clustering for all of the rock art sites from 200 metres to roughly 1.9 kilometres and then indicated complete spatial randomness (see Figure 7.28). The output shows that overall the sites were intentionally clustered in relation to one another at a spatial distance range of 1.6 km. Pictographs also showed clustering between 500-550 metres, again at 1-1.9 km and finally at 4-4.2 kilometres (Figure 7.29). Stand-alone cupules sites showed slight or spatially limited clustering at 2-2.1 km (Figure 7.30). Aggregation at these scales for the sites potentially indicates areas of intentionality of site placement perhaps with reference to localised resources or they could be territorial areas either in terms of the artist or family groups of gatherers. The rest of the analyses found complete spatial randomness for the bifurcated motif, associated cupules, associated BRMs, associated middens, no associated archaeology and petroglyphs (Appendix D). Again, this may be a reflection of the heterogeneous environment and topography in which they were placed or based on social views. With more areas of clustering found for three of the analyses, the results point to the fact that this area could have been a territory, especially based on the stylistic consistency found by Lee (1981) or even as a catchment area described by Horne (1981).

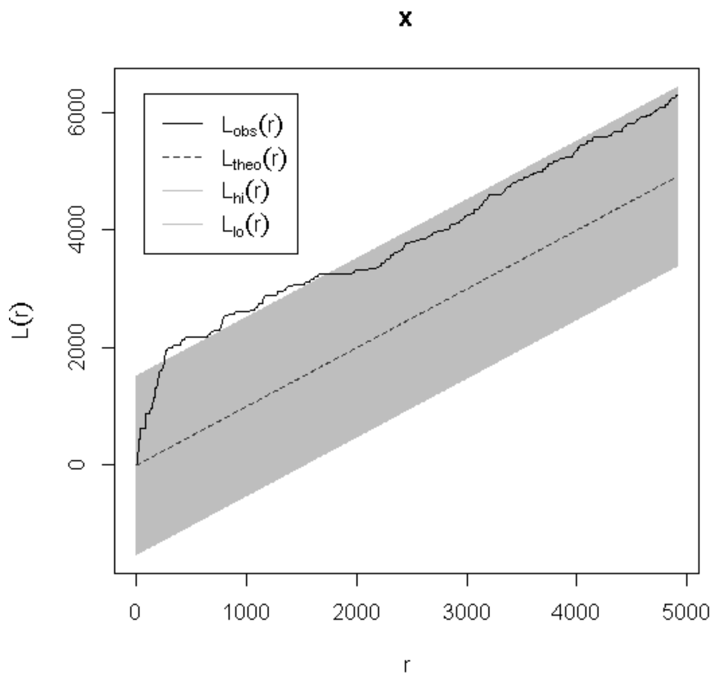

Figure 7.28: The output of the Ripley's *K*-function analysis for the Sierra Madre/San Rafael community-scale of analysis for all recorded rock art sites within the area.

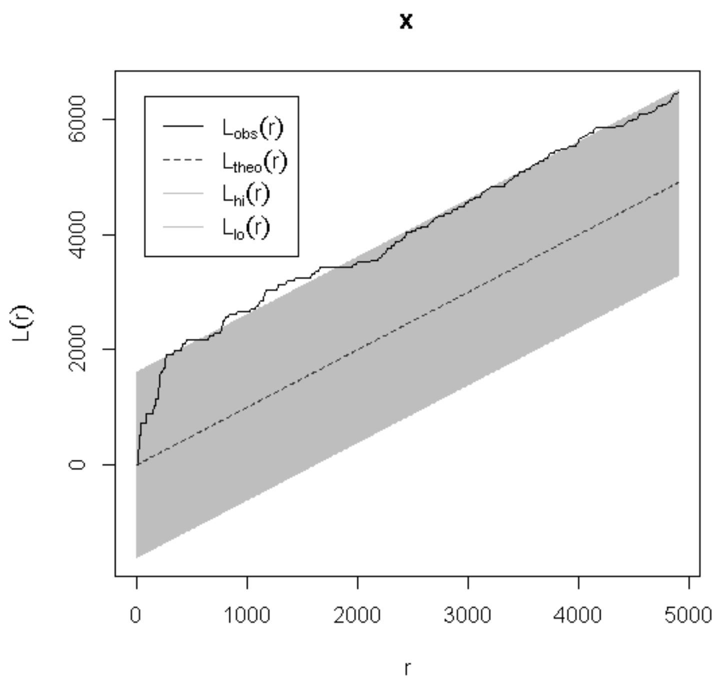

Figure 7.29: The output of the Ripley's *K*-function analysis for the Sierra Madre/San Rafael community-scale of analysis for all recorded pictographs within the area.

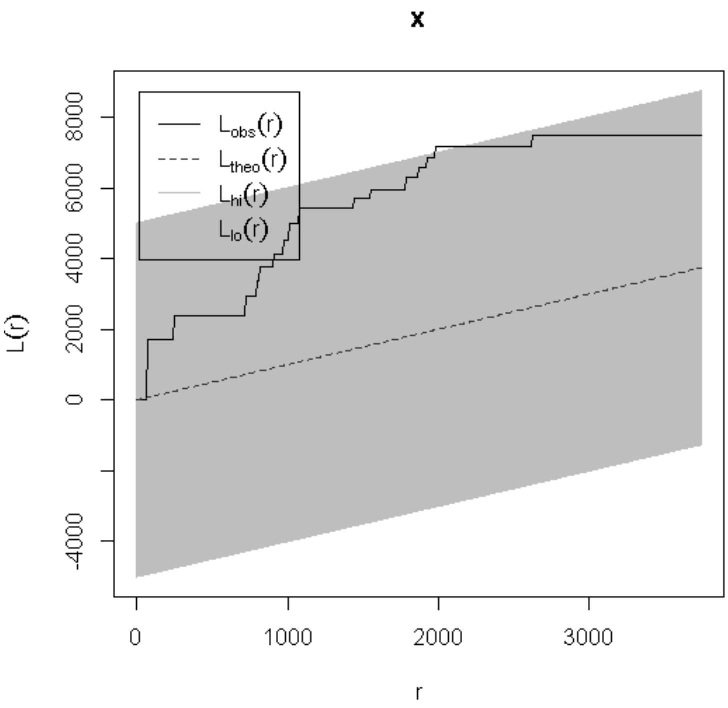

Figure 7.30: The output of the Ripley's *K*-function analysis for the Sierra Madre/San Rafael community-scale of analysis for all recorded stand-alone cupule sites within the area.

For the Santa Ynez Mountains and backcountry, only the total rock art data, pictographs and sites with no associated archaeology have enough numbers to run a full analysis. Both results fell within the confidence intervals and were close to complete spatial randomness (Figure 7.31, 7.32 and 7.33). Again this could be a reflection of underlying heterogeneity potentially based upon either the varying environments or topography in which they are placed or specific socio-economic processes or beliefs. As such, further analysis needs to be done to investigate these potential relationships. While the analysis was tested on the other associated data, the resulting outputs contained warning errors due to the low sample size.

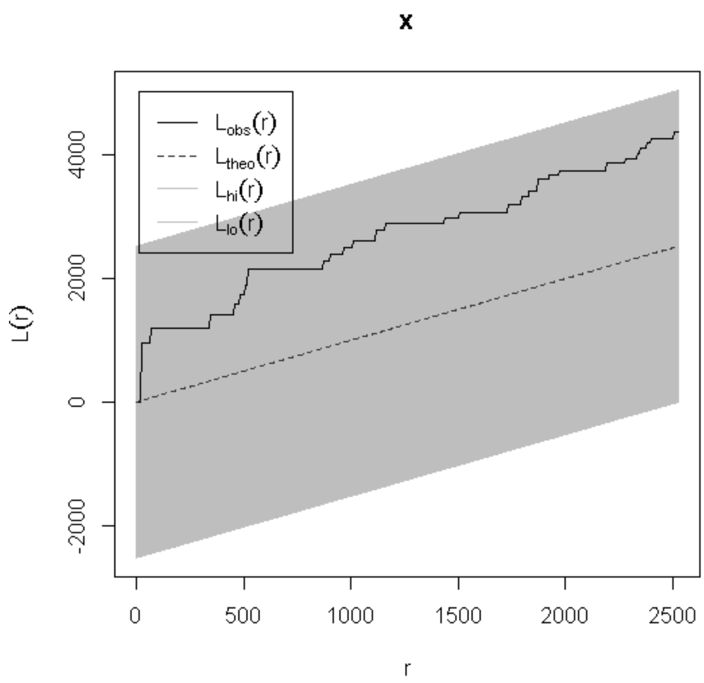

Figure 7.31: The output of the Ripley's *K*-function analysis for the Santa Ynez Mountains and backcountry community-scale of analysis for all rock art sites within the area showing complete spatial randomness.

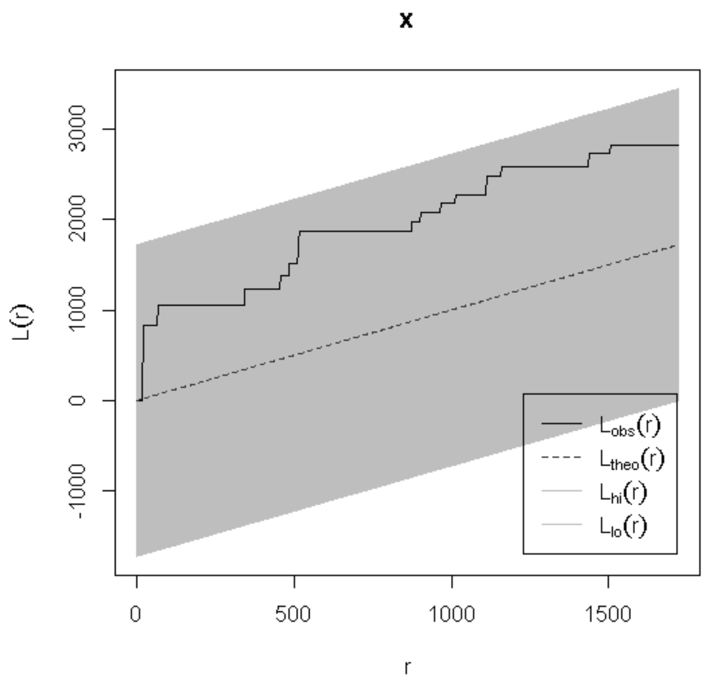

Figure 7.32: The output of the Ripley's *K*-function analysis for the Santa Ynez Mountains and backcountry community-scale of analysis for pictographs within the area showing complete spatial randomness.

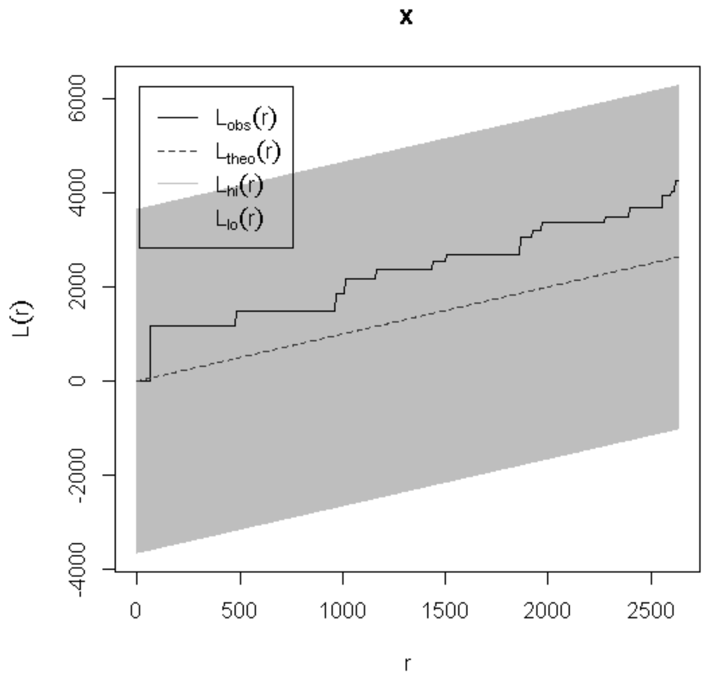

Figure 7.33: The output of the Ripley's *K*-function analysis for the Santa Ynez Mountains and backcountry community-scale of analysis for all rock art sites with no associated archaeology within the area showing complete spatial randomness.

The Simi Hills and Ventura County site area showed significant clustering for all rock art sites from 100 metres to 4 kilometres could represent some intentionality for site placement near other rock art sites (Figure 7.34). Burro Flats could be a result of the low scale clustering, as there are 15 loci within a relatively short distance of one another, but because the clustering continues until 4 kilometres, it is safe to say that it is not causing too much undue influence. Pictographs were also clustered from 100 metres to 1.8 kilometres and then experienced a slight aggregation from 2.5-2.6 km (Figure 7.35). Data with no associated archaeology showed clustering after 100 metres and continued showing heterogeneity even at the community-scale (Figure 7.36). Complete spatial randomness was found for associated middens and associated cupules while the rest of the data did not have enough data to produce significant results (Appendix D). Again, this output needs to be further explored in terms of other environmental features present within this area.

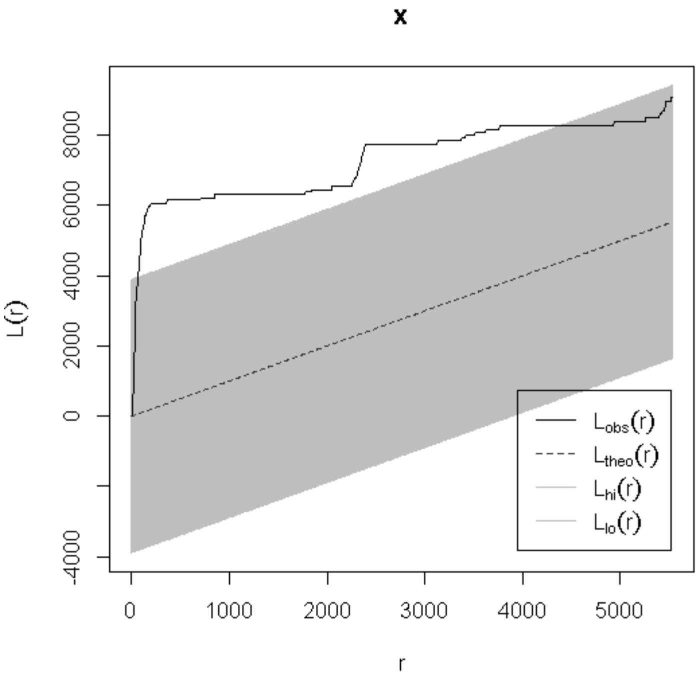

Figure 7.34: The output of the Ripley's *K*-function analysis for the Simi Hills/Ventura County community-scale of analysis for all rock art sites within the area showing complete spatial randomness.

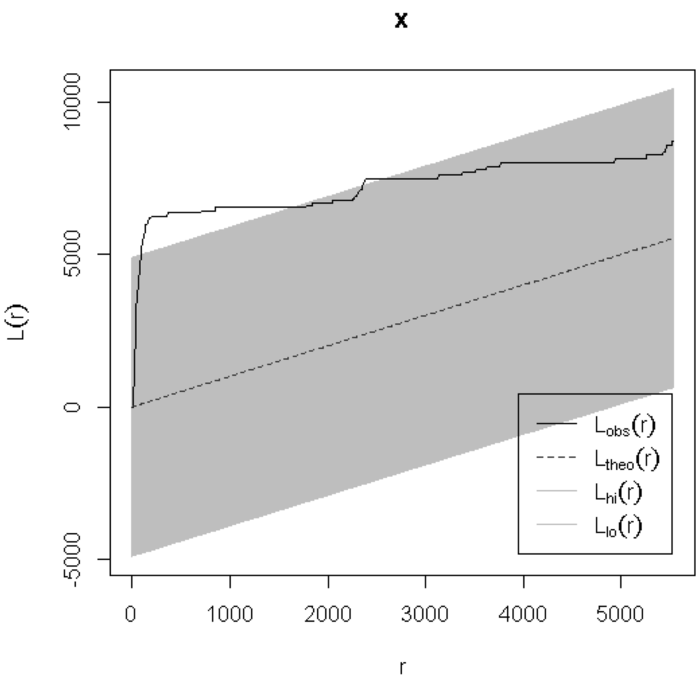

Figure 7.35: The output of the Ripley's *K*-function analysis for the Simi Hills/Ventura County community-scale of analysis for all pictographs within the area showing complete spatial randomness.

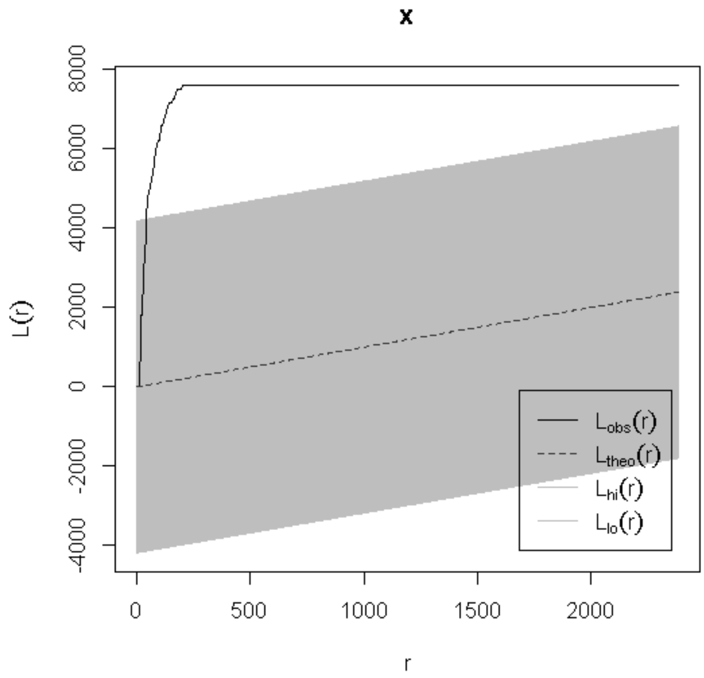

Figure 7.36: The output of the Ripley's *K*-function analysis for the Simi Hills/Ventura County community-scale of analysis for all sites with no associated archaeology within the area showing complete spatial randomness.

Finally, the Wind Wolves area was run for all categories except associated middens and the bifurcated motif due to low numbers for input. All results showed complete spatial randomness for all analyses (see Appendix D). Potentially a variety of underlying environmental factors could be at work here for the placement of these sites within the Chumash landscape. The rock art site locations were not affected by the placement of other rock art sites within this area.

7.4 Discussion

Kernel Density Estimation provided an initial means to explore the point intensity at the regional scale and informally analyse the data for underlying patterns. The instances of clustering and segregation of the data begin to identify the levels of effort of current and past archaeologists, the instances of areas without access to survey and the expansion of urban areas within the geographic region. Culturally, these areas of high point intensities create samples for further analysis at the community- or meso-scale to study more localised patterns that could reflect rock art site placement and patterns in the associated data. Analysis at smaller regions can reflect the cultural differences found throughout the Chumash interaction sphere and help researchers to understand potential cultural nuances within these smaller communities found in the different physiographic areas. Additionally, the data point to important areas within Los Padres National Forest that needs to be furthered surveyed for rock art, especially in the Santa Ynez backcountry. While this analysis is more about the defining multi-scalar space within the Chumash landscape, conservation is also a part of the networks in which rock art resides. Briefly, in terms of conservation, it is important as this area experiences a high rate of fires that can destroy the rock art before it has even been discovered. If rock art is identified then procedures can be implemented to prevent its destruction such as utilising retardants near the site or removing brush to stop its spread. The areas identified also show relevance to research on the associated ethnohistoric villages in terms of their hypothesised areas of foraging and connections to important socio-political centres. Further analysis on the cost of traversing these community areas would help to understand possible foraging areas associated with permanent settlements. Also, sites defined as inclusive with associated middens and BRMs are good places to explore their connection to networked areas of biotic communities and local hydrology such as hypothesised by Horne (1981) and Robinson (2006). If one looks at both ethnographic and energetically measured information on hunter-gatherer foraging radii of 6-10 km (Kelly 1995) or Steward's (1933) study of the Paiute's documented 3.6 km one-way radii can be a good starting point distance when applying anisotropic cost in these topographically challenging areas.

Ripley's *K*-Function at the regional scale showed heterogeneity of rock art points for each of the analysed categories except the bifurcated motif and petroglyphs. As was discussed earlier, due to the linear aggregation of the points, there was a need to select specific areas of analysis to find potential homogenous groups of points. The output of the KDE provided the contours to extract the point data from the original regional distribution for the community-scale. Clustering of sites, as with the regional petroglyphs, at such a large scale (regional-scale) is important as it shows a potential homogeneity and interdependence between the spatial locations of petroglyphs. As has been discussed in the past (Grant 1965; Lee 1984), petroglyphs could be older than the pictographs, although dating such sites is not possible (Lee 1984). Previous research on the Coso rock art has shown petroglyphs chronometric antiquity (Dorn and Whitley1984). If that is the case for the Chumash petroglyphs, then we could have a possible reflection of deeply entrenched prehistoric networks. If one visually studies the site distribution (Figure 7.37) there is a distinct pattern of petroglyph aggregation located within the Sierra Madre/San Rafael, the most prolific, followed by the Wind Wolves area and then the Carrizo Plain. The rest of the distribution represents only a few singular or small clusters of sites sparsely populating the landscape. There is a large gap within the central Chumash landscape, which includes the sacred areas of Mt. Pinos, Frazier Mountain and the Cuddy Valley, that seems to be bordered by the single or double petroglyphs locations along the linguistic boundaries. Again, this could simply be a result of various erosion processes that have left only a few petroglyphs visible within their environment. Further analysis of environmental features can investigate this potential bias. Finally, the bifurcated motif presents a complete lack of spatial interdependence with the locations of other bifurcated motif sites. The potential of sites with this motif being dependent on underlying environmental and ideological processes needs to also be further investigated.

Figure 7.37: Distribution of petroglyphs sites over the Chumash interaction sphere.

Overall the regional scale pointed to further investigation at the community-scale of analysis. Clustering of the ethnohistoric village sites pointed to aggregation of these sites after 10.2 kilometres instead of the immediate clustering output seen in the other categories. This indicates that there is significant clustering of the village sites and potentially reflects the political and socio-economic networks discussed in the ethnographic literature and in the marriage ties between these settlements. Clustering would be indicative of these networks, as villages in close association could potentially have strong or persistent relationships to one another.

At the community- or meso-level of analysis for the Ripley's K-Function, there were only five analysis outputs that showed any statistically significant results other then complete spatial randomness in two communities: Sierra Madre/San Rafael area and the Simi Hills/Ventura County area. The overall placement of all rock art and pictographs was the most consistent in terms of significant clustering, while in the Sierra Madre/San Rafael there were only instances of a slight aggregation for stand-alone cupules. In those outputs showing significant clustering, this could reflect the influence that the rock art locations had on similar sites, so that a rock art site was interdependent on the spatial placement of the other sites. In addition, since the majority of the sites in these areas are pictographs the clustering of this type of rock art within these areas further proves interdependence. I must also take into account the underlying ideologies associated with the environment and the rock art that perhaps has the most influence on its placement within the Chumash landscape. The personified environment that is deeply tied into the Chumash folklore and supernatural beliefs may have influenced its placement and cannot be statistically measured. Furthermore, as Woodman (2000, 445) states, "…hunter-gatherers do not locate their sites randomly across landscapes… Consequently it can be safely assumed that patterned associations with environmental features will arise. In areas where the archaeological record is sufficiently complete one should expect to identify those associations - even if the particular decision criteria used by the prehistoric hunter-gatherers remain unclear." Therefore, further analyses needs to be completed to look at associations with the environment to discover any influence between the art, specific environmental variables and archaeological data. The most obvious would be the geology, as rock art is a cultural artefact placed on rock. Furthermore, with its associations with BRMs for food processing the vegetation and biotic communities may have influenced its placement.

Finally, this analysis looks at isotropic processes or non-directional dependency; so further analysis of anisotropy would be beneficial. Markofsky and Bevan (2012, 429) state in their study of directional influences on surface pottery sherds, "…in archaeological survey, directional influences may factor heavily in the distribution of surface material, reflecting not only trajectories of artefact deposition from settlement derived and post depositional processes, but also recovery biases that may influence the interpretation of the surface distribution." The cause of complete spatial randomness would then be obvious as the rock art was placed in areas with heterogeneous environments and their relative placement with other rock art sites would have no significant weight in the decision of their location. Finally, the high mobility of hunter-gatherer groups such as the Chumash needs to be taken into consideration, and further investigation to the variability that is gleaned in these analyses needs to be studied.

7.5 Conclusion

This chapter looked to answer specific research questions using two exploratory analysis techniques for point patterns: KDE and Ripley's *K* (*L*). I wish to briefly go over the research questions here and answer them according to the outputs of the analyses discussed above.

1) **Where are the gaps in spatial and archaeological knowledge within the Chumash landscape and why?**

The gaps have shown us that survey needs to be done in areas that have long been ignored by archaeologists and also areas that are ethnographically important. Community-scales of analysis can be identified through KDE to being an exploration of smaller activity areas and networks associated with ethnohistorically identified villages.

2) **Are there areas of spatial clustering or disbursement of sites and the associated data?**

The outputs of the Ripley's *K*-function have shown mostly heterogeneity at the regional scale indicating other contributing factors for the spatial distribution of sites. Furthermore, at the community-scale of analysis, the instances of statistically significant clustering only occur when applied to the totality of rock art sites within the community or with pictographs and a slight aggregation for one instance of stand-alone cupules. The clustering shows a possible interdependence with the spatial locations of all rock art sites but this is not consistent with all the communities extracted. Extraction of more specific data such as the motifs and associated archaeology was shown to be completely spatially random for the majority of the data.

Therefore, the null hypothesis was accepted. This result does not mean that further analysis is no longer applicable. Random outputs potentially reflect underlying dependence on other variables that need to be further explored such as environmental properties and social, cultural or political network relations.

3) **How does this change at the various scales of analysis?**

The extraction of the community areas through KDE generally failed to describe what is going on at multiple scales when applying Ripley's *K*. Although there is some interdependence of all rock art sites and pictographs pointing to some interdependence of rock art site locations within the community areas, further analysis at multiple scales needs to be examined.

4) **Based on associated cultural material and specific element/motifs types are there a potential pattern that reflects the ethnographic literature or cultural ideology and socio-economy?**

The areas of clustering and 'holes' within the data were identified through KDE analysis, and in this chapter, I point out specific examples of areas of exclusion that are reflected in the ethnographic literature. Community-scales of analysis were also identified and may reflect areas of foraging based on their locations near ethnohistorically documented villages.

While analysis could be further examined with a localised Ripley's *K* as shown by Markosky (2013), the majority of instances with complete spatial randomness have shown that additional analysis on rock art's relationship with the environment need to be explored. Furthermore, analyses using anisotropic distances should be applied to understand the energetic cost and its influence on the cultural networks and its application for further study of the socio-economic and political networks within the Chumash interaction sphere.

Within the tenets of ANT, the analyses presented above have shown some clustering, or the persistence of network relations, that were interwoven to create a network outside of the environmental variables; a network that is based only on relationships between the sites. For the KDE analysis, space is defined by the intensity of rock art sites and the associated archaeological context for the community-scale of analysis. Within Ripley's *K*, there were only a few outputs represented within the distributions that reflect network relationships and show an intentionality in rock art placement based on the location of other rock art sites. In contrast, there were many outputs that exhibited complete spatial randomness pointing to other underlying network relations between rock art sites and associated archaeology that should be explored through environmental features or anisotropic distances. Even through extraction of specific information from the rock art attributes to create a more homogenous set of data, the outputs further reflect strong heterogeneity within the data pointing to the rock art sites being highly complex heterogeneous network themselves. As was discussed in Chapter 5, sites were not considered actants but also networks and this output supports this inference. While this also points to further social and ideological structures influencing rock art site location within the Chumash landscape, more analysis through GIS is required to understand the topographical entrenchment of these sites before a discussion can be made concerning the interwoven assemblage of the varying relational effects within the network. Therefore, the next two chapters further examine these avenues of research through maximum entropy modelling and anistropic movement towards and away from sites. The analyses are used to explore the research questions outlined in Chapter 6.

Chapter 8 Landscape Association to Chumash Rock Art Sites

8.1 Introduction

Predictive modelling in archaeology is a process that determines the existence of archaeological sites within areas that have not been surveyed (see Verhagen 2007 for a review of predictive modelling in archaeology). This process uses environmental data to find common patterns where sites do and do not exist and projects these patterns over the region of study (Kvamme, 1988, 327). The success of predictive models is based on the fact that archaeological sites tend to occur in environments that are favourable to human settlement (Warren and Asch, 2000, 5) or in the case of this thesis, for patterned associations that influence the placement of rock art and its various associated data. Therefore, I am using a predictive modelling approach to synthesise, explore and understand the different environmental variables (another type of network relations) that are favourable or may have influenced rock art site entrenchment at multiple scales. The secondary output will be the predictive surface that can be used to direct future survey to fill in the 'gaps' of the database so that rock art sites can be preserved from destruction (i.e. fire). Like most predictive models, this type of analysis makes the assumption that prehistoric people's site choice was influenced by specific characteristics within the environment (Warren and Asch, 2000, 6). As was described before, the environment played an important role in Chumash social and ideological systems. As Robinson (In Press, 5) states, "like the places where mythic narrative focuses most attention, pictographs are typically found at important locales in the terrain at places of high value based upon a range of desirable attributes". Rock art was entrenched to varying degrees within the Chumash interaction sphere, and as such, rock art's placement will potentially be a reflection of a variety of social, economic, political and supernatural beliefs. I studied site clustering and regularity in the last chapter and used rock art distribution as defining the multiple scales to show the persistence of heterogeneous relations. Therefore in this chapter I will study another tenet of ANT, that of entrenchment, by analysis of the anthropomorphised Chumash landscape and rock art's association to the environment through predictive modelling.

Many of the critiques of using a predictive model in archaeological studies are described by Verhagen (2007, 17) and include:

1) The use of incomplete archaeological data sets;
2) The biased selection of environmental parameters, often governed by the availability of cheap data sets such as digital elevation models;
3) As a consequence, a neglect for the influence of cultural factors, both in the choice of environmental parameters, as well as in the archaeological data set;
4) And lastly, a neglect of the changing nature of the landscape

While Verhagen (*ibid*, 17) argues that the predictive surface is more important and less attention should be paid to the environmental associations, his goal was for the use of these surfaces to point to accurate areas for survey. In contrast, I am stating that my primary goal is using a predictive model to study and explore the environmental variables that may point to the choice of rock art site locations. All of the critiques are applicable to the following study, but I argue here that not doing such a model would be more detrimental to the overall discussion in Chumash rock art research.

As was stated before in previous chapters, rock art is firmly placed within the Chumash landscape, a fixed, immovable artefact that has shown to have positive correlations to its environment. Also, as I have argued, the environment played an important role according to the ethnographic record while the rock art is fixed within their personified environment. The following analysis will study how the network relations of the rock art record and associated archaeology were connected to and incorporated within the relevant environmental variables at multiple scales. Analysis of the environment will specifically focus on how the rock art was tied to specific environmental features; the Chumash landscape perceptions and their taskscapes. Therefore the process of identifying those potential influential variables will only continue the discussion that has been going on for more than four decades for Chumash researchers (see below) for its association to the environment. It will also stimulate relational thinking on the rock art within entrenched topographical areas that may have been more persistent and, therefore, a reflection of Chumash landscape perceptions and their ideology. Also, an important factor here is that as much associated data as possible were included to try and create a more holistic analysis on the different relations that are interwoven within the heterogeneous networks. Even more importantly, I wish to explore the ethnographic literature and if it is reflective of the archaeological record. The outputs of the Ripley's *K*-function have shown that many of the sites had a tendency to be close to complete spatial randomness in relation to one another. As was discussed in Chapter 7, though, this could also be an issue with an incomplete archaeological record throughout the Chumash landscape or due to a dependency on underlying environmental processes and changing topography. Therefore, I wish to also begin to test for other underlying network relations within the environment that may have influenced the decision for site placement.

As was stated within Chapter 5, I will be assuming that modern environmental input variables can be used by proxy to represent past environments and will give some insight to rock art site location. Modern environmental variables are used as approximate representations of past environments. Predictive modelling as applied here is not to oversimplify the process of rock art site location choice, but to develop a further understanding of the potential and probable ideology associated with the environment that created the Chumash landscape. As I have stated before, the Chumash interaction sphere, including rock art, was not only a landscape but a taskscape entrenched in the cultural, socio-economic and political structures and beliefs of its inhabitants where the environment was another important relation of the rich and nuanced ideology interwoven in its networks as reflected in the ethnographic record.

The following research questions were therefore asked in this analysis:

1) **What is the correlation between the rock art sites, specific element types and the associated cultural material to specific landscape features?**

Furthermore, I wish to expand this and discuss the following:

- **Is this reflective of what is written in the ethnographic data about Chumash ideology or similar to what other researchers have posited?**

8.2 Rock Art and the Chumash Landscape

Currently within the published literature there are many hypotheses and conclusions concerning the relationship of Chumash rock art to the associated modern natural environment or archaeological material culture. Beginning with Campbell Grant (1965), one of the first rock art researchers to visit and document many of the sites within the regional area and recognize regional variations. He states, “pictography sites are always found near permanent water, either a spring or a running stream” (Grant 1965, 74). Furthermore, when discussing associated material culture, he concludes: “…around most sites are bedrock mortars” and in terms of geology states, “…most of the paintings are on sandstone” (Grant 1965, 89 & 96).

Hyder (1989) argues more specifically about rock art sites within smaller geographic areas (San Marcos Pass and the Sierra Madre Ridge) within the Chumash region. He states that: “…most of the sites are found in ecotones in the transition zone between oak woodland and chaparral…” and that “sites in both areas generally are found at ecotones where there is greater diversity of plant communities…” (*ibid*, 6). He argues that sites within the Sierra Madre Ridge are found around mountain protreros at approximates 1400 metres (*ibid*). In terms of associated archaeology, Hyder (*ibid*, 34) posits that Chumash rock art in general was often found within short distances to other sites such as “…camps, gathering areas, or other evidence of day-to-day human activities.”

Lee (1984, 14) makes further associations between the rock art within the Sierra Madre Ridge and “…upthrust faults atop the ridge have exposed large outcrops of rock which were subject to wind erosion. These have been formed into bizarre shapes and cave shelters…many of these shelters contain rock art”. She further goes on to explain, “it is possible that the sites were selected because of the particular shape of the rock itself” so that “…some rocks were seen as a person or an animal” (*ibid*, 17). Again, types of occupation sites, BRMs and cupules (although she does not distinguish which type, it is most likely stand-alone cupule boulders she is referring to) are posited to be typically located within the vicinity of rock art sites (*ibid*, 17). What is important to note here about the hypotheses above, is that all three of the rock art researchers making these arguments about rock art and its context and associations were actively involved in visiting these sites throughout their research.

The hypotheses concerning environmental and archaeological associations are based upon site observations and not desk-based analyses. As Hyder (1989, 34) states after finding apparent, but “superficial” environmental patterns, “it probably would be easier to detect these patterns on a more widespread regional scale then attempted here”. This is hopefully what a multi-scalar predictive model will achieve in this chapter.

One important point to note here concerns the reoccurring correlation between rock art sites and nearness to water. As was discussed in the chapter on ANT, water played an important role in the Chumash ideology. I conducted my fieldwork and visited multiple rock art locations, one observation that I made was that the rock art was “near” water, but I believe that this is misconceiving. The stream, river or spring was often located in deep, narrow canyons carved over time. Therefore if this is indicative of past hydrology, the energy to actually travel to the water would have been costly. In this analysis, I have chosen to use the cost distance of travelling to and from these sites as input instead of the Euclidean distance to water for further exploration and discussion.

8.3 Presence-Only Predictive Modelling Methodology

In this chapter, a 'presence-only' approach to predictive modelling is introduced and applied to analyse the environmental variables that influence the rock art site placement. The predictive model uses the theory of maximum entropy in an open-source program titled Maxent[11] to analyse the distribution of rock art and associated data for multiple scales of analysis. This program was developed by Philips et al. (2004; 2006) to bypass the problems of finding accurate, unbiased absence data within ecological datasets for research within biodiversity, conservation biology and ecology. Prediction is problematic when a researcher wants to apply the more commonly used predictive modelling techniques (e.g. logistic regression) to species' datasets that require both presence and absence data with a normal distribution. The main bias with species data comes from accurately collecting or sampling data where the species is confirmed to be absent. Some examples of these types of issues are that the species simply was just not observed through various data collecting mediums, was not present at the time of observation at a selected location or a logical habitat, for historical reasons, has caused the species to avoid the site (Hirzel et. al., 2002, 2027). Therefore having confidence in a true absence of a particular species at a specific location can cause problems during the sampling process and leave the researcher with only datasets with presences as input for their analysis. In many archaeological

[11] The program can be downloaded here: http://www.cs.princeton.edu/~schapire/maxent/ (Accessed June 2012).

datasets, especially those that involve the study over large regions or landscapes, similar issues arise as to the availability of absence data. Comprehensive levels of reconnaissance performed at large scale is often impractical and can be further inhibited by environmental conditions such as rugged topography and the high vegetation coverage or by getting permission to enter private land. There is also no confirmed guarantee that there was never human activity in the area through just survey and this issue is rarely discussed within predictive modelling studies in archaeology.

In the study area presented in this synthesis, some data for areas that have been surveyed archaeologically were available, but it was outside the scope of this project to collect, gather and digitise, and was not consistent for the entire geographic area. No data were therefore documented through GIS for locations where there is an absence of rock art. Maxent works well with incomplete datasets, so that a predictive model can still be applied.

'Presence-Only' predictive modelling, as was outlined before is prevalent within biodiversity both globally and locally to identify areas of probable locations of species. A common application within the general field of conservation, it is especially important for species that are very sensitive to environmental change and human development and need to be protected through human intervention. A variety of models have been developed based on ecological theories such as Biomapper for ecological niche factor analysis (ENFA) (Hirzel et al. 2002), the genetic algorithm applied by GARP (Stockwell and Peters 1999) and artificial neural networks in a program titled SPECIES (Pearson et al. 2002) among many others described more exhaustively in Pearson (2007). The programs are based on the ecological niche concept by Hutchinson (1957) that is defined as the region in a multi-dimensional space of environmental variables that can maintain species viability. Many of these ecological models use 'presence-only' modelling but others work with what are described as 'pseudo-absences' that are locations selected from non-optimal geographic areas within the study area to condition the model for better results in regression models (see Chefaoui and Lobo 2008).

Much of the literature on predictive modelling for species distributions is based on the comparison of models for their performance in predicting realised distributions based on ecological niches (e.g. Elith 2000; Guisan and Zimmerman 2000; Pearson et al. 2006). Each of these programs uses different algorithms to predict species distribution, or more accurately, the areas within the environmental input datasets where the species is likely to occur. No clear answer is available as to which program is the overall most successful. This leads to the conclusion that the decision should be based on the type of research being conducted, the research questions being asked and the data available within the areas of study. Logically these studies also show that using both presence and absence data out-performs the models using only presence data in terms of accurate predictions. Due to the issues discussed previously, presence-absence modelling is often not applicable for the available datasets. Out of the programs, it was decided that Maxent would be the most useful for the rock art analysis. Maxent was chosen not only because it consistently outperforms other types of predictive models within the literature but also because it was the only program that allows the user to change the memory use so that the whole geographic region could be analysed. It also allows the user to statically measure the outputs on their prediction by randomly selecting out a percentage of the input rock art database. The use of both categorical and continuous raster datasets is allowed within the program, so it enables an analysis using various types of background variables. Other programs (i.e. Biomapper) are more user-intensive as they only allow for continuous environmental variables. Categorical data (i.e. geology) has to be converted to a continuous dataset such as a cost surface or a frequency of presence or area using a user-specified radius.

There are some issues with Maxent too that need to be outlined. First all of the algorithms used are not transparent and are difficult to understand without a background in machine learning theory and statistical analysis (Elith et al. 2011). It can be a challenge for the user to understand each process that the tool is applying to the input variables. A more transparent set of algorithms was highly desirable because this study was used to not only predict the potential rock art site distribution, but to study which environmental variables were preferable for rock art site location and which were not. This type of transparency would be helpful for the user to easily interpret the various model outputs and would make troubleshooting problems much less time consuming. Other programs, such as Biomapper that uses a form of Principle Component Analysis (PCA) and is highly transparent, were tested at the regional scale but could not handle such large environmental variables and produced an 'out of memory' error. Refer to Chapter 5 for the exact size of the input variables. Finally, there are inherent problems that may affect the accuracy that all presence-only modelling, similar to those found in archaeology. The first is the biases in the data collection, and the second being the available environmental variables used for input that may not fully describe the data to be modelled (Phillips et al 2006, 233).

Within archaeology, these types of models are slowly being applied and making their way into the literature. One predictive model has been performed within the study area by Neal (2007) and utilises 'presence-only' data. His study explores the environmental variables applied to ethnohistorically Chumash village sites within the Santa Ynez Valley using weights of evidence to predict potential undiscovered village locations. He found that village site locations with less than a 15º slope, within 800 metres of perennial streams, within 200 metres of an ecotone, and in areas with a relatively high diversity of habitats were greatly preferred for settlement (*ibid*, 111). No such analysis has been done for Chumash rock art at the local, community or regional scale. In terms of borrowing presence-only modelling from ecology, Banks et al. (2006, 2008) used the Genetic Algorithm for Rule-Set Prediction (GARP) to reconstruct past human settlement systems in terms of migration and adaptation across both the New and Old World. This study used the term 'eco-cultural niche modelling' to describe such techniques that use ecological niche modelling and apply it to archaeological site data to model human interaction with the environment (*ibid*. 2006 and 2008). GARP uses a machine learning algorithm which creates specific rules to maximize predictability, creates pseudo-absences in order to evaluate the predictive accuracy of the model and predicts the potential distribution across the geographic space (Stockwell and Peters 1999). Maxent has been applied to archaeological datasets and the results were presented at the CAA's in 2012 by Kondo and Oguchi (2012), who further promote the use of the term 'eco-cultural niche modelling'. It has made its way into the published literature through a study by Galietti et al. (2013) who used Maxent to understand the environmental variables that identify the differences between modern and ancient agricultural terraces in Cyprus. These studies have shown that ecological modelling can be useful for incomplete archaeological datasets. Therefore, I wish to further explore its potential within rock art studies and what environmental and archaeological variables may have been the underlying processes contributing to rock art site placement.

8.4 Methodology

The principle of maximum entropy was first introduced within statistical mechanics by Jaynes (1957) and is still an important aspect of research within ecology, astronomy and physics, among many other disciplines. It also has its beginnings within information theory and is highly compatible with Bayesian methods (Galletti et al. 2013). Entropy is at its most basic definition "a measure if dispersedness" (Elith et al. 2011, 48). As was stated above, Maxent is a machine-learning algorithm or technique that is best defined by Philips et al. (2004, 655):

> Briefly, in maxent, one is given a set of samples from a distribution over some space, as well as a set of features (real-valued functions) on this space. The idea of maxent is to estimate the target distribution by finding the distribution of maximum entropy (i.e., that is closest to uniform) subject to the constraint that the expected value of each feature under this estimated distribution matches its empirical average. This turns out to be equivalent, under convex duality, to finding the maximum likelihood Gibbs distribution (i.e., distribution that is exponential in a linear combination of the features). For species distribution modeling, the occurrence localities of the species serve as the sample points, the geographical region of interest is the space on which this distribution is defined, and the features are the environmental variables (or functions thereof).

Explaining the algorithm behind the Maxent program requires a background and understanding of both machine-learning and statistical applications as it applies a variety of different algorithms and methods from the different disciplines. Therefore, it is a black box to most users. While a full explanation of the algorithms implemented in the program is outside the scope of this chapter (see Phillips et al. 2004; Phillips et al. 2006; Elith at al 2011), I will discuss some of the more important aspects applied to the data. The principle of maximum entropy is about approximating an unknown probability distribution using known constraints and a distribution that is as *close* to uniform as possible. The null hypothesis would be that the rock art distribution is uniform throughout the geographic space. This probability distribution is best described as an estimated density distribution (Phillips and Dudik 2008). The input data are comprised of discrete grid cells of a chosen study area or geographic region, a set of locations or points within that region that represent the position of rock art sites and the environmental variables/covariates within the study area that are the known constraints. The main assumption is that the rock art sites were independently chosen from the study area based on the unknown probability distribution that Maxent is trying to approximate (Phillips et al 2004). The constraints are functions of the environmental variables/covariates and are expressed or transformed into what machine learning jargon calls features through randomly sampling 10,000 locations from the environmental covariates (Phillips and Dudik 2008). This will in most models create more features than covariates. Overall Maxent "minimizes the relative entropy between two probability densities (one estimated from the presence data and one from the landscape)" (Elith et al. 2011, 43) while maximizing the entropy of the rock art site distributions and maximize the distribution of the covariates. The program produces a final probability density estimation as a continuous raster of the probability of site occurrence within the study area. Or more simply, Elith et al. (*ibid*, 46) state that "…the core of the MaxEnt model output, giving insight about what features are important and estimating the relative suitability of one place vs. another".

8.4.1 Model Building

The analysis here was run at the regional scale and further used the community-scale areas defined through the KDE. The same rock art variables, as used in the Ripley's *K*-function analysis, were again selected so that further exploration can be applied to gain an understanding of the different processes and associations happening within the Chumash landscape. One exception was the stand-alone cupule sites that were now considered an environmental variable in this study. Due to their locations away from pictograph and petroglyphs sites, I decided to apply them as an archaeological context instead of another rock art type. It was considered more important to have more cultural context within the model than instances of more rock art site types as input. The following environmental variables were used:

1. Digital elevation model (DEM) (continuous);
2. Slope (continuous);
3. Aspect (continuous);
4. Landcover (categorical);
5. Cost from water/hydrology isotropic or to/from water/hydrology anisotropic (continuous);
6. Cost from stand-alone cupule sites isotropic or to/from stand-alone cupule

sites anisotropic (continuous);

7. Cost from ethnohistoric villages isotropic or to/from ethnohistoric villages anisotropic (continuous);
8. Geology (categorical)

For information on how these variables were created, refer to Chapter 6 on methodology. Cost distances from discrete points (stand-alone cupules and ethnohistoric villages) and the hydrology dataset were created within a 10 km buffer outside of the KDE contours so that sites further away, but with potential cost of travel to and from the rock art falling within the KDE cluster, were included to prevent edge effects and present a more holistic picture of the area. All data were resampled to a 10-metre resolution. Data was analysed so that 50% of the input rock art points were randomly subsampled as test data to run the statistical analyses for model evaluation. By using a random sample of a 50% subset of the data "…it is possible to identify which environmental variables are influential for site location…" and "it serves to characterise the background environments which is a crucial step prior to assigning significance to a variable in relation to its influence on locational decisions" (Woodman 2000, 449). A total of 5000 iterations of the optimisation algorithm were used for each model run so that there were enough iterations to prevent both under-and over-predicting. All of the other parameters were left at the default settings.

Due to the large file size and long processing times at the regional scale, the models were only run one time for each rock art and associated attribute dataset. More than one run would have been ideal, but as the processing of one file took days this was not feasible. At the community-scales, the models were run ten times each and average results of the replicates were then used as the final output. With each replicate a different random seed was run, so it was possible to study the variability within the model. Maxent allows a bias grid/raster to be used as input to identify areas that have most likely been surveyed and reduce the area where the background points are generated. Because the region of study has so many large 'holes' in the data across a very large region and this analysis is trying to identify the networked topographic Chumash landscape, this option was not used.

Finally, testing for confounding, correlation or interaction of the data was performed on this dataset. Relationships of these types within the independent environmental variables "…may disguise or alternatively exaggerate the effect of other variables" (Woodman 2000, 451) (see Table 8.1). Most correlation (>0.49) is between the archaeological data (i.e. ethnohistoric villages and stand-alone cupules) and the DEM. There was also a correlation between the hydrological cost surface and aspect. The data did not have a large amount of correlation and all was under 0.8 (strong correlation) so it fell under moderate to weak. Overall, in most studies maxent was found to work well with correlated variables (Elith et al. 2011). Furthermore, many of the variables that were correlated pertain to archaeological data and the elevation or the cost from water and are important variables to test within the model due to their relevance in past literature. It was, therefore, decided to include them all within the analysis.

	Village (cost)	Cupule (cost)	Landcover	Geology	Aspect	Slope	DEM	Hydro (cost)
Village (cost)	1.00							
Cupule (cost)	0.64	1.00						
Landcover	0.13	0.27	1.00					
Geology	-0.09	-0.22	-0.12	1.00				
Aspect	0.01	0.04	0.01	-0.20	1.00			
Slope	0.43	0.43	0.14	-0.12	0.07	1.00		
DEM	0.76	0.53	0.21	-0.05	0.01	0.47	1.00	
Hydro (cost)	0.44	0.42	0.10	-0.11	0.05	0.62	0.47	1.00

Table 8.1: Correlation coefficients for the independent environmental variables. Any value over 0.8 is considered strongly correlated, 0.79-0.5 is moderately correlated, 0.49 –0.3 is weakly correlated and 0.29-0.0 probably has no correlation at all.

8.4.2 Model Performance

As the model is being run with the rock art data, test data (data remove from the input rock art database to test the models predictive power) and environmental variables within the geographic region/study area, it computes a gain statistic, a measure of goodness of fit while producing the probability distribution beginning from the null hypothesis, or the uniform distribution, and repeatedly improving the fit to the data (Phillips et al. 2006). Whereby, "the gain is defined as the average log probability of the presence samples, minus a constant that makes the uniform distribution have zero gain" and will determine the "average likelihood of the presence sample… than that of a random background pixel" (Phillips 2010, 112). The outputs are numerous and consist not only of a predictive surface, but also plots of statistical analyses based on omissions of sample data to test the model. A plot of the receiving operator curve (ROC) including the area under the ROC curve (AUC) for both the input data and the test data are created and tests against psuedo-absences created by the program. The AUC tests whether the model is more accurate than a random predictive surface (Pearson 2007), where output values from 0.5 indicate a model that is no better than random, >0.5-0.6 indicate low predictability, values between 0.7-0.9 indicate moderate predictability and values above 0.9 indicate high predictability which shows the model can discern areas of species presence and absence (Phillips 2010, 112).

Another output is the percent contribution of each of the environmental variables to the final model although this can be misleading as different parameter choices will create different percentages that are not necessarily reflective of what is being used to create the final model. Output also consists of marginal response curves that show how each environmental variable affects the predictive surface by plotting the effect of changing one variable. This can also be a misleading output as oftentimes the model is based on the responses of multiple changes in multiple variables each affecting one another. Another set of response curves results from the program creating models using just the individual variables independently and showing how dependent the model is on that individual variable. One benefit of these outputs is that both sets of response curves allow the user to see specific values within each variable that are more important to the model instead of just the environmental variable as a broad entity. It can also show if variables are negatively or positively correlated to the variables. Finally, three jackknife tests for the training gain, test gain and AUC are created that excludes one variable at a time from the model and tests for its importance. Outputs show which of the environmental variables were the most important to the model and, therefore, independently the most useful variable to predict rock art sites. Jackknife tests also show the variable that decreases the gain the most when it is removed from the model, which indicates it has the most information that is not present in the other variables. All of the results here are also presented on one HTML file that can be easily accessed once the model has completed.

8.5 Regional Results

The model was run at the regional scale for the following variables:

1) Rock Art All

2) Pictographs

3) Petroglyphs

4) Rock Art with Associated Middens

5) Rock Art with Associated BRMs

6) Rock Art with Associated Cupules

7) Bifurcated Motif

8) Rock Art with No Associated Archaeology

The overall AUC results for the models are shown in Table 8.2.

	AUC Score
Rock Art All	0.969
Pictographs	0.974
Petroglyphs	0.968
Associated Middens	0.975
Associated BRMs	0.981
Associated Cupules	0.981
Bifurcated Motif	0.989
No Associated Archaeology	0.966

Table 8.2: AUC scores for the regional scale predictive model for the different rock art styles and associated data.

The scores show the predictability of the models to be all above 0.9 showing high model performance. The individual results are explored below, while the marginal response curves (graphs showing specific variable values important to the model) and the predictive surfaces can be found in Appendix E. Caution must be taken in the following regional interpretations as the model isapplied to a very diverse landscape with many different types of environments. The regional scale here is more of a gross generalisation of the Chumash landscape. The community-scale of analysis will present more fine-tuned results that can be more important overall due to the smaller scale.

For all rock art collated within the Chumash interaction sphere, geology had the highest gain when it was tested as the only predictive variable. It also decreases the overall gain when it is not used as input and shows that it contributes the most information that is not represented by the other variables (see Figure 8.1). Table 8.3

shows the relative percent contribution of the environmental variables.

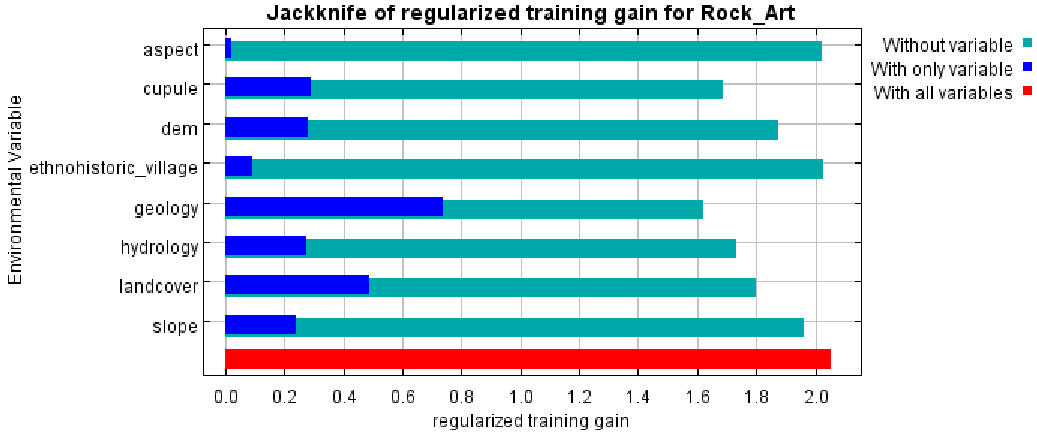

Figure 8.1: Jackknife of regularised training gain for all rock art showing the most important predictive variables for all rock art sites within the Chumash region.

Relative Percent Contribution for all Rock Art (Regional)	
Geology	**37.2**
Cupule Cost	**15.9**
Landcover (vegetation)	**15**
Hydrology Cost	13.7
DEM	11.7
Slope	4.8
Aspect	1
Ethnohistoric Village Sites Cost	0.6

Table 8.3: Relative percent contribution to the Maxent model for all rock art sites. The values in bold are the top three contributors.

Geology, cost distances from stand-along cupule sites and landcover compose the most important environmental variables for predicting all of the Chumash rock art and its associated data.

While the regional analysis of all rock art is very general, we can see that it begins to show some important trends. It is important to note the cost distance from water locations is not as important overall as the literature has indicated. The energetic cost of travelling from the water near the sites is perhaps too high for some sites to indicate a significant contribution for rock art site prediction. It falls as the fourth most important contributor. If I look at the response curves from creating models using only the corresponding variable for the top four contributors we can get more specific values to study. Cupule cost surface showed high prediction power with low cost values as did the cost distance values for water. The geology types were as follows in order of probability of rock art occurrence: serpentinite, basalt, and a variety of sandstones. One interesting aspect of the results is the lack of predictive power of the ethnohistoric village sites. Landcover results were high for scrub, chaparral, pine woodland and forest to coastal sage-chaparral scrub. All of these results represent a generalisation of the overall independent variables that increased model performance and potentially describe rock art site placement.

The next outputs represent selecting out more specific attributes from the rock art database. First, I look at pictograph sites throughout the overall landscape and the environmental variables that increased model performance (see Table 8.4). Overall, the relative percent contributions for the predictive model were geology, DEM and the cost of travelling from stand-alone cupule sites. Geology was the highest contributor followed by the elevation and then the cost of travelling to and from stand-alone cupule sites. Cost of travel from the ethnohistoric village sites contributed the least to the model.

Relative Percent Contribution for Pictographs (Regional)	
Geology	**29**
DEM	**21.8**
Cupule Cost	**19.6**
Hydrology Cost	12.3
Landcover (vegetation)	9.5
Slope	6.8
Aspect	0.9
Ethnohistoric Village Sites Cost	0.2

Table 8.4: Relative percent contribution to the Maxent model for pictographs. The values in bold are the top three contributors.

Again, geology had the highest gain when it was modelled on its own while the cost from stand-alone cupules decreased the gain more than the other variables. That means that the variable has the most information available that is not present in the other variables (see Figure 8.2). Geologically the highest responses were from basalt and a variety of local sandstones. For landcover the best predictors were a variety of chaparrals, coastal sage-chaparral scrub, pine forest and big sagebrush scrub.

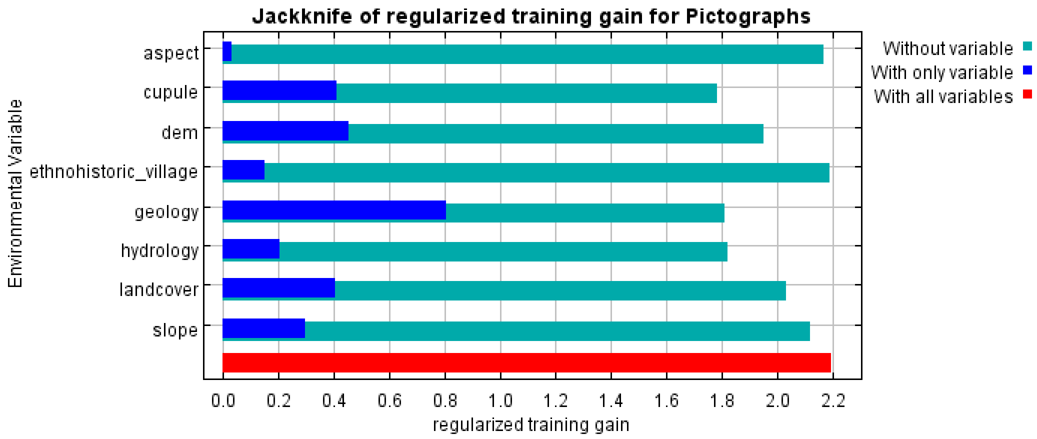

Figure 8.2: Jackknife of regularised training gain for pictographs showing the most important predictive variables for pictographs within the Chumash region.

Petroglyphs had geology, stand-alone cupule cost and landcover as the top three relative contributors to the model, and elevation and the cost of travelling from water were next in line (see Table 8.5).

Relative Percent Contribution for Petroglyphs (Regional)	
Geology	**41.5**
Cupule Cost	**20**
Landcover (vegetation)	**18.8**
DEM	7.8
Hydrology Cost	7.2
Slope	3.3
Aspect	0.8
Ethnohistoric Village Sites Cost	0.7

Table 8.5: Relative percent contribution to the Maxent model for petroglyphs. The values in bold are the top three contributors.

Again geology had the highest gain so when it was modelled independently, it outperformed the other variables. Also, it decreased the gain the most and means it had the most information present that isn't represented by any of the other variables (Figure 8.3). A variety of sandstones were the most important geological attributes whilst pine woodland, various chaparral and coastal sage-coastal scrub were the highest predicting vegetation. Low-cost from both cupules and water were important as were elevations around 800 metres.

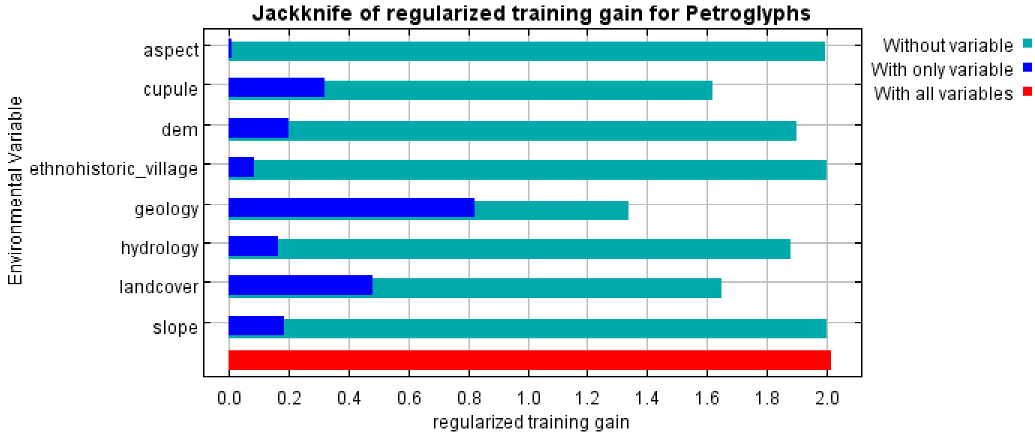

Figure 8.3: Jackknife of regularised training gain for petroglyphs showing the most important predictive variables for all petroglyphs within the Chumash region.

Geology, landcover and stand-alone cupule cost were the relative highest contributors for the rock art sites with associated middens (Table 8.6). Geology had the highest gain and also decreased the gain, making it the single most important predictor of all of the environmental variables (Figure 8.4). Especially important were various local sandstones, mudstone and basalt. Low cost from cupules and water were important and so was elevation at 1,400 metres. Vegetation that was preferred was various chaparrals, pine woodlands, and central coast cottonwood-sycamore riparian forest.

Relative Percent Contribution for Associated Middens (Regional)	
Geology	**39.7**
Landcover (vegetation)	**15.1**
Cupule Cost	**14.6**
DEM	13.9
Hydrology Cost	7.3
Aspect	4.8
Slope	3.8
Ethnohistoric Village Sites Cost	0.8

Table 8.6: Relative percent contribution to the Maxent model for rock art with associated middens. The values in bold are the top three contributors.

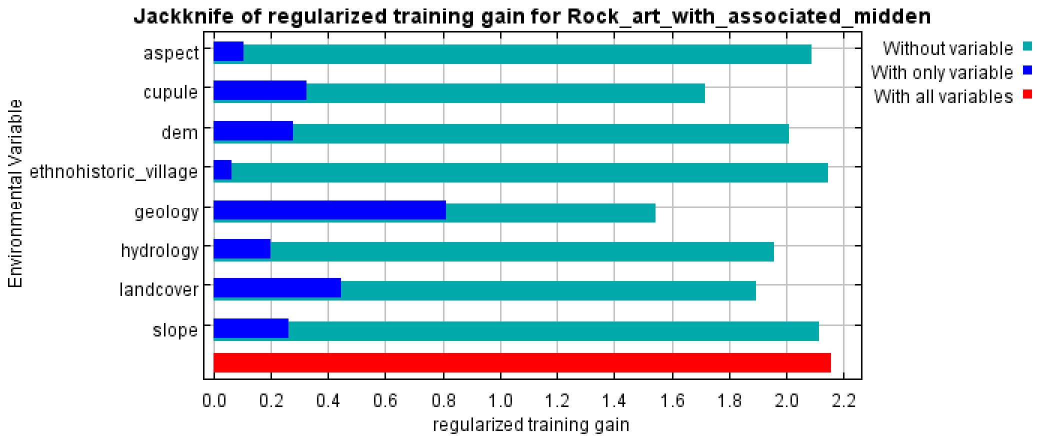

Figure 8.4: Jackknife of regularised training gain for rock art with associated middens showing the most important predictive variables for all rock art sites with associated middens within the Chumash region.

For rock art with associated BRMs, geology, cost from stand-alone cupule sites and elevation were the most important relative contributors for the model (Table 8.7). Geology had the highest gain and also decreased the gain making it the most important environmental variable for the associated BRM model (Figure 8.5). Geologically various sandstones were the most important common attributes for predicting sites. Elevation was relevant if it was around 700 metres as was low cost from stand-alone cupules and water. Preferred vegetation was various chaparrals and coastal sage-chaparral scrub.

Relative Percent Contribution for Associated BRMs (Regional)	
Geology	**26.8**
Cupule Cost	**19**
DEM	**22.2**
Landcover (vegetation)	14.5
Hydrology Cost	12.2
Slope	3.7
Ethnohistoric Village Sites Cost	0.9
Aspect	0.8

Table 8.7: Relative percent contribution to the Maxent model for rock art with associated BRMs. The values in bold are the top three contributors.

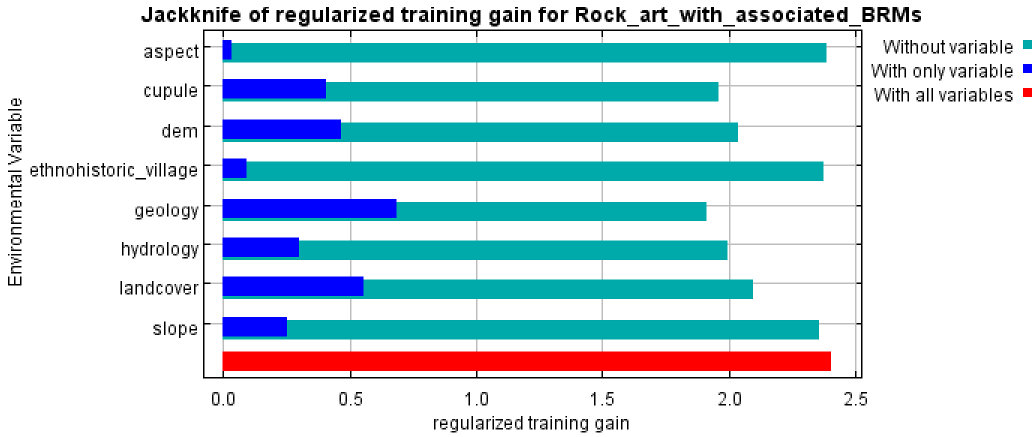

Figure 8.5: Jackknife of regularised training gain for rock art with associated BRMs showing the most important predictive variables for all rock art sites with associated BRMs within the Chumash region.

The bifurcated motif had a more unique output than the other attributes that is similar to the Ripley's *K*-function analysis at the regional distribution of the centimetre-scale (Table 8.8). The top three relative contributors were the elevation, geology and the landcover. The DEM was the input variable that increased the gain the most while geology had the highest decrease in gain when modelled independently (Figure 8.6). Therefore, elevation had the most important information, but geology had the most information that was not present within the other variables. The bifurcated motif was predicted at around 700 metres on sandstone, basalt or mudstone. Low cost values from water and stand-alone cupules were preferred while cost from the ethnohistoric village sites was not relevant to the model. Vegetation that was important to the model was various chaparrals and pinyon and juniper woodlands.

Relative Percent Contribution for the Bifurcated Motif (Regional)	
DEM	**36.8**
Geology	**29.3**
Landcover (vegetation)	**18.5**
Hydrology Cost	12.2
Cupule Cost	19
Slope	3.8
Aspect	1.3
Ethnohistoric Village Sites Cost	0.7

Table 8.8: Relative percent contribution to the Maxent model for rock art with the bifurcated motif. The values in bold are the top three contributors.

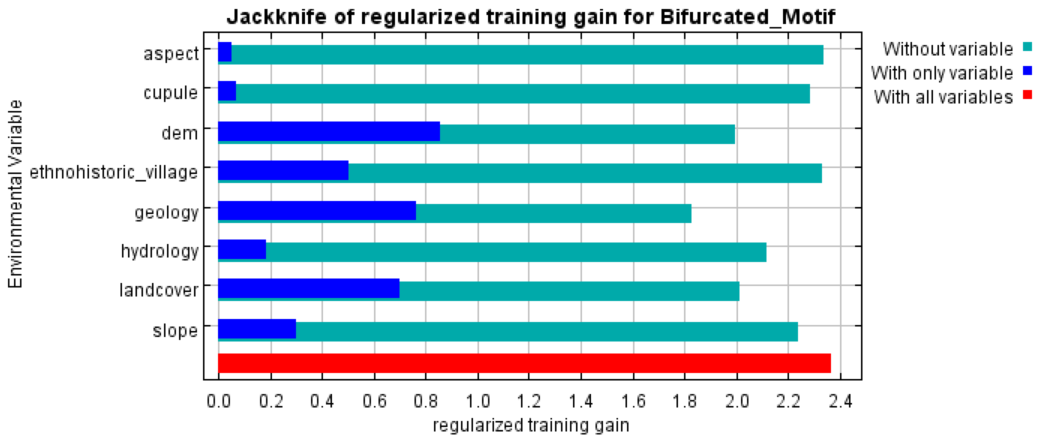

Figure 8.6: Jackknife of regularised training gain for rock art with the bifurcated motif showing the most important predictive variable for all rock art sites with the bifurcated motif within the Chumash region.

Continuing to analyse the centimetre-scale and its regional distribution, associated cupules were modelled and again were more unique than the other associated data. Stand-alone cupule cost, geology and slope were the top relative contributors to the model (Table 8.9). Low cost from stand-alone cupules and low cost from water were important (Figure 8.7), and the rock art sites were placed in areas with low slope values. Various sandstone types and basalt were predominant for prediction whilst various scrubs, sage scrub and coastal sage-chaparral scrubs were the preferred landcover types.

Relative Percent Contribution for Associated Cupules (Regional)	
Cupule Cost	**26.1**
Geology	**21.1**
Slope	**16.9**
Hydrology Cost	12.2
Landcover (vegetation)	11.2
DEM	10.7
Ethnohistoric Village Sites Cost	1.2
Aspect	0.5

Table 8.9: Relative percent contribution to the Maxent model for rock art with the associated cupules. The values in bold are the top three contributors.

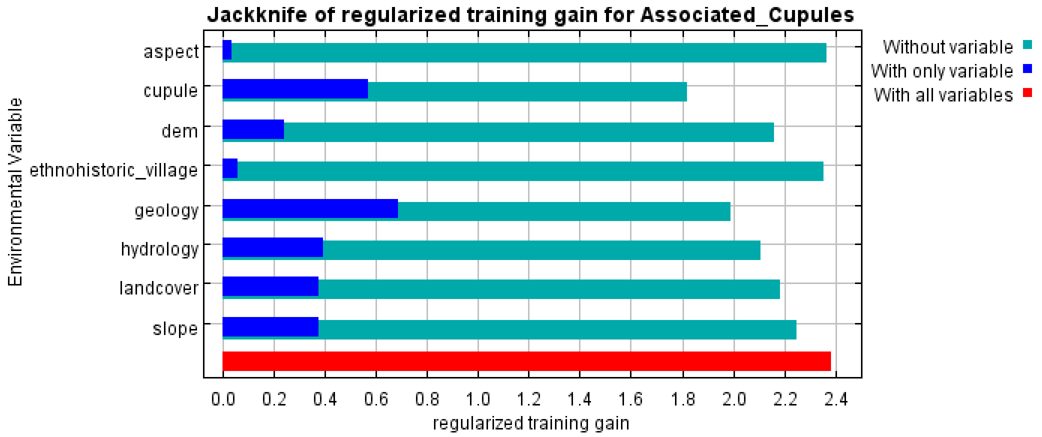

Figure 8.7: Jackknife of regularised training gain for rock art with associated cupules showing the most important predictive variable for all rock art sites with associated cupules within the Chumash region.

To complete the regional scale of analysis, rock art with no associated archaeology was modelled (Table 8.10). Elevation, slope and landcover were the top three relative contributors for this model. Preferred elevation was around 800 metres and as slope increased so did model performance. Low cost from water was preferred while various types of sandstones were the geologic setting. Vegetation that performed well was usually scrub and pine woodland and forest. Finally, geology was the best predictor when used in isolation while hydrology decreased the gain showing that it had the most information that was not present within the other variables.

Relative Percent Contribution for Rock Art with no Associated Archaeology (Regional)	
DEM	**20.9**
Slope	**18.4**
Landcover (vegetation)	**17.2**
Geology	16.5
Hydrology Cost	15.6
Cupule Cost	11
Ethnohistoric Village Sites Cost	0.3
Aspect	0.1

Table 8.10: Relative percent contribution to the Maxent model for rock art with no associated archaeology. The values in bold are the top three contributors.

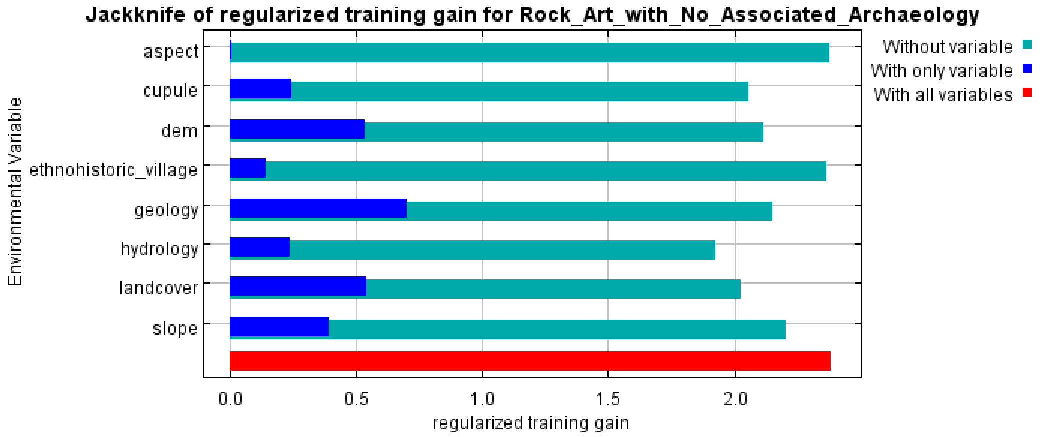

Figure 8.8: Jackknife of regularised training gain for rock art with no associated archaeology showing the most important predictive variable for all rock art sites with no associated archaeology within the Chumash region.

8.6 Regional Discussion

As stated earlier, the results at the regional scale of analysis need to be interpreted with caution as we are looking at associated landscape trends over a broad and nuanced physiographic regions that require different adaptations and housed diverse linguistic groups. Also, the input variables are all modern and aren't representative of the palaeo-environment and palaeo-topography that would have been present during Chumash occupation. That being said, the general trends found here do point to some interesting results and show that there are underlying environmental and potential social processes at work that are not interdependent on the locations of other rock art sites. Overall the geology of the area was the most useful (had the highest gain) when dealing with all rock art sites except for the bifurcated motif. Obviously, as rock art is art placed on rock within an environment, this is hardly surprising. Yet, not every cave, shelter or rock outcrop has rock art present showing that there were specific properties determining site locations. Various types of sandstone were consistently an important attribute for the areas and matched many of the hypotheses and local observations by other rock art researchers discussed above. Furthermore, the geology was the most important predictor overall so it perhaps would have been the first defining landscape property the Chumash would have looked for in determining the sites, and the cost of procuring water would not have been an issue. As Lee (1984, 17), "natural features described as having been the 'First People' at the beginning of the world which were transformed into stone for one reason or another…some rocks were seen as a person or an animal". Rocks were therefore anthropomorphised and could have a high influence on site location decisions (Robinson In Press). Whitley (2000, 80) states "…caves (and rocks more generally) were considered entrances or portals to the supernatural world". While Whitley believes that rock art sites were places of exclusion and dangerous to those who were not shamans, this hypothesis stills points to the rock itself being the main choice in site location due to its mythological and ideological importance. Geologic attributes were important and, therefore, heavily influenced the choice of where to place rock art regardless of which theory the researcher subscribes to as the source of the rock art.

One point here that should be made is that geology for the associated middens and the associated BRMs not only increased the gain, but also decreased the gain and showed that it was the single most important landscape feature for those two models. Interestingly, if geology is so important for site placement, it could be argued then that these sites were chosen for the ability to have rock art or BRMs first based on initial geological features. The locations of these two features would be logically dependent on specific geological attributes found within the landscape. Middens could then be a bi-product of the sites from numerous visits by groups of people for either food processing (BRMs) or perhaps for ceremonial purposes. Again this would point to rock art sites as social areas or where groups of people met to perform duties and perhaps share ideas; areas of inclusion. Various chaparrals were an important predictor within the area. This type of biotic community contains a wide variety of plants and animals including the oak, one of the most important plants for the Chumash inland/interior populations for its acorns and an important item in the trade networks with the coastal populations. Again we see trends here that point to rock art being generally placed on sandstone and in areas near or in specific plant communities that lends more to a gathering, processing or preferences for specific plants purpose.

Low cost from water was not always the most important aspect of rock art placement, but overall it was always selected out for low and not high energetic cost. This reflects my field observations that rock art was near water through Euclidean distances, but in terms of energetic cost, the art was oftentimes located at a high cost distance from water due to steep slope and canyons. Water would have been an important part of the processing of foodstuffs and for sustaining groups of people during seasonal gathering, so perhaps this was stored in woven baskets lined with asphaltum (see Whitby 2012) as it would have been a high cost to consistently travel down these steep slopes to gather water. Most likely it could simply point to the high mobility of the Chumash in navigating their landscape and that steep slopes would not have been a deterrent for site placement and water procurement.

In terms of archaeological features and their association to rock art, out of the eight regional models analysed, six (or 75% of them) had cost from the stand-alone cupules as the top three relative contributors. Rock art with no associated archaeology and sites including the bifurcated motif were the only models that had low values for this archaeological data. This could point to an importance of these stand-alone cupule sites within the ideological/social aspects that have not been documented within the ethnographic literature. They are tied within the network based on underlying mythological or ideological belief. Even if these sites were contemporaneous, due to the low cost of travel between them, it would have been likely that the people would have known of the other site due to their high mobility. It could also be that the low cost from the cupule boulders potentially indicates an association that resulting from utilising both sites simultaneously or points to a contemporaneous relationship between them based on site access. Stand-alone cupule sites, as was stated in Chapter 5, had 59 out of the 66 total sites with associated archaeology indicating that the majority, 75%, of these sites would have been used for other purposes besides the rock art. Furthermore, these boulders have been found widely distributed throughout the landscape. Rock art with no associated archaeological data did not have cupule boulder cost as an important relative contributor which also points to the idea that there were varying degrees of inclusivity and exclusivity. While Hyder (1989) uses the terms public versus private in his analyses, I move away from these dichotomies in my application of ANT and state that there were different degrees of inclusivity and exclusivity that ebbed and flowed. This would be based upon things such as seasonality and family ownership of the taskscapes. It is possible that cupule boulders were more important to the taskscapes where food was being processed, people were socially gathering or group ceremonies were being conducted. Cupule boulders were socially tied to rock art sites because they were easily accessible to each other, while at sites that were more exclusionary (no associated archaeology) there was no need to have much access to other sites due to the very nature of privacy. The sites with higher degrees of inclusivity were entrenched within the networks for a variety of social purposes with multiple associations and more ties to a variety of resources and functions within the overall landscape network. The outputs point to how the rock art sites were tied to not only other archaeological sites in the case of the cupules but also the associated archaeology and the environmental variables. Private sites were still part of the overall network and were necessary based on the ideology of differentiated power as outlined by Robinson (2011) and tied to supernatural interactions (Blackburn 1975), but were perhaps less tied or entrenched within the more social networks of the landscape or taskscape, as they were more peripheral but not any less important. They were firmly entrenched in varying degrees of inclusive or exclusive relations and had different network connections, each one representing a different aspect of the Chumash ideological or social interactions. The more exclusive a site, the more entrenched it was within the supernatural or mythological networks of the Chumash ideology of power. As Blackburn (1975, 31) states, "thus life, for the Chumash, is generally predictable within narrow limits, but there is always an element of uncertainty due to the fact that man's fate depends ultimately on the actions of remote and occasionally whimsical supernatural beings". As described in Chapter 3, this idea would support the theories that rock art was used by shamans to interact with the supernatural to specifically deal with malevolent beings wreaking havoc upon the Chumash society.

Interestingly enough the ethnohistoric village site cost was the least important variable for all of the regional models. It could represent the rock art sites and the ethnohistoric village sites as not contemporaneous so there was no association between them. This would point to an older age for rock art then the villages, as the villages were those documented during the mission records during the Mission Period. However, it is likely that the rock art site locations, especially those with associated archaeological data, were more dependent upon the resources within the landscape than having a specific type of access (low to high cost) to village sites or being near potential routes between the village sites. This would also point to the fact that the rock art was not used to communicate to internal Chumash groups travelling between village sites for feasting or the various Chumash ceremonies. Finally, as discussed in Horne (1981) in his analysis of a village site catchment within the Sierra Madre Ridge area, during the late summer/autumn people would have travelled away from the permanent residences to gather. Those people such as children and the elderly would stay behind, but those that were physically able would leave for periods of time (*ibid*). If the associated BRMs and associated middens were an indication of gathering camps and food processing then they would be located near resource-abundant areas and not dependent upon nearness to their permanent residences and people who were more fit and had easy mobility would be travelling to gather resources for the winter season.

If we look at the centimetre-scale at a regional distribution, there are different variables that affect the model when compared to the overall regional patterns. The bifurcated motif reflected this more so than the associated cupules. It shows the importance of this ubiquitous motif and that its placement had differing underlying environmental processes than the overall rock art and associated cultural material. The change in the underlying processes, when compared to the other rock art sites, could reflect an ideological or social shift in the decision making for sites including this motif. Elevation had the highest gain whilst geology decreased the gain the most. Elevation, at rock art sites with the bifurcated motif, was preferred at around 700 metres overall which is much lower compared to the overall rock art sites at a value of 1400 – 1500 metres. Therefore, the bifurcated figure was located at lower elevations. The rest of the environmental variables were typical of what was found for the regional results. Associated cupules were found to have a strong relationship with the stand-alone cupule sites. This variable decreased the gain so showed the most information not present in the other variables when modelled independently and was also the most important relative contributor to the model. The outputs show a strong relationship between the cupules in terms of access to each other and connectivity between the associated cupules and stand-alone cupules locations.

Finally, the sites with no associated archaeology had cost distance from water decrease the gain, and also had the most important information for site location than any other variable. Perhaps this idea points to a need for water nearby if these were indeed private and occupied by one individual or the shaman during a vision quest. It could also point to a more ideological aspect for water found in some of the Chumash narratives and discussed previously in Chapter 5. In addition, the predictive performance increased as the slope values increased; the sites were found on steeper slopes. This could point more to a place of exclusion, away from where people could easily access or gather for ceremonial or processing purposes. These areas, while not as entrenched in the Chumash daily, social networks, could have been more important in the spiritual and mythological networks, as they may have been where the shamans went to interact with the spirit or mythological world. If so, the shaman's spirit quests would be entrenched in the ideological aspects of society and result in these types of narratives found in the ethnographic literature. When the shamans visited the sites for the betterment of the community, the networks were strengthened as the people could continue with their daily tasks without fear of malevolence. In contrast when the shamans visited the sites to create problems (such as the ethnographic example presented in Chapter 3), networks connections could be broken due to malevolent spirits creating havoc on the Chumash people and represented by such events as sickness or drought. Finally, it could also mean that these locations are biased due to the lack of excavations at rock art sites and more information needs to be obtained at these sites.

The predictive outputs for this analysis, while not of particular importance to understanding the underlying environmental variables, are important to direct further survey within the region to document more sites to create an even more robust analysis for Chumash rock art. More documentation would therefore result in more robust samples of analysis for rock art site distribution and further areas of community-scale of analyses described below. In addition, using the outputs to direct survey for the land-holding organisations will in time help to conserve these sites and preserve them for educational purposes.

8.7 Community Results

Maxent was then run for the community scale of analysis at the areas defined by the KDE in the previous chapter (see Figure 7.2 for the community-scale areas) to understand potential underlying environmental processes that may have affected site choice. Complete spatial randomness was found to be the most prevalent output so further modelling to other associations needed to be explored. Multi-scalar analysis here should pinpoint the cultural and ideological networks entrenched locally reflecting more specific cultural attributes in the landscape and taskscape then found at the more generalised regional scale. Rock art data with less than ten locations was chosen as the cut-off for modelling. By testing data with less than ten input sites, it was found that model performance was low so was not included in the analysis.

Sierra Madre Ridge/San Rafael Wilderness

The first community-scale study covered the Sierra Madre/San Rafael area (see Appendix E for full results and figures). The analyses looked at the same rock art and associated data as the regional scale because there were enough sites to provide adequate samples for analysis. Results of these analyses provided the following AUC scores for the final predictive surfaces (see Table 8.11). The models were run for ten iterations so that the AUC score represents an average of these iterations. As we can see from Table 8.11, the AUC score is lower than the score from the regional model. Results such as these would be the result of a lower number of input rock art locations for the model.

	AUC Score
Rock Art All	0.897
Pictographs	0.877
Petroglyphs	0.888
Associated Middens	0.893
Associated BRMs	0.866
Associated Cupules	0.896
Bifurcated Motif	0.706
No Associated Archaeology	0.816

Table 8.11: AUC scores for the community-scale of analysis for the Sierra Madre Ridge/San Rafael Wilderness. The results show a mean score from 10 iterations of the model.

The overall rock art within this area was relatively dependent upon geology, cost to and from water and landcover (Table 8.12). Geology both increased and decreased the gain so when modelled independently had the most useful information and also contained the most information not found in the other variables. Preferable attributes were various types of sandstone while central-coast cottonwood-sycamore riparian forests, native desert grassland, pine woodland and bigcone spruce-canyon oak forest was the most important landcover attributes. The vegetation coverage here points to a great diversity of plants when compared to the regional scale that pointed more towards chaparral. Low cost to and from cupule sites were also an indication for rock art sites, but was not as important as it was in the overall region. Furthermore, the DEM showed a propensity for these sites to be located at elevations between 1000 and 1400 metres, but the majority is found at 1400 metres. Again we are seeing that cost to and from ethnohistoric villages are not as important to the model, but aspect was more important here than has been seen previously.

Relative Percent Contribution for Rock Art Located in the Sierra Madre Ridge/ San Rafael Wilderness (community-scale)	
Geology	**51.1**
Hydrology Cost	**27.1**
Landcover (vegetation)	**9.5**
Aspect	4.9
Cupule Cost	2.8
Ethnohistoric Village Sites Cost	2.7
Slope	1.8
DEM	0.2

Table 8.12: **Relative percent contribution to the Maxent model for all rock art in the Sierra Madre Ridge/San Rafael Wilderness communities. The values in bold are the top three contributors.**

Pictographs similarly showed the same relative top contributors to the model, but this is most likely because most sites here are pictograph sites resulting in similar outputs as the overall rock art sites (Table 8.13). Geology increased the gain while the outputs point to hydrology as decreasing the overall gain of the model. Cost to and from water when removed from the model had the most unique information not found in any of the other environmental variables and low cost distances were the best predictors. Again various types of sandstone were preferred and diverse vegetation created the best model with desert grassland, central-coast cottonwood-sycamore riparian forest and bigcone spruce-canyon oak forest.

Contribution for Pictographs Located in the Sierra Madre Ridge/ San Rafael Wilderness (community-scale)	
Geology	**43.2**
Hydrology Cost	**27.9**
Landcover (vegetation)	**12.2**
Aspect	5.9
Ethnohistoric Village Sites Cost	4.8
Cupule Cost	2.7
Slope	1.7
DEM	1.5

Table 8.13: Relative percent contribution to the Maxent model for pictographs for the Sierra Madre Ridge/San Rafael Wilderness community. The values in bold are the top three contributors.

Petroglyphs again had the same top three relative contributors, but aspect was not as important as the two previous models (Table 8.14). Overall geology was the best contributor to the model as it both increased the gain when modelled independently and decreased the gain when removed. Sandstone was the important predictor of petroglyphs location while the vegetation was pine woodland and desert grassland. As the elevation increased the probability of finding a petroglyph decreased. Low cost for both water and cupule sites were important, but cost to and from ethnohistoric village sites was not relevant to model performance.

Relative Percent Contribution for Petroglyphs Located in the Sierra Madre Ridge/ San Rafael Wilderness (community-scale)	
Geology	**52.2**
Hydrology Cost	**20.6**
Landcover (vegetation)	**18.5**
Slope	5.1
DEM	1.6
Cupule Cost	1.4
Ethnohistoric Village Sites Cost	0.4
Aspect	0.2

Table 8.14: Relative percent contribution to the Maxent model for petroglyphs in the Sierra Madre Ridge/San Rafael Wilderness communities. The values in bold are the top three contributors.

Rock art with associated middens also had exactly the same top three contributors while geology both increased and decreased the gain (Table 8.15). Sandstone was the predominant rock type while cost to and from water was preferred at low values. Vegetation types that increased the model's performance were desert grassland, central coast cottonwood-sycamore riparian forest and pine forest. Low slope values and low cost to and from cupule boulders also increased the model's predictability.

Relative Percent Contribution for Rock Art with Associated Middens Located in the Sierra Madre Ridge/ San Rafael Wilderness (community-scale)	
Geology	**52.7**
Hydrology Cost	**27.5**
Landcover (vegetation)	**13.3**
Slope	3.9
Cupule Cost	1.3
Ethnohistoric Village Sites Cost	0.7
Aspect	0.4
DEM	0.2

Table 8.15: Relative percent contribution to the Maxent model for rock art with associated middens in the Sierra Madre Ridge/San Rafael Wilderness communities. The values in bold are the top three contributors.

Rock art with associated BRMs also had geology as the most important predictor that also affected the gain the most through increase and decrease its value (Table 8.16). Sandstone was the most important rock to the associated BRMs while non-native grassland, pinyon and juniper woodlands and chaparral were the most important vegetation. The landcover results are showing a tendency for non-native grassland which represent the problems of using a modern environmental variable. This type of grassland was introduced during more modern times. Therefore, the result can be confirmed and thrown out as biased and now described as 'unknown' due to lack of palaeo-environmental reconstructions. Low cost to and from water was also important to model performance for this rock art type while as the slope increased so did the potential of finding rock art with BRMs within this community.

Relative Percent Contribution for Rock Art with Associated BRMs Located in the Sierra Madre Ridge/ San Rafael Wilderness (community-scale)	
Geology	**53**
Hydrology Cost	**21.7**
Landcover (vegetation)	**15.3**
Slope	5.2
Cupule Cost	2.6
DEM	1.7
Ethnohistoric Village Sites Cost	0.3
Aspect	0.3

Table 8.16: Relative percent contribution to the Maxent model for rock art with associated BRMs in the Sierra Madre Ridge/San Rafael Wilderness communities. The values in bold are the top three contributors.

Looking at the rock art sites with no associated archaeology there is again a focus on the cost to and from water being the most important variable (Table 8.17). It both increased and decreased the gain and had the most relative percent contribution for the model followed by geology and then landcover. Geologically sandstone was the most important setting for the rock art, and both pine woodland and bigcone spruce-canyon oak forest were important landcover contributors. Slope and cost to and from ethnohistoric village sites did not contribute any information to the model.

Relative Percent Contribution for Rock Art with No Associated Archaeology Located in the Sierra Madre Ridge/ San Rafael Wilderness (community-scale)	
Hydrology Cost	**45.4**
Geology	**39**
Landcover (vegetation)	**12.7**
Aspect	1.6
DEM	0.9
Slope	5.2
Cupule Cost	0.1
Ethnohistoric Village Sites Cost	0

Table 8.17: Relative percent contribution to the Maxent model for rock art with no associated archaeology in the Sierra Madre Ridge/San Rafael Wilderness communities. The values in bold are the top three contributors.

As the analysis moves to the community-scale distribution of the centimetre-scale bifurcated motif, again the outputs show the same contributors were apparent: geology, cost to and from water and landcover (Table 8.18). Geology increased and decreased the gain making it the variable to provide not only the most information for the model but also had the information that was not present in the in the other variables. Landcover was biased by the non-native grassland, but provided information on others such as chaparral and scrub oak chaparral. The model preferred low slope values and while the elevation increased so did the probability of finding rock art with a bifurcated motif. Overall the bifurcated motif in the region showed a preference for 700 metre elevations, but in this area the motif shows a preference for higher elevations that is likely due to the higher elevations found in this area. Elevation's contribution to the model showed that the DEM did not positively affect model performance. Ethnohistoric villages sites also played a more important role here than the other data being modelled in this area and performed well for high cost distances.

Relative Percent Contribution for the Bifurcated Motif Located in the Sierra Madre Ridge/ San Rafael Wilderness (community-scale)	
Geology	**34.4**
Hydrology Cost	**29.8**
Landcover (vegetation)	**20.3**
Slope	7.1
Ethnohistoric Village Sites Cost	4.5
DEM	2.9
Cupule Cost	0.9
Aspect	0

Table 8.18: Relative percent contribution to the Maxent model for the bifurcated motif in the Sierra Madre Ridge/San Rafael Wilderness communities. The values in bold are the top three contributors.

Finally, the last set of data for the San Rafael/Sierra Madre Ridge community was for associated cupules found at rock art sites (Table 8.19). Again the same pattern emerges with the top three environmental variables seen almost consistently within this area. Sandstone with a biased landcover result of non-native grassland showed the best model performance. Geology was overall the best variable to use for prediction. As slope increased, so did the preference for rock art sites and low cost to and from hydrology and cupule boulders. Ethnohistoric village cumulative cost, elevation and aspect had almost little to no affect on the model performance.

Relative Percent Contribution for Associated Cupules Located in the Sierra Madre Ridge/ San Rafael Wilderness (community-scale)	
Geology	**56.8**
Hydrology Cost	**20.7**
Landcover (vegetation)	**18.2**
Slope	2.8
Cupule Cost	1.1
Ethnohistoric Village Sites Cost	0.2
DEM	0
Aspect	0

Table 8.19: Relative percent contribution to the Maxent model for associated cupules in the Sierra Madre Ridge/ San Rafael Wilderness communities. The values in bold are the top three contributors.

Santa Ynez Mountains and Backcountry

The next community to analyse is the Santa Ynez Mountains and backcountry. For this community the model was run on the overall rock art sites, the pictograph sites and rock art with no associated archaeology. The AUC scores are found in Table 8.20 and show that the models weren't high performers due to the low number of rock art dependent variables, but the information can give insight in the regional variability.

	AUC Score
Rock Art All	0.774
Pictographs	0.832
No Associated Archaeology	0.800

Table 8.20: AUC scores for the community-scale of analysis for the Santa Ynez Mountains and backcountry. The results show a mean score from 10 iterations of the model.

When modelling all of the rock art sites found at this community scale, the outputs again show the same three top contributors but in a different order of relative importance (Table 8.21). Instead of geology having the most useful information for the model, landcover had the highest relative contribution and increased when modelled independently and decreased the gain of the model showing it had the most information that was not present in the other variables. Preferred landcover for high predictability was various types of chaparral and sandstone was the geologic context for the art. Low cost to and from water was also of importance for rock art site locations. Within this area, the cost to and from cupule boulders and cost to and from ethnohistoric village sites had no affect on the model.

Relative Percent Contribution for All Rock Art Sites in the Santa Ynez Mountains and Backcountry (community-scale)	
Landcover (vegetation)	**45.4**
Geology	**32**
Hydrology Cost	**20.7**
Aspect	3.3
Slope	2.8
DEM	1.7
Ethnohistoric Village Sites Cost	0.7
Cupule Cost	0.1

Table 8.21: Relative percent contribution to the Maxent model for all rock art sites located in the Santa Ynez Mountains and backcountry. The values in bold are the top three contributors.

Pictographs continued to have the same top contributors with landcover being the most important (Table 8.22). Various types of chaparral, sandstone and low cost to and from water were important contexts for rock art placement. In this model, we do see a higher contribution from the village sites and a preference for elevation at around 700 metres.

Relative Percent Contribution for Pictographs in the Santa Ynez Mountains and Backcountry (community-scale)	
Landcover (vegetation)	**44**
Geology	**30.8**
Hydrology Cost	**20.7**
DEM	2.4
Ethnohistoric Village Sites Cost	1.5
Aspect	0.4
Cupule Cost	0.1
Slope	0

Table 8.22: Relative percent contribution to the Maxent model for pictograph sites located in the Santa Ynez Mountains and backcountry. The values in bold are the top three contributors.

Finally, rock art sites with no associated archaeology were modelled showing a different top variable when compared to the other two outputs (Table 8.23). While the relative contribution was the highest for geology, landcover increased the gain showing that it performed the best when modelled independently and hydrology decreased the gain so had the most useful information compared to the other variables. Preferred context was sandstone, various types of chaparral and low cost to and from water increased suitability for rock art sites without known associated archaeological data such as BRMs and middens.

Relative Percent Contribution for Rock Art with No Associated Archaeology in the Santa Ynez Mountains and Backcountry (community-scale)	
Geology	**36.8**
Landcover (vegetation)	**34.4**
Hydrology Cost	**27.5**
Ethnohistoric Village Sites Cost	0.7
DEM	0.5
Aspect	0
Cupule Cost	0
Slope	0

Table 8.23: Relative percent contribution to the Maxent model for rock art sites with no associated archaeology located in the Santa Ynez Mountains and backcountry. The values in bold are the top three contributors.

Simi Hills and Ventura County

Next the KDE cluster for Simi Hills rock art and parts of Ventura County was modelled with Maxent. The following rock art data were used as the dependent variable: all rock art, pictographs and rock art with associated middens. The AUC score for this community is shown in Table 8.24.

AUC Score	
Rock Art All	0.804
Pictographs	0.842
Rock Art with Associated Middens	0.802

Table 8.24: **AUC scores for the community-scale of analysis for the Simi Hills and Ventura County. The results show a mean score from 10 iterations of the model.**

All rock art sites located in this community-scale analysis showed geology and landcover again as providing the best information for the model (Table 8.25). Geology increased and decreased the gain so was the best predictor modelled on its own and also contained the most information for model performance. As the relative contribution values show, the next environmental variable has a value that is considerably less than the first two with a percent contribution of only 8.9%. It seems that the rest of the variables contributed very little information in this area comparatively. Preferred geological contexts were various types of sandstone and basalt and vegetation was coastal sage-chaparral scrub, chaparral and scrub. Looking briefly at the low contributions of the other independent variables, there is a preference for low cost distances to water and better model performance as the elevation increases. Interestingly (as represented in the marginal response curves in

Appendix E), as the cost distance from village sites increases in this area so does the preference for rock art site locations showing a different trend (e.g. very little association of rock art and the ethnohistoric village sites) than any of the outputs so far.

Relative Percent Contribution for All Rock Art Located in the Simi Hills and Ventura County (community-scale)	
Geology	**45.3**
Landcover (vegetation)	**36.5**
Aspect	**8.9**
Slope	3.3
Hydrology Cost	3
Ethnohistoric Village Sites Cost	1.5
DEM	0.5
Cupule Cost	0.3

Table 8.25: **Relative percent contribution to the Maxent model for all rock art sites located in the Simi Hills and Ventura County. The values in bold are the top three contributors.**

Landcover was the most important variable to the pictograph model in this area through relative percent contribution and increasing and decreasing the gain (Table 8.26). The vegetation was predominantly scrub and coastal sage – chaparral scrub. Geology was second in relative percent contribution with sandstone as its preferred attribute while the value of the following input variables decreased significantly in their contributions.

Relative Percent Contribution for Pictographs in the Simi Hills and Ventura County (community-scale)	
Landcover (vegetation)	**49.5**
Geology	**32.8**
Aspect	**8**
Ethnohistoric Village Sites Cost	4.3
Hydrology Cost	4
Slope	1.3
Cupule Cost	0.1
DEM	0

Table 8.26: **Relative percent contribution to the Maxent model for pictograph sites located in the Santa Ynez Mountains and backcountry. The values in bold are the top three contributors.**

For rock art with associated middens, geology was the strongest and most important variable in determining site placement (Table 8.27). The preference was mostly towards sandstone but also a slight preference for basalt. Landcover indicated a strong association to site location and scrub and various types of chaparral. The rest of the environmental variables had low values compared and were of little informative value towards the predictability of the model.

Relative Percent Contribution for Rock Art with Associated MIddens in the Simi Hills and Ventura County (community-scale)	
Geology	**57.8**
Landcover (vegetation)	**20.2**
Slope	**10.7**
Aspect	8.3
Hydrology Cost	2.8
Ethnohistoric Village Sites Cost	0.1
DEM	0.1
Cupule Cost	0

Table 8.27: **Relative percent contribution to the Maxent model for rock art with associated middens located in the Simi Hills and Ventura County. The values in bold are the top three contributors.**

The Wind Wolves Preserve

The final community scale of analysis was the rock art found in the Wind Wolves Preserve in the San Emigdio Hills in the interior of the Chumash geographic region. The model's AUC scores were comparative to the other community outputs (Table 8.28). Rock art with no associated archaeology had the best model with the total rock art sites and pictographs with similar scores and the associated cupules falling below for a model with average predictability. Counts for the bifurcated motifs were too low to run the model, as were associated middens. The rest of the independent variables were used as input and the mean scores from ten iterations are described below.

AUC Score	
Rock Art All	0.794
Pictographs	0.797
Associated BRMs	0.738
Associated Cupules	0.697
No Associated Archaeology	0.851

Table 8.28: **AUC scores for the community-scale of analysis for the San Emigdio Hills and the Wind Wolves Preserve. The results show a mean score from 10 iterations of the model.**

This model performed much differently than the other three community scales that performed well with geology, landcover and hydrology. Here we see more of a trend that was apparent at the regional scale, a strong influence on cost to and from cupule boulders for the best model performance for all rock art sites (Table 8.29). Again geology had the highest gain so it was the most informative variable when modelled independently, but cost to and from cupules decreased the gain showing that it had the most unique information within this community that was not present in the other variables. As cupule cost decreased so did the potential of finding a rock art site yet there was a total of 27 cupule sites. This number is very large for this area and may point to an importance of these sites to the interior Chumash. Geological context was sandstone, gabbro and basalt while landcover context was chaparral, blue oak woodland and pine forest. Low slope values improved model performance and low cost to and from water was important. Cost to and from ethnohistoric villages did not affect the model, but this may be due to very few of these types of sites known for this area.

Relative Percent Contribution for All Rock Art on the Wind Wolves Preserve (community-scale)	
Cupule Cost	**40.8**
Geology	**35.2**
Landcover (vegetation)	**8.4**
Slope	7.7
Hydrology Cost	5.7
DEM	1.6
Aspect	0.5
Ethnohistoric Village Sites Cost	0.1

Table 8.29: **Relative percent contribution to the Maxent model for all rock art located on the Wind Wolves Preserve. The values in bold are the top three contributors.**

Pictographs were very similar to the results for all of the rock art within this area in terms of relative contributions and variables that increased and decreased the gain (Table 8.30). This is most likely due to the fact that there are 19 pictographs sites in this area out of a total of 22 rock art sites so that there was only a difference of three sites from the total rock art model. Context for geology was sandstone and gabbro. Vegetation attributes were chaparral and blue oak woodland. Preference was for low cost to and from water, low cost to and from cupule boulders and low slope values.

Relative Percent Contribution for Pictographs on the Wind Wolves Preserve (community-scale)	
Cupule Cost	**39.7**
Geology	**37.5**
Landcover (vegetation)	**8.8**
Slope	5.5
Hydrology Cost	4.1
DEM	3.7
Aspect	0.4
Ethnohistoric Village Sites Cost	0.2

Table 8.30: **Relative percent contribution to the Maxent model for pictographs located on the Wind Wolves Preserve. The values in bold are the top three contributors.**

For associated BRMs, there is a much larger relative percent contribution for landcover than found in the other two models; it is almost double in its contribution (Table 8.31). Again cupule cost decreased the gain while geology increased the gain. Sandstone and gabbro were high contributors while blue oak woodland was the most important vegetation of these site types. Cost to and from water is now more important than in the other models and is preferred at low costs. Ethnohistoric village contributed no information to the model.

Relative Percent Contribution for Associated BRMs on the Wind Wolves Preserve (community-scale)	
Cupule Cost	**35.7**
Geology	**32.5**
Landcover (vegetation)	**15.1**
Hydrology Cost	9.6
Slope	6.2
Aspect	0.7
DEM	0.3
Ethnohistoric Village Sites Cost	0

Table 8.31: **Relative percent contribution to the Maxent model for associated BRMs located on the Wind Wolves Preserve. The values in bold are the top three contributors.**

At the community-scale distribution of the centimetre-scale, there were ten locations with associated cupules although predictive surface did not have a very good AUC score due to the low number of input locations. It can be briefly discussed here. Overall the top three contributors were different that the other models for this area (Table 8.32). Cost to and from water though did not have a very high value leaving both geology and cost to and from cupule boulders as the most significant variables.

Geology both increased and decreased the gain making it the most important overall for the model and was able to have enough information to be modelled on its own. Sandstone was the most important geological attribute while low cost to and from both cupule sites and hydrologic features were preferred. Low slope values and blue oak woodland were also chosen contexts for the associated cupules.

Relative Percent Contribution for Associated Cupules on the Wind Wolves Preserve (community-scale)	
Geology	**43.1**
Cupule Cost	**34.8**
Hydrology Cost	**9.6**
Slope	9
Landcover (vegetation)	2.5
Aspect	0.2
Ethnohistoric Village Sites Cost	0.1
DEM	0.6

Table 8.32: **Relative percent contribution to the Maxent model for associated cupules located on the Wind Wolves Preserve. The values in bold are the top three contributors.**

The final model looked at rock art sites with no associated archaeology (Table 8.33). Again cost to and from cupules and geology were important predictors and landcover attributes were at only 8.8%. All variables decreased considerably after the top two contributors showing that they had little input for rock art with no associated archaeology. Instead of geology, cost to and from cupule boulders both increased and decreased the gain showing their heavy influence and importance to model importance. Geologically important contexts were sandstone, gabbro and basalt while landcover was important for pine forest and chaparral. The rest of the variables were very low contributors and had little to do with improving model performance.

Relative Percent Contribution for No Associated Archaeology on the Wind Wolves Preserve (community-scale)	
Cupule Cost	**56**
Geology	**33.7**
Landcover (vegetation)	**8.8**
DEM	0.6
Slope	0.4
Aspect	0.2
Hydrology Cost	0.2
Ethnohistoric Village Sites Cost	0.1

Table 8.33: **Relative percent contribution to the Maxent model for no associated archaeology located on the Wind Wolves Preserve. The values in bold are the top three contributors.**

8.8 Community Discussion

Looking at the overall results at the community scale of analyses, the most important attributes for rock art sites were geology, land cover and cost to and from water based on best predictive performance. While the discussion above for the regional scale is still relevant at these scales, I can expand based on more information from the variation found between the community scales. Geology, as with the regional scale, is a logical starting point for rock art location and placement. Sandstone is and has been visually confirmed as the important rock context for rock art location and it was again reflected in the community results. As stated at the regional scale, the preference for specific geological attributes may have been ideological, but it may have been practical too. At sites where BRMs were present, rock that was suitable to creating mortar pits would have been a desirable choice. The fact that rock art sites were also located at these same geological attributes points to the entrenchment of these sites and their immediate corridors. This is because the rock may have had not only a practical setting but also an important ideological or mythological association as represented within the ethnographic literature.

Landcover or vegetation and cost to and from water could point to a purpose of rock art similar to the conclusions that Robinson (2006) made for rock art placement, that of areas of processing and of inclusion or taskscapes. Landcover was variable throughout the region and is to be expected in such a diverse and large physiographic area. There is also a logical setting in areas with vegetation such as various types of chaparral, oak, pine and native grasslands that are ethnographically known to produce specific aspects of the Chumash diet (e.g. acorns, juniper nuts, pine nuts and chia sage) and were then stored for winter in their granaries at the permanent habitation sites. Chaparral was important for many of the models but the outputs also showed the problematic nature of using modern environmental variables. The non-native grassland skewed the results for some of the Sierra Madre Ridge/San Rafael Wilderness community outputs so do not give a complete picture of the landcover for that area. Finally, the variety of vegetation found at these sites points to possible food preferences for either the people within the community areas or to enhance the trade networks from other parts of the Chumash interaction sphere. Particular foods could have been important in strengthening the trade network or for use in trade in procuring food or goods from other areas (King 1976). It also could simply point to a particular preference the group had for a cuisine found in these areas and influenced the placement of rock art especially those with associated BRMs.

Cost to and from hydrological features was also in the majority of the top three contributing variables and showed a preference to low cost to and from water features. The rugged topography of the community areas, being located within the foothills and mountain ranges, can be a hindrance to access to water. Inputting a cumulative cost surface for the model showed that while many of these sites were visually close to sources of water, low cost was still preferred. Low energetic cost points to a decision for rock art placement in areas where transporting water needed to be easier so as to possibly aid in the processing of foodstuffs or for sustaining the people gathering there for reasons such as ceremonies. Processing foods such as acorns requires the use of water to leach the bitter tannins (Basgall 1987). Easy access to the water would allow for it to be transported to the processing areas with ease. Water would also need to be accessible if these areas were inhabited for any length of time due to their distance away from permanent settlements. Distance to ethnographic villages is perhaps the least necessary of the attributes, but if we look at the Chumash as a highly mobile group where perhaps terrain was never a hindrance in terms of gathering, then distance or rough terrain would not have been a problem. Finally, areas where aspect was an important predictor and a higher percentage contribution could be a reflection of wind or water erosion creating high exfoliation of the rock faces in these areas (i.e. Simi Hills/Ventura county community-scale).

As described above, Hyder (1989) rightfully predicted the important variables that were chosen for rock art site placement and his suppositions are verified through this model for all rock art sites within the Sierra Madre/San Rafael community. A variety of vegetation types from central-coast cottonwood-sycamore riparian forests, native desert grassland, pine woodland to bigcone spruce-canyon oak forest were important. Also found were associations to other archaeological sites (in this study that would be the cupule boulders) and elevation of around 1400 metres which are all similar to Hyder's (*ibid*) visual conclusions from site visitations and observing topographic maps of site locations. He also states that "the high elevation means that the Sierra Madre sites are subjected to greater erosion-causing temperature extremes…" which points to why aspect is in the top four contributors for overall rock art sites in this community. For all of the models the most important predictors for this area were geology, cost to and from water and vegetation. The rest of the environmental variables had much lower percent contributions showing that their input did not affect site location as much as the top three. All of the top environmental variables point to this area as a potential taskscape and is similar to the seasonal foraging ideas that were presented by Horne (1981). This was further enforced by the idea that cost or travel (either low or high) to ethnohistoric villages was not important and that the landcover may have been a driving factor due to a preference for specific foods.

In the Sierra Madre/San Rafael community there were no changes to the information for the extraction of the centimetre-scale distribution. Finally, we see a difference in percent contributions for sites with no known associated archaeology. Cost to and from water was the most important, followed by geology. Again the different environmental contributions may point to a more exclusive or supernatural/ceremonial aspect to the site as described in the regional discussion.

For the Santa Ynez Mountains and backcountry models, Hyder (1989) was again shown to be correct as sites were contextually found in chaparral and on sandstone. The top three contributors again were the same as the sites found in the previously discussed community, pointing for the potential of these sites to represent taskscapes. Unfortunately associated BRMs and middens did not have high enough numbers for analysis within the model and perhaps their low numbers point to a more exclusionary aspect for these sites, as 67% of them had no associated archaeology. Rock art sites with no associated archaeology, again had slightly different environmental contributors where water was the highest contributor to model preformance. The consistency of this between the Sierra Madre/San Rafael community and this community is interesting and perhaps points to a higher dependency on water or an importance to water for private sites. While this is discussed at the regional scale, if we look at the example outlined in Chapter 5 of the malevolent shaman creating a curse of drought by painting rocks which was only broken by another shaman 'cleansing' the rock in water, or through the mythological and religious importance of water, it may at least highlight the potential ideological connections.

Rock art sites in the Simi Hills and Ventura County had slightly different top contributors for the models. Cost to and from water was preferable for low energetic cost but was a very low contributing variable. Low preference to water costs would fit nicely with Romani et al.'s (1985; 1988) hypothesis that these areas were used for the solstice and other ceremonies instead of areas for processing food. Although it could be argued that if these areas were taskscapes, then the processing would have been with foodstuffs where water was not needed or they were carrying stored water to these sites. Even then these people were highly mobile so perhaps getting water from difficult terrain was not an issue for them. As discussed earlier, there are only seven BRM sites compared to 15 midden sites that could support a more ceremonial, gathering function or represent possible camp sites. Furthermore in terms of relative contributions, geology and vegetation were preferred over all of the other variables. If I look at the vegetation found for high model performance, coastal sage-chaparral scrub, chaparral and scrub, where many of these areas could have provided plants where water was not necessary for processing nor did they need BRMs for grinding and pounding. Aspect being in the top three, although with a low value, probably points to biases due to erosion. Rock art with associated middens show a different preference for low slope values that would make sense if the middens were an indication of places where people were gathering for specific social reasons. While the results for both the Santa Ynez Mountains and backcountry and for the Simi Hills and Ventura County community areas are interesting, the areas here need to be further surveyed more extensively to continue to understand rock art so that the analysis can make use of more of the associated data to form a more holistic picture.

Finally, the Wind Wolves Preserve was modelled and had a model profile both similar and different to the other communities. Distance to cupule sites, second in importance at the regional scale, was the most important environmental variable for rock art sites in this area. As I stated earlier for the regional scale, this association between rock art sites and the cupule sites could point to a connectivity between them based on food processing or social importance where low energetic travel between the sites was socially important or facilitated the taskscape. Most of the other attributes being modelled showed a predilection for cost to and from cupules, geology and vegetation. Low cost to and from hydrology was a part of the model, but was not as important. This is interesting as blue oak woodland was an important landcover attribute, so acorn processing would have been a potential function of these sites. Again this could reflect that navigating difficult terrain was not an issue for such a highly mobile group nor was carrying water over distances. The Wind Wolves Preserve was the only community-scale area where the sites with no associated archaeology did not have a different environmental variable profile. Yet, there was a big drop in percent contribution for cost to and from hydrology. This may be a reflection of the different physiographic area. It could perhaps point to a different ideology or network being played out in this far interior landscape within areas of potential interaction between other interior groups that may have influenced the Chumash (i.e. the southern valley Yokuts and the Kitanemuk). Finally, associated cupules did display a different variable profile where geology was the most important for prediction followed by cost to and from cupules and then hydrology.

8.9 Conclusion

The research questions outlined in the introduction of this chapter had shown a variety of results.

- **What is the correlation between the rock art sites, specific element types and the associated cultural material to specific landscape features?**

The results above point to an important aspect rarely discussed or represented in the Chumash literature and researched in rock art studies. It is perhaps the most important conclusion to make is that there was regional variability in the decisions for rock art landscape locations which shows that analysis should not be wholly based on the interpretation of stylistic variability made by Grant (1965). The stylistic variability is important as it represents the agency of the individual artists, but by studying the underlying processes, this analysis looks at the potential decisions of site choice. The different environmental contributions are very apparent throughout the results and point to the regional variation potentially based on the varying ideologies or social systems of the different linguistic groups and directly related to the variable physiographic attributes of the Chumash interaction sphere. We also see a preference to different landcover features that would reflect the preference in cuisine for these areas or a demand for cuisine from other areas for trade.

- **Is this reflective of what is written in the ethnographic data about Chumash**

ideology or similar to what other researchers have posited?

Based on the research question much of what has been written about rock art sites is found in the results presented here. Hyder (1989) recognised the potential for variability in his study between the Sierra Madre Ridge sites and sites located in the Santa Ynez Mountains, and this analysis has again confirmed that it is the case. Based on many of the contributing variables, there is a logical basis to conclude that these sites could have been taskscapes such as hypothesised by Robinson (2006) and there is also a logical basis to conclude that certain sites could have had group ceremonial purposes such as purported by Romani et al. (1985). Rock art had an ideological function of differentiated power (Robinson 2011) with varying degrees of inclusivity and exclusivity based on its role as visual media. We see that there could have been sites of exclusion that represent a the creation of a strong ideological network through the belief in malevolent and benevolent entities that needed to be both revered and appeased so that the mundane tasks could function (Hudson and Underhay 1978). There is also evidence that may support that some sites were areas of exclusion that may have only been visited by shamans and their attendants such as discussed by Whitley (2000) and not for the consumption for the general public.

Overall the variation of environmental model contributors at multiple scales represents not only the diverse physiographic environment, but also the entrenchment of the interwoven networks within the Chumash landscape and taskscapes. Chumash rock art was part of highly variable, heterogeneous networks throughout their landscape. The underlying environmental variables also reflect the supernatural, social, economic, political and ideological networks that were layered and entrenched throughout space and time. This is because the Chumash's decision for rock art site location is a part of entrenching them into the landscape of the Chumash interaction sphere. Entrenchment creates strong interwoven, network relations especially as a rock art site has further multiple uses such as a taskscape, hunting/gathering camp or a place to balance power relations with the supernatural.

In this chapter, I also explored the network relations through studying the specific values that were more indicative of rock art site location. Certain rock art attributes such as those sites with no associated archaeology, the importance of stand-alone cupule boulders in the Wind Wolves Preserve and associated cupules for both the Sierra Madre/San Rafael and at the Wind Wolves all show different environmental network relations and highlight the variability within the overall multi-scalar network. As I have stated before, the Chumash landscape, through their supernatural belief system, was filled with both malevolent and benevolent personified attributes that played a role in Chumash daily life. Analysis of the rock art attributes represents a landscape that was entrenched by the rock art's varying degrees of private and public consumption that ebbed and flowed over time. Sites that were more inclusive were entrenched through strong social networks in taskscapes and a power ideology that was reflective of inclusion while sites that were more exclusive were entrenched through more supernatural networks based on power ideology more indicative of exclusion. Finally the analysis now needs to study and understand the isotropic and anistropic cost of movement throughout their landscape to explore the organisational structure behind the rock art placement in relation to other sites to highlight and visualise the network ties in terms of access and associations.

Chapter 9 Travel and Connectivity within the Chumash Interaction Sphere

9.1 Introduction

The study discussed in this chapter aims to ask questions based on energetic cost and travel times throughout the Chumash interaction sphere and study the potential connectivity based on cost at the regional scale and time at selected community scales of analysis. Therefore the main research question being asked is:

1) **What are the potential network connections through accumulated cost between the rock art sites to the other sites?**

The final analysis looks at past dynamic behaviours by studying rough estimates of movement between other archaeological sites and the rock art using accumulative cost surface analysis at a variety of scales. Simply put, it looks at the potential networks on a continuous surface through the energetic cost of movement (Conolly and Lake, 2006), and in this study, focusing on the connectivity and network relations under the tenets of ANT. The previous chapter looked at the underlying landscape characteristics that potentially may have had an influence and further entrenched the network relations of the Chumash landscape and interaction sphere. In this chapter, I will study movement at the overall regional scale between rock art sites and then the relationship between rock art sites and the ethnohistoric villages as a heuristic to understand if energetic cost influenced the placement of rock art sites within the social networks such as the economic (trade) systems and subsystems, political or marriage networks. The GIS analysis will use both isolines and isochrones extracted from the cumulative cost surfaces to study not only groups of site types at the regional scale but also at a more localised scale; the community-scale and site scale. This prevents the analysis from being constrained to specific paths that may not be representative of actual prehistoric paths or movement that would be found in a least-cost path output (see Robinson 2006; 2010a). The areas of movement are then treated as buffers where human agents would have chosen the path within each energetic cost or travel time contour. Cumulative cost analysis can reflect the interwoven connectivity of the rock art sites to the location of other site types, and more importantly, open up discussions on the roles that energetic cost and travel times may have played within the Chumash networks throughout their landscape at multiple spatial scales. Finally other questions can also be explored:

- **How are different types of rock art sites potentially connected?**
- **How are the different rock art site connections related to marriage networks from the mission records or information on the political and economic provinces or religious territories from the ethnographic record?**

The overall aim of this chapter is the premise that the outputs of the analyses can shown how connected the Chumash network relations have become over time through the visualisation of the organisational structures (Knappett 2008, 139) of the innumerable heterogeneous and dynamic spatial and temporal networks that created their landscape and are represented through movement to and from rock art sites.

9.2 Isolines and Isochrones

The most simplistic output for this analysis is that of the isolines that are created by converting the cost surface into contours based on specific energetic cost values. In contrast isochrones are defined as the cost of travel where "…the time required to reach this point from the origin is constant" (Herzog 2012, 18) therefore all points that fall on a specific isochrone can be reached in the same amount of time. Points that fall within the isochrones would be reached at some time between the designated interval values. The time estimations are represented either as continuous bands in a raster format or as contours representing areas of equal travel time using a specific algorithm based on energetic cost over a specific geographic region from input points.

The first application of isochrones within archaeology is from Gaffney and Stančič's (1991) study of the island of Hvar that looked at the resource types that fell within the specific isochrones. Since then other studies have utilised this GIS function (e.g. Chataigner and Barge 2007; Herzog and Yepez 2010; Bevan 2012; Wheatley et al. 2010; Chataigner and Gratuze 2013 among others) and some of these analyses have compared actual hiking times to the outputs of the various programs (e.g. Bevan 2012). In rock art studies, as discussed in Chapter 3, cost surfaces based on time were used in the study by Hartley and Vowser (1998), but the author's focus their discussions on the least-cost path outputs (LCP). Robinson (2006; 2010a) used isotropic cost, again as discussed in Chapter 4, to create LCPs to study external and internal landscape movement of the Emigdiaño Chumash whose landscape is roughly the modern-day Wind Wolves Preserve and one of my community-scales of analysis.

Another study by Armstrong (2011) studied the shellfish profiles between villages sites within the inland during the Late Period to shellfish profiles found on the coast to see if these patterns reflect socio-political and economic ties represented by Johnson's (1988) study on marriage ties. The results suggest that it was potentially more dependent upon geographic distances instead of these other networks (*ibid*). Although no distance analysis was performed through GIS, overall Armstrong (*ibid*, 97) states that "…the primary conclusion that can be drawn from research performed in the Santa Ynez Valley is that issues such as social complexity, exchange, kinship ties, and resource procurement cannot be studied in isolation from the geographic realities in which they existed and that all tools available through both ethno-history and archaeology must be applied in order to gain any real understanding." Therefore studies by both Armstrong (*ibid*) and Robinson (2006; 2010a) point to the potential that geographic distance, and in this analysis when applied through cumulative cost values for rock art sites, can aid in presenting a more holistic picture of the Chumash landscape networks. I will therefore expand on this analysis by using isolines and isochrones from anisotropic cost surfaces at the community-scale to further explore Robinson's (2006; 2010a) research to discuss rock art connectivity without the use of LCPs. While Johnson's (1988) complex ethnohistoric ties to marriage, economic and political systems are very important, research into the whole Chumash interaction sphere was not possible due to the extensive landscape this study represents. Johnson's (*ibid*) performed a study encompassing the coastal sites and those within the Santa Ynez Valley.

In order to discuss the issues with this analysis, I need to go back to a time before GIS was fully utilised as an application or tool within archaeology. Historically, the application of this type of analysis originated in archaeology to determine site catchment studies that were popular in the late-60s and throughout the 1970s (Roper 1979) to determine discrete geographic territories (see Wheatley and Gillings 2002, 162 or Conolly and Lake 2006, 224-225 for a full discussion on how to create them).

Yet as Conolly and Lake (2006, 224) suggest, the analyses using cost surfaces also suffer from similar problems to the older applications. Roper (1979, 124) succinctly outlines one of the main problems that is still very applicable to these types of studies today by stating (emphasis the authors):

> Very early in the development of site catchment analysis the terms *territory* and *catchment* were distinguished—the former as the area immediately accessible to a site's inhabitants, which was habitually exploited, the latter as the total area from which the contents of a site were derived. A territory as defined therefore became an analytic device whose size was determined by ethnographic analogy. A catchment, on the other hand, became a behavioural unit whose referent must be inferred from comparative knowledge of site territories, resource distribution, site contents, and settlement system morphology. Obviously, the better the analytic device approximates the behaviorial unit the better the analysis of the catchment itself…Thus, 2-hour or 10-km (or whatever) territories have been treated as if they were actual catchments: time or distance contours as if the site's inhabitants were on a 10-km long leash.

Further critiques stem from the lack of a theoretical basis for the catchment size (Roper 1979). Often, such analyses did not consider any overlap of these 'territories' by particular groups of people which is often the case for if the area has a specific resource that two groups prefer (*ibid*). The use of energetic cost isolines and isochrones are more realistic than the original site catchments that oftentimes relied simply on buffers of a specific radius. Herzog (2012, 18) also discusses problematic aspects of using the realistic travel costs and time site catchments as specific boundaries where distances are not weighted and suggests that, "…increasing cost limits could be added, so that the area close to the site centre is assigned a higher weight or importance than areas at a distance."

I argue that the study outlined here is different from site catchment analysis. First, the isolines and isochrones produced here are based on cumulative cost surfaces so it is looking at how these sites are networked and associated with each other based upon two different measurements. In addition, previous catchment analyses are focused on a single site at a single scale, but I am presenting a multi-scalar analysis of cumulative costs to understand the connectivity of the network relations. I also use the term 'connectivity' (Latham et al. 2008) or 'connectedness', to describe the areas of low energetic cost or relatively short travel times to create the isolines and isochrones respectively that join the sites through isotropic and anisotropic network relations from analysis of movement. As I have stated previously, these analyses are a heuristic to increase the dialogue on rock art sites and identify the numerous organisational structures that may have entrenched rock art within the landscape that are further supported through the archaeological and ethnohistorical and ethnographic record. The outputs will also not stop at specific distances to create discrete areas or catchments but will connectively continue throughout their regional interaction sphere and community-scales to look at how movement may have facilitated the site placement and important cultural interactions.

I am basing the study on the fact that the Chumash were a highly mobile group of complex hunter-gatherers that had networks of movement influenced by social, economic and ideological ties through such things as trade, marriage and feasting ceremonies (Gamble 2008). As complex hunter-gatherers, the Chumash would have been highly mobile and able to navigate their physical environment quite well to facilitate their many networks. The underlying movements to and from rock art sites will be a heuristic to continue to visualise and conceptualise the many layers of networks already starting to develop from the analyses in the previous chapter. If rock art was ideologically important, or if it was a place of gathering for either ceremonies or as a taskscape, then its placement would be entrenched in the movement of people throughout their landscape to and from these sites. Therefore, these travel networks may have potentially influenced rock art site placement, for example, based on items that were important trade goods such as preferred cuisine choices found in specific geographic regions or travelling for political or religious ceremonies. Of course, there is never a simplistic relationship with real prehistoric territories or provinces and this study never claims to provide all of the answers for their movement. As was seen in the previous chapters, there are possible underlying environmental variables and persistent clustering that may have influenced site choice which also have recorded evidence found within the ethnographic literature, but they may not be the only structural determinant in the Chumash rock art network.

9.3 Methodology

The algorithms for creating travel times are based upon Tobler's hiking function (see Gorenflo and Gale 1990; Tobler 1993) or Naismith's rule for walking times (see Langmuir 1995). In the analysis presented here, Tobler's hiking function was applied to the slope variable. Originally presented by Gorenflo and Gale (1990) as:

$$W = 6e^{-3.5|S+0.05|}$$

where W is travelling on foot at 5 km/hour , e is the natural base for logarithms and S is slope measured by percent. The algorithm used in this analysis is a derivative of this function (*ibid*) and allows for the conversion from kilometres into metres:

$$t = {}^{d}/_{6e^{-3.5|S+0.05|}}$$

where t is the estimated time in hours, d is the distance in kilometres converted into metres and s is again the slope measured by percent.

Slope was deemed an appropriate input variable for the energetic cost and the travel times based on a number of reasons outlined here. First, the Chumash were highly mobile hunter-gatherers that would have utilised the landscape for procurement of many resources. Slope would most likely be the greatest hindrance to their movement although it could be argued that perhaps this was not as insurmountable for them. For example at Pool Rock (CA-SBA-1632), located in the San Rafael/Sierra Madre Wilderness area, there is a cave located up a sheer rock face that has archaeology that can be seen from the ground. Experienced climbers would be needed with proper gear to access this site today. Water was not used as a hindrance for movement throughout the topography as modern streams in the inland and interior are shallow and are easily forged. It is more the shear canyon walls that create the largest cost and is demonstrated instead in the slope variable. Furthermore, due to the climatic variability from the ENSO throughout different times in prehistory, it is difficult to assess which streams were ephemeral or perennial during snapshots through time. The general temporal scale for this analysis should be that travel was outside of the months when snow would cover the higher elevations found places like the Sierra Madre Ridge. While this would not be true for those areas near the coast which have a more Mediterranean-like climate, if we are to look at the regional model as a whole, the late autumn and the winter months are understood as being seasonal times when many of the rock art sites and taskscapes were utilised for hunting or gathering camps.

Tobler's hiking function was applied to slope for travel times, but it is not the only algorithm available for determining cost of movement through time. As was stated above, other studies include the Naismith's rule for walking times (Langmuir

1995), which is also a part of the algorithm to determine anisotropic cost in the r.walk analysis in GRASS GIS (e.g. Bevan 2012). Further studies have used metabolic rate in watts as a measurement for cost outputs (e.g. Krist 2001). Tobler's hiking function applies cost to provide a rough estimate of time at an average speed of six km/hr on a flat surface with values that change over the area according to slope values. It is generally assumed that humans walking to a destination will walk a roughly seven to eight hour day yet the hiking function does not factor in any type of break that may be needed during the course of the day. Additionally, a study of soldiers and their packs found that with a load of 35 kg, a soldier walked roughly 4.5 km/hr while with a 20 kg pack, a soldier walked 5.5 km/hr (Scott and Christie 2004). It is known through ethnohistorical and archaeological evidence that the Chumash would have hiked with a variety of goods if they were travelling to ceremonies or feasts or brought foodstuffs back from autumn harvesting in the higher altitudes (Hudson and Blackburn 1983). Therefore, travel times can be argued as the application of weight-bearing walking and it can be logically applied to the Chumash. Travel times for people walking or hiking without carrying any loads would be faster. General fitness and body type of the person walking is not taken into consideration but it would affect the outcome. A variety of different time scales and energy costs can also be extracted using the outputs to measure specific costs or for times that have ethnographic meaning.

While not necessarily applied to isochrones, Kondo et al. (2011) studied actually hiking times from least-cost paths created in a variety of commonly used GIS programs. The authors wanted to determine which GIS algorithm was the most accurate to the human examinee's time and distance measurements from hiking the program's path outputs. The determining travel times were gathered from the hiking function and ArcGIS anisotropic costs were also explored. Therefore, it can be argued that it is applicable to this study even if I am not using a LCP output. They found that the ArcGIS and GRASS GIS r.walk anisotropic algorithms were relatively close to the actual distances and travel times when compared to the other algorithms (*ibid*). The output also shows that the ArcGIS anisotropic surface with the hiking function applied to the slope values underestimates time (*ibid*) and should be taken into consideration when interpreting the outputs presented below.

Cost surfaces had previously been applied for the inputs to the Maxent analysis discussed in Chapter 8. Two different algorithms were applied by two different GIS programs (i.e. ArcGIS Cost Distance and GRASS GIS r.walk) due to issues with data size of the regional variables and memory and size constraints in GRASS GIS. The decision to use two programs for the predictive model stemmed from the preference for the most accurate cost possible when dealing with input at the community-scale. For the analysis here, I believe that it is more important to analyse and compare similar algorithms for travel times to the best extent possible. Since GRASS GIS could not process the data at the regional scale and since GRASS applies Naismith's rule for hiking, it was decided to use Tobler's hiking function and apply it to the slope. It was important to at least have some similarities to compare and contrast for both the regional- and community-scales of analysis.

The community-scale of analysis applied the Path Distance tool in ArcGIS that allows for information on anisotropic walking times for travelling both towards and away from the rock art sites. Travel times were based on Tobler's Hiking Function and the output was anisotropic isochrones base on return trip times and also energetic cost isolines. In contrast, the regional scale, only the Cost Distance tool could be applied so therefore the output was isotropic and times were based only on travelling away from the sites. Therefore, the same time and cost will be incurred from walking to and from a site. This is not true of actual hiking as different costs should be applied for hiking uphill or downhill.

Just as in the previous chapter, the regional scale allows for more broad generalisations while the community-scale provides much more nuanced outputs although all outputs were relative estimates of both energetic cost and travel times. While most GIS programs do not model the zig-zag motion of most hikers on steep hills or mountains, it was this author's choice to remove the LCP aspect from the study. This allows the isolines and isochrones to at least represent an area where the person walking had multiple choices for which way to walk or travel to arrive to their destination. LCP does not give agency to the person hiking and makes a specific decision for the hypothetical person concerning their journey that would include switchbacking up a mountain. Isolines and isochrones may not necessarily model this in their travel times; it leaves room for discussion on many potential paths to the sites being studied. The analyses will be performed on the two more heavily surveyed areas of the San Rafael Wilderness/Sierra Madre community and for the Wind Wolves Preserve for both energetic cost and time travel. The two areas were chosen because they have been comprehensively surveyed, and more associated information has been documented in these landscapes. For example, while conducting the surveys the information that was gathered included looking for BRMs and middens within the surveyed areas (Horne and Glassow 1974; Robinson 2006).

During fieldwork and as described in the introductory chapter, I was able to document real travel times on two different occasions for sites in the San Rafael wilderness in my field notebook. First a trek to monitor Pool Rock (CA-SBA-1632) and Condor Cave (CA-SBA-1633) (see Figure 9.1 and 9.2) for Los Padres National Forest was done in October 2011 and later a hike to Negus Cave (CA-SBA-1628) and Bear Track Cave (CA-SBA-1627) (Figure 9.3) in February 2012. A National Forest site steward, Jon Picciuolo, and I completed the hikes to monitor site visitation by hikers and any potential destruction from weather erosion to human destruction. Other sites were visited on the Vandenberg Airforce Base and in the Santa Ynez Mountains, refer to Chapter 1, but are outside of the two community-scales being studied here. Furthermore, travel times to visit them were relatively short as they could be accessed by car and walking a short distance. The results for my other site visits therefore would be found within the regional scale, and because of its size, the GIS cannot handle representing bins shorter than an hour. Comparisons to actual travel times can only be made at the more localised analysis. Time to reach the destination was roughly three and a half hours from a local campground and at a low fitness level as one of the hikers was not used to the terrain. The second hike was around three hours and began about a half a mile from the same campgroup. Time costs will be compared to the actual hiking hours although the fitness of the Chumash would have most likely surpassed the author's. The Chumash would have also had a much more intimate relationship with their landscape as evidence has shown from the numerous prehistoric camps found within these geographical areas[12]. Finally, it should also be

[12] While inclusion of these types of sites are outside the scope of this paper, studies by Hyder (1989) and Robinson (2006; 2010a) have shown that temporary camps have a positive spatial association to the rock art sites.

noted that this analysis is looking at internal areas and potential conduits as movement to and from rock art locations. Specific analysis on the areas of potential conduits for the ethnohistoric villages, for example, are outside the scope of this research, but would be exceptional future research. Therefore in this analysis, only through the overlay of the ethnohistoric villages onto the rock art isolines and isochrones will the relationships be interpreted. More specifically, the outputs presented below will study ethnohistoric village overlap in order to discuss potential connective and interwoven networks relations.

Figure 9.1: Photo of the main shelter at Pool Rock taken by Michelle L. Wienhold on an October 2011 visit.

Figure 9.2: Photo of the main shelter at Condor Cave taken by Michelle L. Wienhold on October 2011.

Figure 9.3: Photo of one of the many shelters at Bear Track Cave taken by Michelle L. Wienhold on February 2012.

9.4 Results: Regional Scale of Analysis

The first part of this analysis will look at the isolines at the regional scale of analysis from the isotropic cumulative cost surface created from the rock art site locations. Again at such a large scale the outputs are heuristics for looking at more broad generalisations of the overall area. The outputs were arbitrarily converted into bins representing 10% of the energetic cost values so that the first bin represents the lowest 10% cost and the last bin represents the highest 10% cost (Figure 9.4). The cost values show connectivity through energetic output grouping many of the sites together. As the output suggests, there are clustering of places that are similar to the outputs of the KDE for the extraction of the community-scales of analysis. It is to be expected, as the outputs are cumulative rather than on a site-by-site basis. The high-density areas represent a stronger internal connection, as the sites are spatially located near each other while also showing a stronger entrenchment within the over network through connectivity. There is no longer the smoothing of the surface but rather a reflection of the actual energetic cost of traversing the overall landscape. As was shown in the last chapter, cost from the ethnohistoric villages did not provide much information for the model of the placement of rock art sites, but this can now be explored further by also overlaying the sites to study the reasons why this may be.

Again, while these ethnohistorically documented villages may not have been contemporaneous with the rock art, through research by Glassow et al. (2011) it is known that some of the rock art sites existed while the villages or other settlement types (e.g. hunting camps) were actively occupied. The isolines can also visualise and conceptualise energetic cost for the sites where people could easily, and at low cost, travel to other places within the landscape.

Figure 9.4: Regional isolines in 10% bins representing energetic cost for the Chumash interaction sphere.

There is a 20% isoline (in pink) that connects the Santa Ynez Mountain and Valley area to the sites in the San Rafael wilderness and continues up into the Sierra Madre Ridge. This 20% cost also links the Sierra Madre Ridge with sites in the Carrizo Plain showing an overall connective network here based on energetic cost. This same cost bin shows connectivity from the coastal sites to the sites of the Ventureño Chumash located in the Simi Hills and other parts of modern-day Ventura County. There is a slight connection to the Emigdiaño Chumash rock art in the Wind Wolves Preserve from the Carrizo Plain, but the topography seems to isolate this group of sites more so than the other areas. There seems to be an easier connection for the Emigdiaño to the north with the Southern Valley Yokuts in terms of topographic access than with other parts of the Chumash interaction sphere.

More specifically, the Santa Ynez Mountains and back country rock art sites associated with the Ineseño Chumash have a much lower energetic cost creating easier connections further into the valley instead of towards the coastal ethnohistoric villages where there are purported to be important political centres (Figure 9.5). There are approximately six villages located in this area possibly connecting the rock art to these inland areas rather than the coastal areas. There are two sites that were located within the original KDE that are now seen as stand-alone sites as the cost to traverse the landscape to reach these areas is much higher. Both sites, CA-SBA-120 and CA-SBA-1652 have no known associated archaeology and contain just pictographs (Figure 9.6). Their isolation isn't as relevant due to their close location near two ethnohistoric villages. Therefore during ethnohistoric times these sites were known even if they were created much earlier. The cost to reach the Santa Barbara coastal area is in the 20% cost bin and would require, in many places, a person to cross another higher cost area with values of 30% cost. It would take more energy to reach the coastal political centres. A person could choose to take the lowest energetic cost route which could potentially have them navigating the areas nearby the two pictograph sites.

Figure 9.5: Travel costs within the Santa Ynez Mountains and backcountry.

Figure 9.6: Travel costs in the Santa Ynez Mountains and backcountry highlighting the two rock art sites in turquoise that is isolated within the 10% isoline but connected to the coastal villages through the 20% isoline.

In the Sierra Madre/San Rafael community area, the low cost breaks the area into two distinct areas based on the cost values: San Rafael Wilderness and the Sierra Madre Mountains (Figure 9.7). Both areas still contain ethnohistoric village sites. For the sites associated with the Ventureño Chumash located in the Simi Hills/Ventura County area, there is a much lower cost showing a stronger connectivity to the coastal settlements. Easy access to these areas could point to groups utilising the rock art locations. While for sites associated with the Emigdiaño Chumash located on the Wind Wolves Preserve, there is a large clustering of the sites showing a strong connectivity at the regional scale. Similar results are shown for the Carrizo Plain area. The other isolated or less connected area seems to been south of Mount Pinos and Cuddy Valley. While there are no sites within that particular area, to the south there are known ethnohistoric sites and also small clusters of rock art sites that include both BRMs and middens.

Figure 9.7: Low cost areas within the Sierra Madre/San Rafael community area at the regional scale of analysis.

Figure 9.8: Low cost areas within the Simi Hills/Ventura County community area at the regional scale of analysis.

While energetic cost times are a typical output, travel times are much more intuitive and less frequently used. Even so, when analysing topographic movement, travel times are more relatable to most modern humans as this is how travel is typically described. Looking at the outputs for the travel times associated with these areas, it gives a clearer picture of how long travel would take to reach certain places within the Chumash interaction sphere (Figure 9.9). For many of the sites in the Santa Ynez Mountains, the trip to the coastal sites is only a three hour walk which is not overly long although the terrain, as seen in the isolines, has a higher energetic cost when compared to going towards the valley. Likewise, the actual time to walk to rock art sites and ethnohistoric villages within the backcountry area and in the valley is less than two hours. Within three hours of walking away from the rock art sites there is a strong connectivity with the backcountry and also with the coast representing the potential relationships the rock art had with settlement sites in these areas. More importantly there is much less time to walk to each of the rock art clusters. One could 'leap-frog' from different sites in less than an hour showing strong connectivity between the rock art sites themselves.

Figure 9.9: Regional isochrones in 1 hour hiking increments over the Chumash interaction sphere.

The rock art sites located within the Simi Hills/Ventura County area are again connected through about four to five hour walking times (less than a day) to the coast. While more localised (within the community-scale) settlements and other rock art sites were only within one to two hours (Figure 9.10). Most rock art sites within the San Rafael Wilderness can be reached from nearby rock art sites within an hour while this area is connected to the Sierra Madre Ridge by a two-hour isochrone (Figure 9.11).

Furthermore, it requires the individual to traverse through or nearby the ethnohistoric village site of *Siwil*. Within the Wind Wolves Preserve a person is able to reach another rock art site in less than an hours time (Figure 9.9). It is similar for the Carrizo Plain and for sites near the coast at Point Conception (Figure 9.9).

Figure 9.10: Low travel time areas within the Simi Hills/Ventura County community area at the regional scale of analysis.

Figure 9.11: Low cost areas within the Sierra Madre/San Rafael community area at the regional scale of analysis.

Overall there is less connectivity for the time travel of an hour throughout the landscape as places like the Carrizo Plain and the Wind Wolves Preserve are more topographically isolated when compared to the energetic costs. As the time increases to three hours we see a similar connectivity found with the energetic cost of the 20% bin. Finally, if a person was at a rock art site within this regional area, they would more often be able to reach another rock art site or ethnohistoric village within an hour.

9.5 Regional Discussion

The regional analysis shows that from the majority of rock art sites the Chumash were able to reach either another rock art site or ethnohistoric villages through low energetic cost and short travel times of less than an hour. This represents the organisational structure of the network relations through the connectiviey of the sites throughout their landscape. At the regional scale, while there are only broad generalisations being made, it shows the potential of some rock art sites to be associated with other settlements found in areas within the isolines or isochrones. It further promotes the concept that the Chumash had an intimate relationship with their environment and their landscape. Sites were located so that travel to any other groups of sites was not overly costly, so an individual at most rock art sites wouldn't go for long distances without encountering either another rock art or a permanent village site. While the coastal sites have been documented as being important political centres with chiefs that may have had control over the provinces, it is interesting to see that in terms of time there is some connectivity between specific coastal sites into the interior. The large areas where KDE showed high site densities were shown to also have low cost and short time to travel between them. The low value isolines or isochrones may point to perhaps what Hudson and Underhay (1978) describe as the provinces or the larger religious territories. Overall what we are seeing at this scale is a snapshot of many different dynamic networks that have aggregated over time entrenching this area through the isolines and isochrones.

Results in the Santa Ynez Mountains and backcountry could potentially support Johnson's (1988) study on stronger marriage ties between sites in different ecological zones. The coastal settlements and the settlements in the Santa Ynez Mountains are two very distinct ecological zones. Areas of rock art within the Santa Ynez Mountains, if highly connected to the valley settlements, as shown by the low cost values and the low time values, would give the people in the valley easier access to these resources. This could be concluded as enabling control over particular resources found within the mountains due to less topographic obstacles. Therefore, stronger marriage ties would indeed strengthen the trade economy of these goods with the coast. Within the Sierra Madre Ridge/San Rafael Wilderness, sites that were also studied by Horne (1981) using site catchment also show a more localised connectivity of low cost and low travel times. The localised connectivity is very relevant to Horne's (*ibid*) hypothesis that sites in some of these areas belonged to specific villages located within the area. Obviously it is difficult to point to one specific village in any of these areas that potentially had control of the rock art sites. I can only surmise that these sites were potentially connected to others within similar isolines and isochrones. There are potential relationships to specific areas of gathering for many of the associated permanent settlements during late summer/autumnal months. Low energetic cost of bringing large amounts of foodstuff back would be easier than in areas of high cost. The sites in the Simi Hills potentially point to the rock art sites as places of engagement for the coastal villages such as was associated in Romani et al. (1985). There was easier access to the coastal villages in terms of cost yet in travel times there is usually a three-to four-hour travel time to these sites. Fifteen known associated middens at rock art sites are located here pointing to activity areas or temporary camps and could mean that people were spending longer periods of time at the sites for either ceremonial purposes or for performing specific tasks indicative of taskscapes. If solstice ceremonies were being held as hypothesised (*ibid*), then the conclusion would be made that all of the people within the area would be participating. Children and the elderly would most likely require overnight stays within this area, or the ceremonies and tasks would last much longer than one day. The Wind Wolves sites were all accessible to each other within an hour so that 'leap-frogging' from site to site was neither time consuming nor had a high energetic cost. As with Robinson's (2006; 2010a) least-cost path studies there is connectivity with all sites within this landscape.

Overall, as seen in Figures 9.4 and 9.9, while there are ethnohistoric villages located within some of the low-cost areas, there are many more that are located within areas that are not associated to rock art at all. It almost seems that sometimes in the inland and interior regions, rock art sites "fill in the gaps" so to speak between ethnohistoric village locations. Whether that is a direct result of survey and excavation biases or not remains to be seen in future archaeological work within this area (Robinson 2011). Looking at Armstrong's (2011) study of the shellfish profiles of four ethnohistoric villages, for one example, we see that one of these villages, *He'lxman*, was found to have a strong connection to the rock art within the Santa Ynez Mountains and also a lower cost of access to the coast (Figure 9.12). The results of Armstrong's (*ibid*, 94) analysis of this village show that the shellfish taxa for this area was from places such as Santa Barbara and Goleta on the coast almost directly to the south over the Santa Ynez Mountains. While interestingly, the ethnohistoric documentation of *He'lxman* showed that it had marriage ties of sites further up the coast (Johnson 1988). This may point to further entrenchment of these sites into multiple diverse and interwoven networks at different spatial scales. It would make sense that there would be many network ties between places politically and economically. Just because a group was networked through marriage did not necessarily mean there were exclusive economic network ties for the groups involved. It could also represent the different scales of organisation as outlined by Hudson and Underhay (1978) of provinces and larger religious groups. What Armstrong (*ibid*) also did not discuss is that there were perhaps stronger ideological or social motivations for different types of network ties to power (Robinson 2011) or access to resources (King 1976) (to more address this requires a push for excavations at most of the sites within the Chumash geographic region to understand that type of ties that exist through time at all of the sites types).

Figure 9.12: Example of an ethnohistoric village, *He'lxman*, studied by Armstrong (2011) and its ties to the coastal communities and the rock art in the Santa Ynez Mountains.

In the overall regional scale, there was a high rate of connectivity for the lowest 10-20% of energetic cost and at 1-2 hour walking times. In order to get more specific information from the isolines and isochrones, I will now look at the community-scale of analyses within the Wind Wolves Preserve and the Sierra Madre Ridge/San Rafael Wilderness area. The smaller areas will allow for smaller bins that look at how the sites are also separated. Finally, anisotropic cost (total cost of return trip) are shown here next instead of isotropic that shows the same times for either direction which is not representative of real life travel. Analysis at the community scale will also allow individual sites and groups of sites to be further explored a variety of smaller time and cost bins to further localise the analysis.

9.6 Results: Community Scale of Analysis

9.6.1 Sierra Madre Ridge/San Rafael Wilderness Community-Scale

The first community scale of analysis that I will look at here is the San Rafael/Sierra Madre community by first considering the isolines and then the isochrones. The idea is to 'drill-down' using lower smaller scales of analysis and study what is located in the connected areas grouped by either energetic cost or travel times. The first analysis used energetic cost representing the total cost of moving towards and away from the site (Figure 9.12). Similar to the regional energetic cost, the isolines were created using bins representing 10% of the values.

Figure 9.13: Isolines with 10% cost bins showing energetic cost within the Sierra Madre Ridge/ San Rafael Wilderness community.

Immediately apparent is the connectivity between groups of sites and areas including the ethnohistorically documented villages. There is a connectedness between groups of sites so that as you leave one site you are connected to another site. Therefore travel to rock art sites within this community would most likely entail the people travelling near these sites especially based on low-cost values. At this scale of analysis it is now apparent how these areas are further structured as at the regional scale--the sites were more broadly grouped together. Further separation gives a better picture of what could represent areas that smaller groups of people utilised for ceremonial or task-related purposes. Within the 30% isoline, the two areas are also now connected.

Figure 9.14 Isochrones representing 1 hour return times for travelling towards and away from rock art sites within the Sierra Madre/San Rafael community.

Analysis of the anisotropic travel times are then analysed to compare the two values, and as was stated earlier, the travel time values are much more intuitive values for understanding movement within the geographic areas (Figure 9.14). Between the two areas (Sierra Madre cluster and the San Rafael cluster), there are slightly less connected outputs for energetic cost for the Sierra Madre Ridge sites which is to be expected due to its much more extreme topography when compared to the travel times. I will focus on exploring two different groups of the larger site clusters, one in the San Rafael Wilderness and one on the Sierra Madre Ridge using the more intuitive travel time values (Figure 9.15). The clusters represent less than one hour return times to move towards or away from the other rock art sites. Sites within the San Rafael Wilderness stayed connected for both the energetic cost and the travel times while the sites in the Sierra Madre Ridge area were segregated in the 10% energetic cost but at the 20% cost values became more connected. There is one major conduit shown with both the isolines and isochrones which connected the two areas together and the village site located there could have been politically important place as it would have controlled some of the internal movement between these two areas. This study so far has only discussed connectivity between groups of sites that fall within the isolines and isochrones and how they are potentially part of a greater Chumash network. Here I want to now look at specific site clusters and what they are comprised of to potentially understand why these connections may exist. Therefore the isochrones were used based on their more intuitive values to select out two areas of further site-scale analysis.

Figure 9.15: Selected isochrones for site analysis to further explore how these sites are connected.

Within the San Rafael cluster, there are ten sites, nine of which are pictographs and one petroglyph site. 70% of the sites had associated BRMs and 40% had associated middens (Figure 9.16). If these sites were relatively contemporaneous and assumed to be used such as hypothesised by Horne (1981), then there are potential taskscapes here based on the number and nature of the associated data. Return trips to another rock art site are less than an hour and based on the intimate landscape knowledge that the Chumash had, it is probable that people at one or more of these sites would have known the location of some if not all of the other sites in the area. It is also likely that these areas represent sites belonging to family groups or specific nearby permanent settlements. There is an ethnohistorically documented village [13]at an estimated three-

[13] The ethnohistoric village site found here is documented as *Hawamiw* through Johnson's database, but Horne (1981) located this site further to the north. Regardless of the actual name of the site, there is

hour return travel time that is less than a day's walk. It is possible that this village was connected to this cluster of rock art sites.

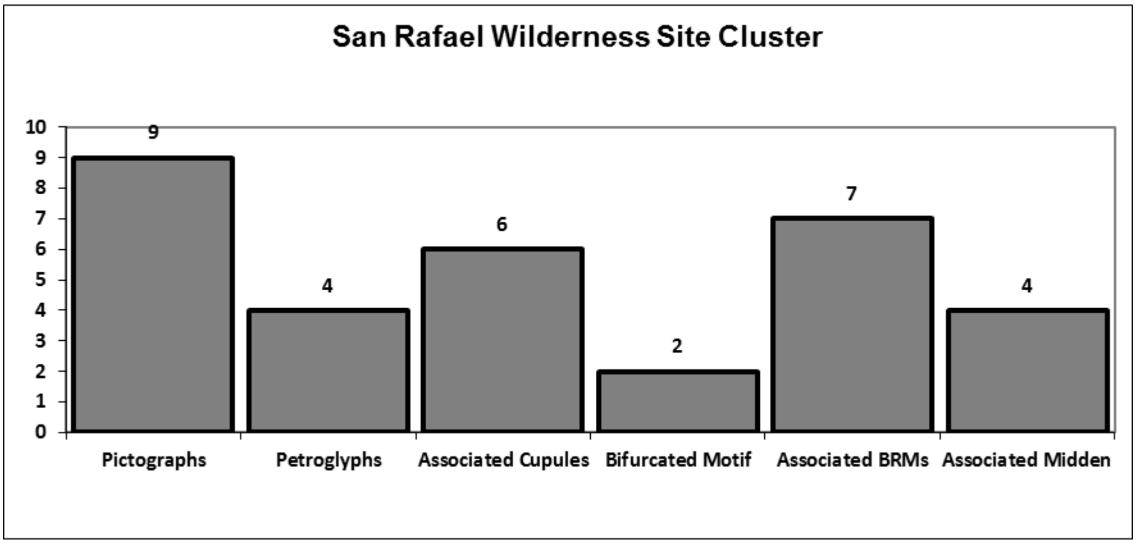

Figure 9.16: Counts of rock art types and associated data for the San Rafael Wilderness isochrone.

There were no stand-alone cupule sites in this area, but 60% of the sites had associated cupules. The outputs of the predictive model for the San Rafael cluster selected geology, low cost distance to and from water and landcover as good indicators of site locations. By looking at the variables within the isochrone value, the outputs show that specific landcover for this area is predominantly buckbrush chaparral and a slight overlap with Venturan coastal sage scrub while the rock art sites are located on sandstone. Buckbrush chaparral is known to be seral or successional to some deciduous oak woodlands or Lower Montane Coniferous Forests in some areas (UCSB GAP Data 1986). This could mean that in the past oak woodland was present in this area based on potential ecological succession that may have been restarted or initiated by fire. Excavations around these sites could potentially reveal the presence of acorn processing at the sites to support such a conclusion of oak presence. By travelling a total of an hour return trip to one of the rock art sites, a person would also encounter more of the same buckbrush chaparral. No springs are located within this area, but there are local ephemeral streams nearby that may have been perennial at some points during prehistory (Figure 9.17).

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still archaeological evidence showing a permanent habitation site at this location.

Figure 9.17: San Rafael isochrone of one-hour return walking times and associated hydrological features.

Figure 9.18: Counts of rock art types and associated data for the Sierra Madre Ridge isochrone.

Looking towards the Sierra Madre cluster of sites, there are a total of 15 rock art sites, two of which are stand-alone cupule sites (Figure 9.18). Every site had either an associated BRM or a midden while 11 or 73% of these sites had both present. Both of the stand-alone cupule sites had BRMs while one also had a midden present. Within this isochrone, the geology of this area is sandstone and mudstone and the sandstone matches the overall predictive model of the area. There are numerous ephemeral streams and drainages that at some point could have been perennial in prehistoric times but require further palaeo-environmental reconstructions to determine. Surprisingly there are 12 springs located in this area, an extremely high number with some being right next to the rock art sites (Figure 9.19). Landcover vegetation was a variety of scrub oak chaparral, pinyon and juniper woodlands, semi-desert chaparral and non-native grassland. Looking at the landcover that represents non-intrusive plant species, we again see a reflection of plants that were part of the Chumash cuisine. Again the majority of the rock art sites located in this area again have all of the attributes of taskscapes. Interestingly, there are no villages closely associated with these sites in terms of short walking times due to the extreme topography of these mountains. This would more so point to people camping within these areas, hence the presence of middens. Finally, the strong presence of springs near these sites even lends rock art sites to also being temporary camps because being near water would be necessary.

Figure 9.19: Sierra Madre isochrone of one-hour return walking times and associated hydrological features.

In terms of sites with no associated archaeology (Figure 9.20), there are two located in the area studied within the San Rafael Wilderness. It now seems much less convincing that these sites are private based on their close association to the other sites within the group. Within the Sierra Madre area there are five sites with the potential to be private or were either completely isolated by the isochrones or less connected and more stand-alone sites. Four of these were pictograph sites and one was a stand-alone cupule site showing that these were potentially more private or exclusive sites that were more important ideologically and potentially created by shamans but yet still directly entrenched within the social networks similar to Robinson's (2011) hypothesis of differentiated power.

Figure 9.20: Isochrones showing association of sites with no associated archaeology.

9.6.2 Wind Wolves Preserve Community-Scale

First, looking at the energetic cost found within in the Wind Wolves Preserve, I again show the energetic cost as 10% bins (Figure 9.21). The internal movement between the sites has strong connectivity but not as strong as was found at the regional scale. Here we are seeing more specific outputs instead of a more generalised output. Two of the ethnohistoric village sites (*Malapwan* and *Tashlipun*) are directly associated with the low cost values and the other is within the 20% bin so still within the lower values. Similar to Robinson's (2006; 2010a) outputs with his LCP, we see an internal connectivity that while showing connection with the Southern Valley Yokut area, was much more prominent within the areas defined as part of the Chumash landscape. Further study with data from the Yokut sites would potentially provide further connectivity and show how potential external trade networks were created. It has been shown through J.P.Harrington's work that there were similar cultural ties between the groups through, for example, social organisations (Blackburn 1974, 11). Overall there is a full connectivity between all sites within the 20% isolines for low energetic cost.

Figure 9.21: Isolines for rock art sites within the Wind Wolves Preserve.

Figure 9.22: Isochrones for rock art sites within the Wind Wolves Preserve.

Looking at the isochrones for the Wind Wolves area for the Emigdiaño Chumash (Figure 9.22), we see a similar connectivity between the sites within the area. In terms of one-hour return trips to and from the rock art sites we see even more connectivity for the sites. In this area, it was very easy to get from one rock art site to another through 'leap-frogging' within a short period of time. This creates an overall connectivity in this landscape where the people would pass by rock art sites as they moved throughout the areas. When compared to the connectivity of the region, again there are more specific and nuanced isolines and isochrones instead of an overall grouping of sites as found at the regional scale. Also, when compared to the other community-scale of analysis we are seeing a more interactive landscape where sites are easier to travel to and from, most likely due to less extreme topography.

Figure 9.23: Selected isochrone for further exploration of sites.

In this area, one isochrone is used to extract a group of connected sites (Figure 9.23) to study more specific site analyses to see if any further information can be gained. There is one ethnohistoric village located within the isochrone, *Tashlipun*, and connects the internal sites to sites in the north. A total of 21 sites were located within this isochrone representing 43% of the total rock art sites found on the Preserve (Figure 9.24). Eleven were pictograph sites and 21 were stand-alone cupule sites while 13 sites had associated BRMs and 6 sites had associated middens. Again we are seeing fewer middens in areas with more connectedness to ethnohistoric villages similar to the group found within the San Rafael Wilderness. While this could potentially point to low return cost to and from villages so that fewer camps were needed within these areas, more studies within the isochrones are need to determine the actual relationship. At this time, it is only a potential even though it makes sense in terms of both energetic cost and travel times. Unfortunately within this area the landcover vegetation results are all non-native grassland, which is a result of invasive species within California and have no potential representation of what biotic communities were present here in the past. Further excavations would potentially reveal flora analysis at these sites to reconstruct the palaeo-environment. Geology of the sites in this isochrone shows a predominance of sandstone and alluvium that mostly represents the overall regional and community-scale trends described in Chapter 8. The number of associated BRMs and middens points to similar conclusions as Robinson's (2006; 2010a) study of the area that suggests these areas were taskscapes. The sites located within the Wind Wolves Preserve also had eight K-locales showing the intensity of food processing that went on within this area. In terms of hydrology, no known springs were available for this area through the USGS topographic maps but most of the sites are found near ephemeral and perennial streams (Figure 9.25).

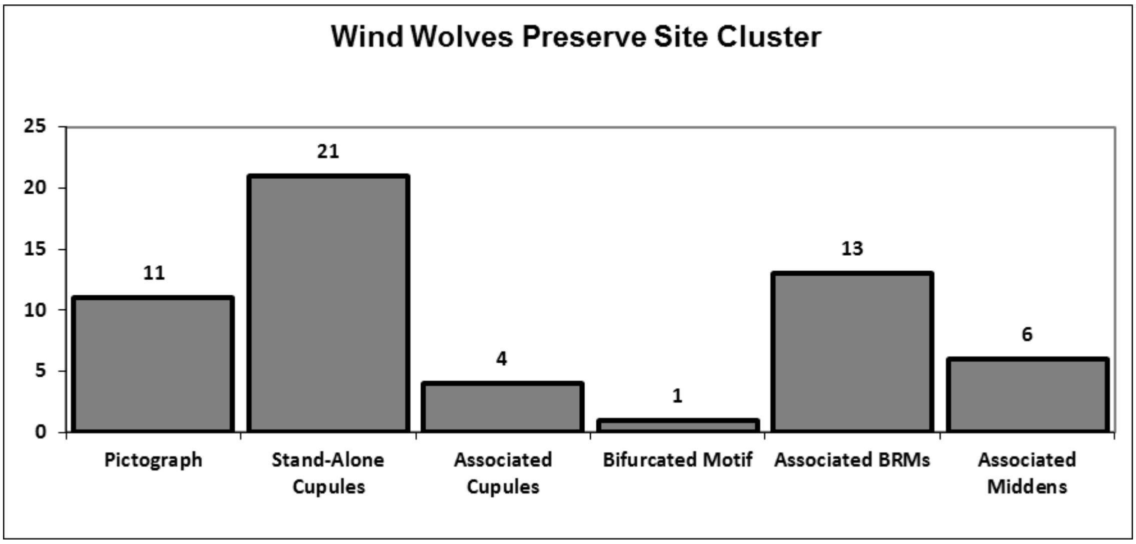

Figure 9.24: Site types and associated archaeological data for the rock art sites within the selected isochrone.

Figure 9.25: Wind Wolves isochrone of one-hour return walking times and associated hydrological features.

Finally, when one studies the location of the sites with no associated archaeology within the Emigdiaño Chumash (Figure 9.26), there are very few sites without associated archaeology that is not near other rock art sites. In other words, most of these sites are located within areas of low energetic cost and short travel times to other rock art sites so that it is unlikely that these places would have been places of exclusion. Travelling within these areas, one would have most likely encountered the other sites not only because of low cost values but also because of spatial proximity. The two potential sites of exclusion are located in the Northeast part of the preserve and the third site located in the Southeast corner. One is a petroglyph and an associated cupule site, the next is a site with a boulder showing light pigment smears and the last in the Southeast corner is a pictograph site. These three fit the profile of a private site, are not located within the larger groupings of sites and are spatially isolated in terms of nearness to other sites. It is apparent that in order to reach many of the sites from the ethnohistoric village in the far Northeast through the areas of low cost, a person would traverse near these sites. Therefore, these sites again had varying degrees of exclusivity based on local people's interaction with them throughout time. Excavation at these sites would need to be completed to further address how exclusive these sites were.

Figure 9.26: Locations of sites with no associated archaeology on the Wind Wolves Preserve.

9.7 Community Discussion

Between the two community-scale areas (Sierra Madre/San Rafael and the Wind Wolves Preserve), visually there is more connectivity of sites with low values within the Wind Wolves when compared to the San Rafael/Sierra Madre community based on the differing terrain found in each area. This again supports the fact that there are variable environments for rock art site locations between these two areas as shown in the analyses performed in previous chapters. It still does not explain the presence of more overall stand-alone cupule boulders within the Wind Wolves Preserve community. More analysis of these site types needs to be performed to further understand their overall preference in the Emigdiaño Chumash landscape.

One interesting point is that the bifurcated motif was found within each of these three site groups showing how ubiquitous it is throughout the landscape. It may point to an important Chumash ideological function of this motif. Because it was found in all three site groups, it could represent a cohesive identity marker referencing a specific symbol/motif used by the *'antap* cult or a specific type of visual media understood by Chumash society. Further analysis of its location within low cost aggregations of sites would need to be studied before any strong conclusions could be made.

Through this analysis, it is apparent that aggregations of rock art sites that are spatially near each other represent more entrenched places either for potential ceremonial purposes or taskscapes through movement and activity within the topography to and from these sites. The connectivity found within these areas shows that if these rock art sites with BRMs or middens were utilised by family groups (or even larger groups), communication between the family groups would have been quite easy as the sites could provide easily reachable areas for group aggregation. It could further point to the fact that these groups would need to work together between the connected sites to share resources and taskscapes. Not only because they would potentially be gathering from the same areas, but also they would likely encounter each other within the lower value isolines and isochrones. It is safe to assume that if the sites were contemporaneous, the people that utilised the sites at the low value isoline and isochrone clusters could belong to the same inclusive group or at least had some sort of alliance based economic, political or social ties. Based on ethnohistoric literature, "intervillage warfare was endemic" (Johnson 1988, 116; Johnson 2007) perhaps due to fighting over resources, so one could conclude that if these areas were shared by neighbouring groups then the sites experienced a connectivity through inter-group or inter-village alliances. An important point to make here concerns the taskscapes and the Chumash women's role within these specific areas. As women had ownership of these places (Robinson 2011), it can be assumed that they played a role in these alliances with other taskscapes. Women would forge relationships in these areas through the social networks with other gathering groups from potentially other villages.

Within the San Rafael Wilderness area, it is likely that people would have stayed in this area to gather their cuisine choice over the designated months with perhaps trips back to store the foodstuff at the village. It is difficult to tell which villages were perhaps more important within this area as ethnohistoric data has been unclear. *Soctonocmu*, a site that was studied by Johnson (1988) as having marriage ties to villages located to the north, is located just to the southeast of this community-scale of analysis indicating that it had marriage ties that connected villages located within this scale of analysis (see also Robinson 2011). *Soctonocmu* was further hypothesised by Horne (1981) to be the centre of a network that would encompass part of this area under analysis. *Soctonocmu* is roughly 4-5 hours just outside of the cluster of rock art sites studied here (Figure 9.27). All of these sites could have been potentially been a part of this larger marriage (and perhaps economic network) as it would take the inhabitants only a half a day to travel to the rock art site and return. It would also make sense since there are many clusters of sites within low cost isolines and isochrones, so that alliances would facilitate cooperation for gathering within this larger network.

Figure 9.27: Location of *Soctonocmu* (in turquoise) in relation to the Sierra Madre/San Rafael community-scale output.

Within the Wind Wolves area, similar to Robinson's (2006; 2010a) study, this analysis shows evidence that travelling to many of the rock art sites through low cost areas and for short travel times a person would encounter other rock art sites. If these places were used at the same time then cooperation between different families or groups from the nearby settlements utilising these areas would be encouraged due to the easy access and spatial nearness between them. Associated archaeology such as middens and BRMs found at these sites point to the fact that they were not places of exclusion but places where multiple tasks were being performed. Overall it should be noted that these people were most likely women because they were known to be the predominant gatherers and processors of foodstuffs within Chumash society (Hudson and Blackburn 1983). Again as hunters and gatherers, the Chumash were highly knowledgeable about their surrounding landscapes and utilised it for a variety of purposes. It is highly unlikely that the rock art was unknown and areas that had excellent resources would also be unknown. As Robinson states (2011, 34) in his analysis of K-locales within the Wind Wolves Preserve: "…it is through these kinds of long-term engagement with the local landscape that traditional notions of triblet ownership and rights of access should be understood…and local communities certainly would have claimed ownership of important resource patches surrounding BRM sites."

Within the two areas at the community-scale of analysis, it seems that the Emigdiaño Chumash were less likely to have private or exclusive sites than rock art located within the San Rafael/Sierra Madre Wilderness. If this is truly the case and not simply a result of the lack of discovery, then we are again seeing a variation between the two areas. Sites of exclusion were perhaps ideologically different to varying degrees when compared to the sites with associated archaeology. Robinson (2006; 2010a) also found that there was a lack of private sites for the Emigdiaño's landscape showing a possible reflection of the variation or differentiation of ideology between the linguistic groups or the sites' use as a taskscape ebbing and flowing over time.

9.8 Conclusion

The results of this analysis have provided potential conclusions for the research questions outlined in the introduction. Firstly I asked:

1). What are the potential network connections through accumulated cost between the rock art sites to the other sites?

As the results have shown, there is a strong connectivity between sites throughout the regional scale of analysis as the isolines and isochrones create a connectedness throughout the region. The regional analysis shows that from the majority of rock art sites the Chumash were able to reach either groups of rock art sites or ethnohistoric villages through low energetic cost and short travel times of less than an hour. Travelling through the landscape through perhaps 'leap-frogging' from site to site could represent the movement within their landscape. At the community scale, we see how groups of sites were potentially organised for use by either people in family groups or various settlements. Next, I asked:

- **How are different types of rock art sites potentially connected?**

The rock art sites are found to be aggregated in low cost/low travel times showing how they may have been related to each other through movement through the landscape. People moving towards and away from rock art sites would most likely encounter another rock art site within the same isoline and isochrone based on their spatial nearness and low cost. As the values increase, the sites become more and more connected within and show how dynamic network ties would be forged between groups of people.

- **How are the different rock art site connections related to marriage networks from the mission records or information on the political and economic provinces or religious territories from the ethnographic record?**

This question was difficult to answer, as very little information on these types of ties exists within the two community areas. The results did show a connection between the rock art sites within the Santa Ynez Mountains to the villages within the Santa Ynez Valley showing potential ownership of the rock art and resources within the mountain. Further more, a highly networked village was found to be only a four to five hour hike away from the San Rafael Wilderness showing the potential that the smaller ethnohistoric villages and rock art sites may have been a part of the larger political, marriage and economic network of the area. By using one ethnohistoric village from Armstrong's (2011) analysis of shellfish profiles we also see how there are multiple connections, through landscape movement, at a variety of spatial scales for the Chumash.

The overall goal of this chapter is to understand and conceptualise how the isolines and isochrones can show the organisational structures of the network relations within the Chumash landscape through movement to and from rock art sites. The outputs of the analyses for both travel costs and travel times have shown that rock art is entangled and interwoven within the various networks of the landscape and the taskscapes; there is no exclusive relationship to any one network. Through the addition of the environment and ethnohistorically documented villages, it is even more apparent that strong network interrelationships existed through movement within the Chumash interaction sphere and that rock art relations were connected within the gathering, processing, ceremonial, economic, political and mythological networks. Movement to other rock art sites and ethnohistoric village sites, therefore, represents one of the many underlying structural and organisational principles of the dynamic interrelationships.

Chapter 10 Conclusion

10.1 Overview

As I previously highlighted in Chapter 2 in the contextual background section (Section 2.2), South-Central California is home to diverse and dynamic physiographic and ecological regions that broadly entail the Channel Islands, expansive coastal areas and the varying topography and terrain of the inland and interior. For at least the past 10,000 years, this area has been home to a society of complex hunters and gatherers called the Chumash. Chumash complexity stems from their hierarchical and heterarchical social and political organisation reflected within their material culture consisting of shell bead currency, plank canoes, intricately woven baskets, elaborate mythology and supernatural beliefs and a rich ethnohistoric and ethnographic record amongst many others. Contextual information pertaining to their complexity has been further gathered through the extensive survey and mitigation on the Northern Channel Islands and along the expansive coastal areas especially from shell middens and cemeteries. One of the most striking features of Chumash material culture is their elaborate, complex polychromatic pictographs, petroglyphs and cupule boulder sites (rock art) found through the inland and interior that is, unfortunately, left out of the main discussions on the rise of Chumash elites.

In the first two chapters, I expanded on the rich environmental settings in the region to study and further synthesise Chumash society through the past and present analysis of archaeological research, ethnohistoric documentation and ethnographic research. Additionally, I synthesised the more problematic areas currently facing Chumash rock art research and addressed them in this thesis. Problems arise with the fragmentary nature of Chumash rock art research that has been based on either the physiographic regions or specific linguistic groups (see Section 1.2) but never comprehensively analysed over the whole Chumash geographic area. In order to produce a more complete methodology to perform rock art research, I discussed three relevant approaches used internationally as a framework for my analysis: scale, informed and formal methods (e.g. Chippindale 2004; Chippindale and Nash 2004; Hyder 2004). As rock art is fixed within the landscape and environment, a push in the past 20 years has been to incorporate rock art studies within a landscape framework to study the topography and landscape of rock art settings instead of focusing on rock art as a portable artefact (Bradley 1991). Past efforts for rock art research have focused on the gathering of geographic information for the conservation and preservation of these sites (Schaafsma 1985), so therefore, the data exists to apply these methodologies. Next I outlined the various theoretical frameworks in Chapter 3 from Ross (2001, 545) that have been applied to Chumash rock art in the various regions and linguistically defined areas. The neuro-psychological model, archaeoastronomy, puberty and other communal rites, riverine, territory and trail/path markers and event/mythical/historical markers have been applied to Chumash rock art (see Section 3.3), and I discussed their use through examples from past and current Chumash research to further highlight how they have utilised the three methodological applications. Quantitative and spatial analysis, what is described as the formal methods of analysis, is extensively reviewed as it aids in further understanding how this type of methodology is picking up momentum within rock art studies but is still not prevalent.

An introduction into the theoretical framework applied in this thesis, ANT, is presented in Chapter 5. ANT is a descriptive methodology that provides the framework to discuss the assemblage of topological network relations under the assumption of a flat ontology. Furthermore, it adds non-humans (i.e. objects, features, the landscape) into the heterogeneous networks through material semiotics where agency is ubiquitous and endlessly extended through interwoven relationships; both Gell's (1998) primary and secondary agency is, therefore, also intertwined within ANT's networks. Similar to the theory of affordance, the actors/actants/networks act and enact creating relational associations and effects by inciting behaviour and moving away from dualist paradigms. Incorporating space within ANT's associations allows the data or information to define space. The network relations are described as 'fractal-like', where the closer one may look at an association the more networks a researcher is likely to find (Law and Mol 2009). Therefore, I argued that rock art itself is also a network, especially referring back to Chippindale's (2004) multi-scalar methodology and of the multiple networks previously described through the symbol and stylistic interpretations (see Section 1.2).

In order to develop the three methodologies for holistic rock art research presented in Chapter 3, I further modified ANT's tenets (section 5.4) so it can be an applicable theoretical framework incorporating formal, informed and multi-scalar analysis. Critiques of ANT had found problems within its original tenet of spatiality (e.g. Bosco 2006; Sheppard 2002). Issues arise when spatial relationships mask specific internal variability and interrelationships that may shift through space and time. Specifically, ANT can be apolitical and ignore the depth and strength of these internal relations. Within my research and in most archaeological research, the data are a sample and research is approached through trying to understand the complexity and variability of the network relations that are represented through the archaeological, ethnohistoric and ethnographic record. Therefore, I argued that ANT must be adapted to the research. I highlighted Inkpen et al.'s (2007) approach to ANT which states that instead of looking at topological networks, researchers should instead begin focusing on the topographic metaphor, or in this case, the topographic networks where the persistence of network relations is entrenched by being more connected and aligned throughout space and time. Scale and spatiality becomes another explanatory device that is defined through both the relations and the networks. I argued that, through these tenets, the archaeological record can be understood through the internal spatial and temporal shifts within the network over varying scales to understand the depth, strength and connectedness of relations. Finally, landscape, within rock art studies is defined as how past humans perceived their environment and how patterns and distributions of artefacts in the environment can be used as a reflection of social behaviours or ideology (Hyder 2004, 85-86). Through the incorporation of ANT, landscape's definition is further expanded as being comprised of networks at dynamic spatial and temporal scales entrenched within social interactions and ideologies.

Next, I argued that using ANT through GIS and spatial analysis can highlight new ways of viewing and researching rock art sites through entrenchment, dynamic heterogeneous networks, connectivity and the topographical metaphor by incorporating and interrogating its relationships to other types of environmental and archaeological information (section 5.4). GIS is a strong heuristic tool and explanatory device within the ANT framework because it allows both multi-scalar analysis and conceptualisation of the heterogeneous network relations and their effects. By using the micro-, community- and regional-scale defined through the collated data, my analyses describe how rock art both acted and enacted to give rise to network relations and interrelationships within the Chumash landscapes and taskscapes. As GIS at a single scale is only a 'snap-shot' within the spatial and temporal scale, multi-scalar analysis is inherent for the success of using GIS within an ANT framework. Rock art's topographical setting and associations to other aspects of the archaeological record promotes its importance through its entrenchment and connectivity intertwined within other networks present in the interaction sphere.

Finally, I used the examples within the ethno-graphic and ethnohistoric literature and past Chumash research to further stress why ANT through GIS and spatial analysis is an innovative and highly applicable framework for Chumash rock art analysis (section 5.5). Expanding my research to include informed methods, I place rock art firmly within the complex social and ideological networks present through oral narratives of past Chumash landscapes and mythological beliefs. By incorporating past hypotheses and research, I highlight and explore the interrelationships of economic and political networks. Therefore, ANT shows how rock art interacted and engaged with and within the other networks recognised through the variety of sources presented in this thesis; how it acted and enacted. The Chumash personified their natural environment through their mythological belief systems and potentially through their celestial knowledge. Rock art's locational setting infers different relational effects based on the anthropomorphised natural environment supported through the ethnographic record. Additionally rock art, as visual media, symbolically means different things to different people based on their age, gender and political identity discussed in Chapter 5. The artist also places a particular meaning through the creation of the art and finally to the end product of element, motif or panel.

10.2 Chumash Rock Art and ANT

The main research question of this thesis as discussed in Section 6.4 pertains to applying ANT to the known Chumash rock art sites at multiple scales by asking:

- **Do the outputs of these analyses reflect how rock art helped to form or was a reflection of the dynamic entrenched topographical and ideological networks?**

This question has evolved from the original question discussed in Chapter 1 that states:

- **What relationships did rock art have within the various aspects of Chumash society and how does it reflect Chumash ideology?**

Overall the results have shown that through analysing rock art data with GIS and spatial analysis at multiple scales under the modified tenets of ANT, I have presented an excellent framework for rock art analysis within its landscape setting. In the following I break up the conclusion into the main points from each spatial analysis and discuss the specific points from ANT that are reflected in the results.

Defining Space, Variability and Heterogeneity

One of the first points I need to make concerns understanding how the data defined space and reflected the network relations heterogeneity. In Chapter 7, I utilise two specific analyses to study rock art's geographic spatial association without the use of the environmental datasets: KDE and Ripley's *K*. KDE is a more informal analysis that uses the rock art and its associated data to explain how the networks assemble by using the defined network space of rock art locations as a tool to conceptualise internal patterns such as clustering and segregation. Furthermore, it is a heuristic to further define the various relative scales to support multi-scalar analysis. Ripley's *K*-function is a more statistically robust multi-scalar methodology to study point patterns that was utilised for the second part of Chapter 7's analyses. A more intuitive output, the *L*-function, was used to easily interpret the data. Important to note for Ripley's *K* is the data should be homogeneous, so extraction via attributes is important to have significant results.

The results of the KDE show that five kilometres was the most intuitive for intensity clustering and highlighted four areas for further analysis and defined the community-scales of analysis: San Rafael Wilderness/Sierra Madre Ridge, Santa Ynez Mountains and backcountry, Simi Hills. These separate community areas show variable results through the extraction of rock art data from high intensity areas and further reflect the spatial differences found within the overall network. While the areas of intensity may reflect levels of effort by archaeologists, I argued that these samples provide a substantial amount of data within varying physiographic regions to begin to understand the spatial and organisational network structures at a more finer-grained or localised scale. This also allowed the outputs to be compared to the more general regional scale outputs. Finally, KDE visually highlights the gaps within the data, showing a lack of rock art sites. The exclusivity of some of the gaps is also supported in the ethnographic record (e.g. Mt. Pinos, Frazier Mountain and in the Cuddy Valley) and points to areas where future survey needs to take place. Overall the KDE analysis defined the community-scale through the intensity clustering which reflects the persistent network relations between the rock art site locations. Instead of masking the variability of the spatial relationships, KDE has highlighted specific spatial areas of internal network relations such as the Sierra Madre/San Rafael Wilderness area with 46 pictographs and large numbers of BRMs (n=34) and middens (n=32).

Overall at the regional scale the results for the Ripley's *K* show that for most of the data, there was heterogeneity even after extracting out attributes. The pronounced linear aggregation points to much more complex processes for the network relations of rock art sites that are not discernable through simple extraction of rock art types or associated archaeological data. This supports the hypothesis that rock art sites themselves are not actants but complex heterogeneous networks that extend into the wider network relations of the interaction sphere. Overlapping motifs at rock art sites further supports this idea as it represents the use of the sites over time (Figure 10.1), and therefore, the multi-temporal aspect of the panel reflects different network relations through multiple site visitations.

Figure 10.1: Overlapping motifs at Condor Cave (CA-SBA-1633). Photo by Michelle L. Wienhold.

Petroglyphs and the bifurcated motif were the two regional outputs showing homogenous results, and the petroglyphs show interdependence upon the spatial location of other similar sites. Complete spatial randomness of the bifurcated motif points to underlying organisational structures not associated with the spatial locations of the other sites with bifurcated motifs, perhaps as a result of specific ideological decisions (such as the notion of power) persisting over time. The multi-scalar clustering of the petroglyph output represents a deep entrenchment of sites within the overall network that reflects a decision of the Chumash to place sites in specific areas relative to other petroglyph sites. Petroglyphs enacted and afforded specific behaviour related to the decisions of the spatial locations of other petroglyph sites between 2.5 to 20 kilometres.

Finally analysis of the ethnohistorically documented village sites shows a homogeneity and interdependence for the sites spatial locations. This represents a specific decision of village locations with persistent network relations above 12 kilometres. Therefore, village site locations afforded specific organisational structures throughout the interaction sphere based on the geographic positions of other documented village sites. This may be a result of competition for resources within the economic exchange networks through cuisine preference and also based upon the interrelationships of ceremonial exchange. Furthermore, it may also be a reflection of the various provinces as described by Hudson and Underhay (1978) further pointing to specific underlying structuring principles.

At the community-scale, there are more localised patterns again representing the heterogeneity of the rock art sites. Analysis of the sites shows results pointing towards complete spatial randomness reflecting other decisions besides locations of similar rock art sites even after specific attributes were extracted. Through the modified tenets of ANT, this represents different underlying organisational structures for the network relations. While some sites did show clustering there were no instances of regularity for rock art sites or the associated data. No instances of regularity or clustering points to site locations based on specific aspects of the interaction sphere such as the anthropomorphised landscape formations through Chumash mythological networks or through the economic and ceremonial exchange networks for preference and preparation of foodstuffs. The clustering in specific community areas, when it exists, points to persistence within the networks and again shows that some rock art locations enacted and afforded specific choices or decisions for the locations of similar rock art sites. For instance, within the Simi Hills and Ventura County and the Santa Ynez Mountains and backcountry areas, data inclusive of all rock art sites showed some clustering. Overall the Ripley's *K*-function results point to differing underlying structural and organisational network effects for the location of rock art sites. As the analysis is only studying rock art locations in relation to each other, looking at the network organisation within their locational setting through environmental variables is necessary.

Variability, Entrenchment and Network Relations

Maximum entropy predictive modelling was used to study how the locational setting of rock art sites within the landscape may have played a role in rock art placement decisions and may have entrenched the rock art within a variety of the Chumash networks. Through the use of informed methods, the Chumash had specific mythological perceptions relating to their environment that may be reflected within the rock art settings. Rock art as taskscapes would also show a preference for specific cuisine types that would be reflected within the associated resources nearby or at rock art sites. This analysis highlights the variability and entrenchment of these sites.

At the regional-scale of analysis, overall geology was the most important landscape attribute for rock art site location. As not all rock has rock art, this points to specific attributes and descisions that afford site location, such as specific landscape features or rock formations. Through the ethnographic literature, I have shown how rock art is tied to the mythological networks where specific rock formations were the ancestors turned to stone. Rock art at these specific places is reflective of the ideology to engage with the mythological past to create benevolent spaces or lesson any malevolent power within the taskscape and allow the Chumash to engage with the setting (e.g. Robinson 2006). As both middens and BRMs associated with rock art sites also show a preference for specific geological features, this points to rock art interwoven and entrenched within taskscapes through specific attributes for the processing of foodstuffs. For example, geology was the most important environmental predictor when independently modelled. Furthermore, choice in rock art sites near specific resources reflected in landcover containing preferred cuisine and low cost from water for acorn processing represents rock art as places of gathering or highly inclusive of groups of people. The inclusivity of these sites entrenches rock art firmly within the social, economic and ceremonial exchange networks through the BRMs and middens. Low cost from stand-alone cupules was also important for rock art settings further entrenching rock art and stand-alone cupules within the social networks of taskscapes. Stand-alone cupules were easily accessible to rock art sites, and through the Chumash's intimate relationship to their environment, would be known to people at the rock art sites. Cupule boulders incorporation into the networks is further supported through the associated middens and BRMs found at stand-alone cupule sites, and therefore through the evidence of the processing of foodstuffs at these locations, within the economic networks. The environmental profile of rock art with no associated archaeology at the regional scale points to patterns differing from that of the other rock art types and the associated archaeology showing an exclusivity more entrenched within the networks of different supernatural power relations than found at the taskscapes. These more exclusive places were entrenched in more private interactions with the supernatural (Whitley 2000). This may have been more reflective of malevolent power because of its exclusivity, yet it could also mean that it was part of supernatural interaction that ideologically required only a shaman and their assistants (Hudson and Underhay 1978). Therefore through the ideology of power rock art had agency and created varying degrees of inclusivity and exclusivity based on its entrenchment within the mythological networks.

At the community scale, results reflect the strong variability of the network relations found through the Chumash interaction sphere by the slight differences for environmental variables predicting rock arts sites and the associated archaeology within the different areas. As with the regional scale, there are network relations for the social, ceremonial and economic networks entrenching rock art sites within these networks through their use as taskscapes. Furthermore, the cost to and from ethnohistoric village sites had little relevance for the decisions of rock art settings and points to the importance of taskscapes as places for processing cuisine choice found in rough terrain away from villages and closer to specific resources. Emigdiaño Chumash sites in the Wind Wolves Preserve had low cost travelling to and from stand-along cupule boulders showing the importance of these sites to this community area's network relations similar to that at the overall regional scale. Sites in the Wind Wolves area with no associated archaeology show no difference to the other types of rock art sites and the associated archaeology. While within the other community areas, low cost to and from hydrology tended to be important for sites with no associated archaeology, within the Wind Wolves this is not the case. I state that this may point to influence from the neighbouring Yokuts, which through Robinson's (2006; 2010a) study showed that southerly movement into the Emigdiaño area from the Yokut's territory was at a low cost. Overall this variability is important as it represents the different types of entrenchment within each community-scale's environment but is also reflective of the variability of the complex social, ceremonial and economic networks within each area.

Connectivity and Network Relations

Within the first two GIS studies, I specifically focused on the regional-scale and the community-scales of analysis. Additionally, I looked at the network relations of Chumash rock art interrelationships between the sites themselves and through their locational settings within the landscape. The cost surface analysis, while incorporating the regional-and community-scale of analysis, further looked at the micro-scale at connections of groups of sites and discussed specific sites and their relationships to their localised settings and other archaeology within the immediate vicinity. While the previous chapters looked at isotropic movement between sites, anisotropy was explored to,

a) understand the connectedness or connectivity of the internal organisational relations;

b) further understand the network relations based on directional-based movement;

c) consider the actual terrain in the variable environments.

Through movement of humans, isolines and isochrones reflect how the networks were connected but yet still retain human agency. The outputs do not make the decisions for the Chumash (such as found in LCP analyses) in terms of specific pathways to follow, but allow for the areas between the isolines and isochrones to represent areas where they could choose to move. Therefore, zig-zagging up steep slopes can be one of the many decisions of movement the Chumash could make to connect the sites together.

For the regional scale of analysis, the isolines and isochrones reflect that there were no exclusive networks for particular rock art sites and ethnohistoric sites. Organisational structures of relations were connected to various networks through movement. Overall visiting a rock art site would put the person within short walking distances to other rock art sites and oftentimes another ethnohistorically documented village site. Rock art also seems to fill in the large gaps between the village sites and could be because specific geological and food preferences are found in these areas. For instance, coastal sites were tied to the rock art of the inland, but oftentimes the inland rock art had more connected relationships through movement to village sites within the backcountry and inland areas. Through ethnohistorically documented marriage networks studied by Johnson (1988), the incorporation of inland villages within the marriage networks of the coastal sites also has overlapping network relations. For example, the inland rock art of these inland areas also has other network ties, such as economic or ceremonial exchange, to villages further inland are represented by the isolines and isochrones. Marriage ties would, therefore, enable strong network relations to the economic exchange network in order to procure specific resources from the inland. Armstrong's (2011) research further supports the idea of multiple connections through the networks across specific geographic areas. Emigdiaño Chumash were more isolated from the other Chumash linguistic groups and had more of an association to their Yokut neighbours to the north. There is some connectivity between the Cuyama of the Carrizo Plain. Overall at the regional scale, there are multiple organisational structures of network relations that connect rock art within the various Chumash networks of their interaction sphere.

At the community-scale and site-scale of analysis, we see that rock art is still highly connected through movement. When a person is located at any one rock art site within these areas, movement to another site is easily accomplished. Additionally, in the three specific groups of sites being studied within the community-scale, the ubiquitous bifurcated motif is ever present pointing to an ideological importance such as a cohesive social identity marker perhaps incorporating the *'antap* or a family group that affords a social or ceremonial meaning to these areas. Overall through the study of these three groups (San Rafael, Sierra Madre and the Wind Wolves Preserve groups) of rock art sites through movement, there is less exclusivity. The results show that the areas were more entrenched in inclusivity similar to Robinson's (2006; 2010a) results.

Resources for the gathering and processing of foodstuffs are abundant, along with BRMs and middens—evidence of persistent human activity other than rock art production. Although few exclusive sites do exist and examples are given, inclusivity becomes more prominent through connectivity. This does not mean, that at some point in time, these sites did not experience some extent of exclusivity, but through entrenchment and persistence of the taskscapes networks, they are more evident within the archaeological record. Groups of sites also show a cohesiveness of potential alliances where people utilising the sites as taskscapes would be connected to other groups of taskscapes through low travel times and costs, then social relationships would need to be forged. As Robinson (2011) states that within the ethnographic record specific BRMs or BRM stations were owned by women and often passed down to their daughters, this shows that the Chumash women would play an integral role in these taskscape alliances and cooperative networks—not just through the marriage networks.

10.3 Future Research

Archaeologically, research through excavation at rock art sites is imperative in order to further understand the role they played within their variable networks. As associated artefacts are discovered, a better overall picture of the chronology of rock art sites can be established (e.g. Robinson and Sturt 2008). Furthermore, the discovery of artefacts and middens at rock art sites would show that they were places of inclusivity at varying temporal scales. This can further tie rock art networks into the social complexity of the Chumash region and move away from dualist paradigms.

Further research for Chumash rock art through GIS, spatial analysis and ANT would require the update of the rock art database through the various data-curating institutions and land-holding organisations as new sites were discovered or as previously discovered sites were verified and validated through their geographic location. Maintaining this database would require consistency for all holders of the data and promote communication between them. Therefore, the data would stay dynamic and could be used by researchers to further explore their landscape setting. Incorporation of other information pertaining to Chumash society would only benefit future analysis such as transforming the cache cave database created by Whitby (2012) into a GIS database and further attributing the other recorded Chumash archaeological sites that have already been digitised.

In terms of GIS analyses, other geographic areas that show promise through clustering of sites, such as the Vandenberg coast and the Carrizo Plain need to be explored for their potential network relations within the overall interaction sphere. Work on creating isolines and isochrones from the individual sites instead of the groups of sites is also important for future discussions. Single site analysis would incorporate a smaller scale of movement and analysis as opposed to the 'leap-frogging' within the site groups described in this thesis. Also understanding movement to and from the ethnohistorically documented villages would further explore the connectivity of the sites within the geographic region.

More specifically, gathering counts for information such as the number of panels at a site and the number of BRMs could further weight the analyses presented here and provide further understanding of the variability of rock art sites found within this thesis. As described in Chapter 2, the sun-disc is another recognised ubiquitous motif that can be further added to the rock art database to be analysed such as the bifurcated figure was in this thesis. Work on what Robinson (2006; 2013) describes as 'set pieces' of elements and motifs ubiquitously found together through the Chumash region needs to be analysed to build on ideas of rock art sites as networks. Finally, the non-representational cupules have shown high inclusivity within the network relations of rock art pointing to further research incorporating them into Chumash rock art studies. If researchers are going to discuss rock art then cupules need to be a part of this dialogue.

10.4 Chumash Network

The Chumash rock art networks were as complex and heterogeneous as the rock art panels themselves, and through the modified tenets of ANT, this thesis was able to describe how these complex and variable relations assembled. My research has shown the geographic region prescribed to the Chumash during the Culture History (e.g. Kroeber) movement is not made of solid boundaries, but is an interaction sphere of interrelationships between various entrenched network relations. Research has shown the variety of interrelationships between the economic, political, mythological, social and ceremonial networks. Therefore rock art, as an important artefact fixed in its landscape setting, is profound in its integration within these networks of the interaction sphere. Additionally, dualist paradigms are too simple in analysing rock art sites as the temporal and spatial scale is extensive: understanding rock art under ANT allows definitions to ebb and flow within the network relations. Through the distribution of rock art sites, the data defines the space and the spatial entities from which to interrogate the data through multi-scalar spatial analysis. Rock art itself is a heterogeneous network through its multiple overlapping motifs and elements, and through the extraction of specific associated archaeology, the persistence of its heterogeneity was highly apparent. Through the Chumash landscape rock art shows high variability within the different regional- and community-scale networks. Under the tenets of material semiotics, rock art had agency that both acted and enacted based on the ethnohistoric and ethnographic literature representing its integration within Chumash ideology and notions of power. The landscape afforded specific behaviour in the decisions for rock art site placement. Network relations that point to inclusivity through taskscapes show the rock art as allowing gathering and processing to take place in the vicinity of the rock art. Areas with no associated archaeology need to be further studied for their role as places of exclusion and how they potentially exhorted mythological power through malevolence or benevolence.

There were no exclusive ties to specific networks, a rock art site may be tied to an economic network based on food preference from another ecological region, but tied through marriage to another social or political network. Overall in this thesis, rock art and ANT show that clustering of the data is an explanatory tool to define space and spatiality. The landscape setting entrenches the rock art based upon the strength of the network relations to the environment and archaeological associations, and it begins to indicate the potential organisational structures of these relations. Movement through the landscape analysis shows the connectivity of the sites and visualises the organisational network structures showing that rock art is not exclusive to any one of the multiple Chumash networks. Finally, the identity of the archaeology changes based upon the scale showing dynamic multi-scalar changes within the Chumash narrative.

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Spatial Analysis and Actor-Network Theory: A multi-scalar analytical study of the Chumash rock art of South-Central California.

(Volume 2 of 2 Volumes)

By

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A thesis submitted in partial fulfilment for the requirements for the degree of Doctor of Philosophy at the University of Central Lancashire.

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Table of Contents

Volume 2

Appendix A Intermediate Rock Art Database

Appendix A restricted in order to keep the site(s) protected.

FS District and Site #	Trinomial	Initial Notes	Previously Digitised or Mapped	Final Database Updates and Decision

FS District and Site #	Trinomial	Initial Notes	Previously Digitised or Mapped	Final Database Updates and Decision

FS District and Site #	Trinomial	Initial Notes	Previously Digitised or Mapped	Final Database Updates and Decision

FS District and Site #	Trinomial	Initial Notes	Previously Digitised or Mapped	Final Database Updates and Decision

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FS District and Site #	Trinomial	Initial Notes	Previously Digitised or Mapped	Final Database Updates and Decision

FS District and Site #	Trinomial	Initial Notes	Previously Digitised or Mapped	Final Database Updates and Decision

FS District and Site #	Trinomial	Initial Notes	Previously Digitised or Mapped	Final Database Updates and Decision

FS District and Site #	Trinomial	Initial Notes	Previously Digitised or Mapped	Final Database Updates and Decision

FS District and Site #	Trinomial	Initial Notes	Previously Digitised or Mapped	Final Database Updates and Decision

FS District and Site #	Trinomial	Initial Notes	Previously Digitised or Mapped	Final Database Updates and Decision

FS District and Site #	Trinomial	Initial Notes	Previously Digitised or Mapped	Final Database Updates and Decision

FS District and Site #	Trinomial	Initial Notes	Previously Digitised or Mapped	Final Database Updates and Decision

Appendix B Final Rock Art Database and GIS Attribute Table

Appendix B restricted in order to keep the site(s) protected.

FS #	CA Trinomial	Site Name	Pictograph	Petroglyph	Cupule	Aquatic	BRM	Midden	Description

FS #	CA Trinomial	Site Name	Pictograph	Petroglyph	Cupule	Aquatic	BRM	Midden	Description

FS #	CA Trinomial	Site Name	Pictograph	Petroglyph	Cupule	Aquatic	BRM	Midden	Description

FS #	CA Trinomial	Site Name	Pictograph	Petroglyph	Cupule	Aquatic	BRM	Midden	Description

FS #	CA Trinomial	Site Name	Pictograph	Petroglyph	Cupule	Aquatic	BRM	Midden	Description

FS #	CA Trinomial	Site Name	Pictograph	Petroglyph	Cupule	Aquatic	BRM	Midden	Description

FS #	CA Trinomial	Site Name	Pictograph	Petroglyph	Cupule	Aquatic	BRM	Midden	Description

FS #	CA Trinomial	Site Name	Pictograph	Petroglyph	Cupule	Aquatic	BRM	Midden	Description

FS #	CA Trinomial	Site Name	Pictograph	Petroglyph	Cupule	Aquatic	BRM	Midden	Description

FS #	CA Trinomial	Site Name	Pictograph	Petroglyph	Cupule	Aquatic	BRM	Midden	Description

FS #	CA Trinomial	Site Name	Pictograph	Petroglyph	Cupule	Aquatic	BRM	Midden	Description

FS #	CA Trinomial	Site Name	Pictograph	Petroglyph	Cupule	Aquatic	BRM	Midden	Description

FS #	CA Trinomial	Site Name	Pictograph	Petroglyph	Cupule	Aquatic	BRM	Midden	Description

FS #	CA Trinomial	Site Name	Pictograph	Petroglyph	Cupule	Aquatic	BRM	Midden	Description

FS #	CA Trinomial	Site Name	Pictograph	Petroglyph	Cupule	Aquatic	BRM	Midden	Description

FS #	CA Trinomial	Site Name	Pictograph	Petroglyph	Cupule	Aquatic	BRM	Midden	Description

FS #	CA Trinomial	Site Name	Pictograph	Petroglyph	Cupule	Aquatic	BRM	Midden	Description

FS #	CA Trinomial	Site Name	Pictograph	Petroglyph	Cupule	Aquatic	BRM	Midden	Description

FS #	CA Trinomial	Site Name	Pictograph	Petroglyph	Cupule	Aquatic	BRM	Midden	Description

FS #	CA Trinomial	Site Name	Pictograph	Petroglyph	Cupule	Aquatic	BRM	Midden	Description

FS #	CA Trinomial	Site Name	Pictograph	Petroglyph	Cupule	Aquatic	BRM	Midden	Description

Appendix C Distribution Maps

Distribution Maps of Rock Art Types and Associated Archaeology

This appendix shows the results of the final database represented through distribution maps of the various rock art types and associated archaeology found throughout the Chumash landscape.

Figure C.1: Pictograph distribution throughout the Chumash landscape.

Figure C.2: Petroglyph distribution throughout the Chumash landscape.

Figure C.3: Stand-alone cupule site distribution throughout the Chumash landscape.

Figure C.4: Rock art with associated cupules distribution throughout the Chumash landscape.

Figure C.5: Bifurcated motif distribution throughout the Chumash landscape.

Figure C.6: Bifurcated motif types throughout the Chumash landscape.

Figure C.7: Rock art with associated BRMs throughout the Chumash landscape.

Figure C.8: Rock art with associated middens distribution throughout the Chumash landscape.

Appendix D Ripley's *K*-Function Results

This appendix is comprised of the outputs of the Ripley's *K*-function described in Chapter 7.

Regional Scale

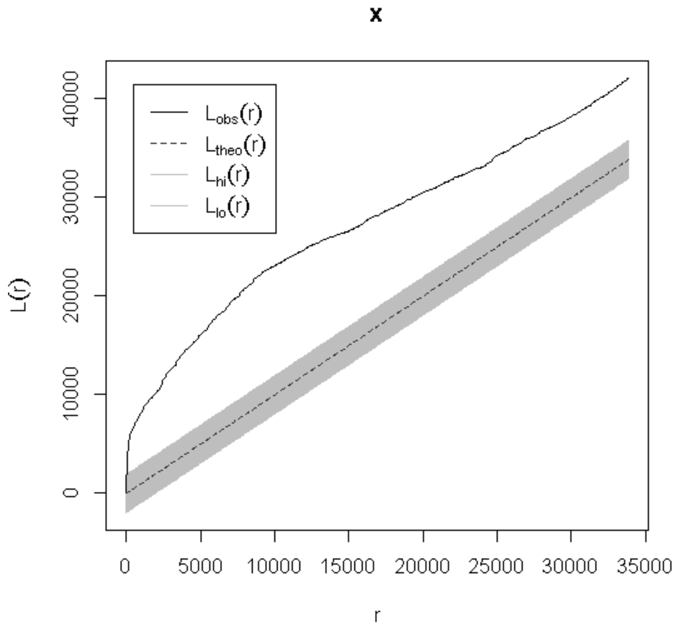

Figure D.1: The output of the Ripley's *K*-function analysis at the regional scale for all pictographs showing strong linear aggregation.

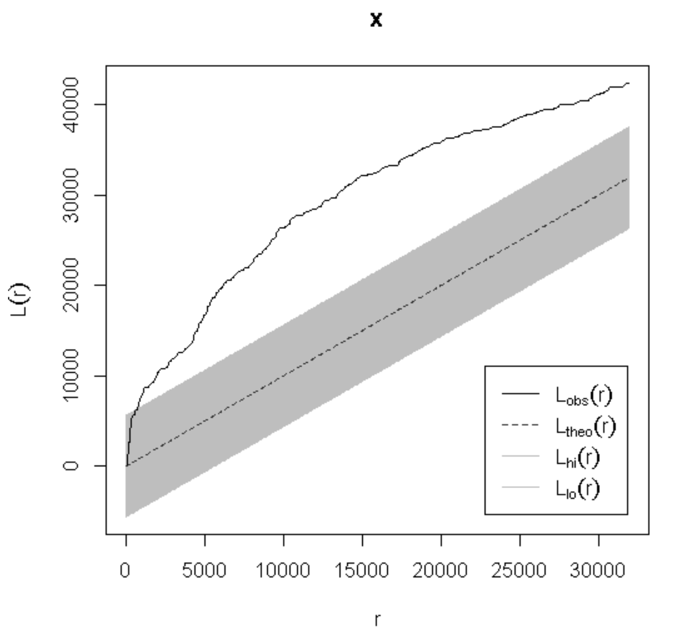

Figure D.2: The output of the Ripley's *K*-function analysis at the regional scale for stand-alone cupule sites strong linear aggregation.

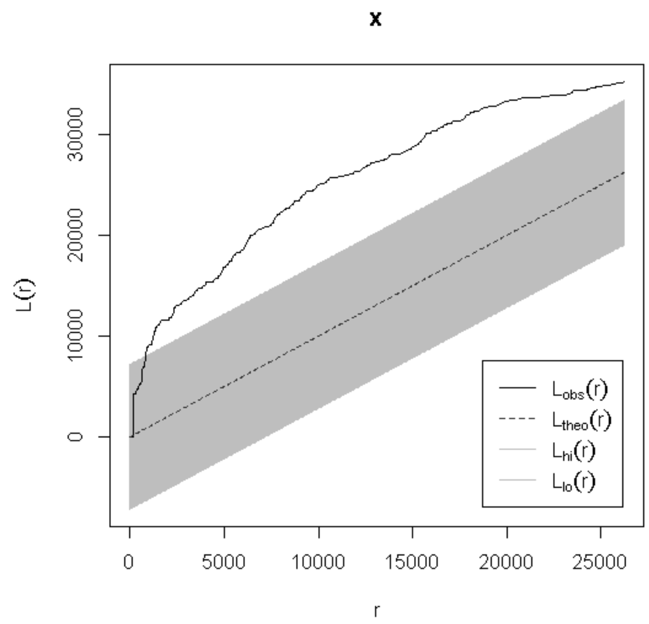

Figure D.3: The output of the Ripley's *K*-function analysis at the regional scale for associated cupules showing strong linear aggregation.

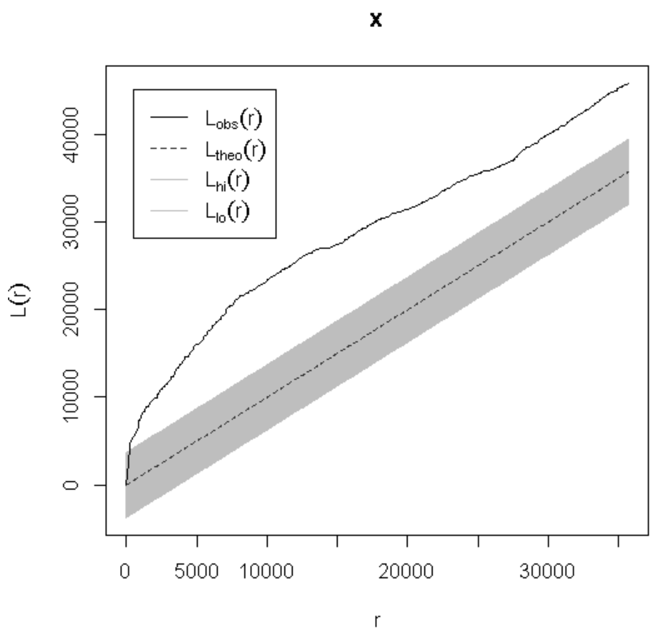

Figure D.4: The output of the Ripley's *K*-function analysis at the regional scale for rock art sites with associated BRMs showing strong linear aggregation.

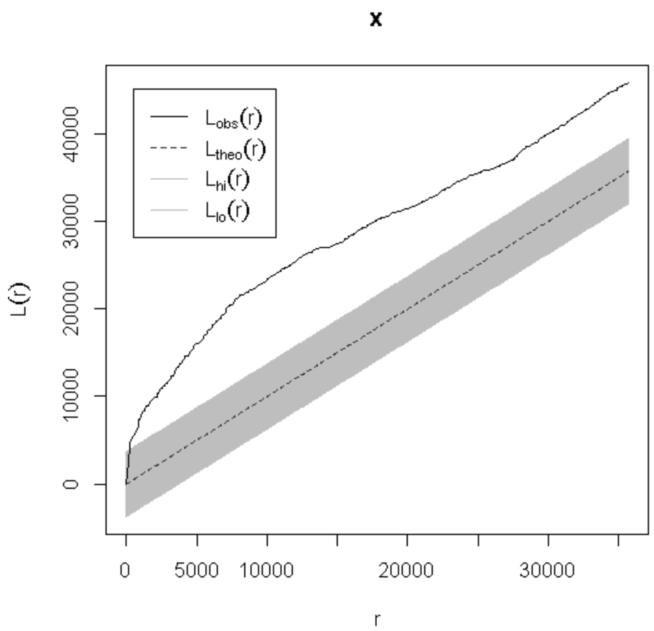

Figure D.5: The output of the Ripley's *K*-function analysis at the regional scale for rock art sites with associated middens showing strong linear aggregation.

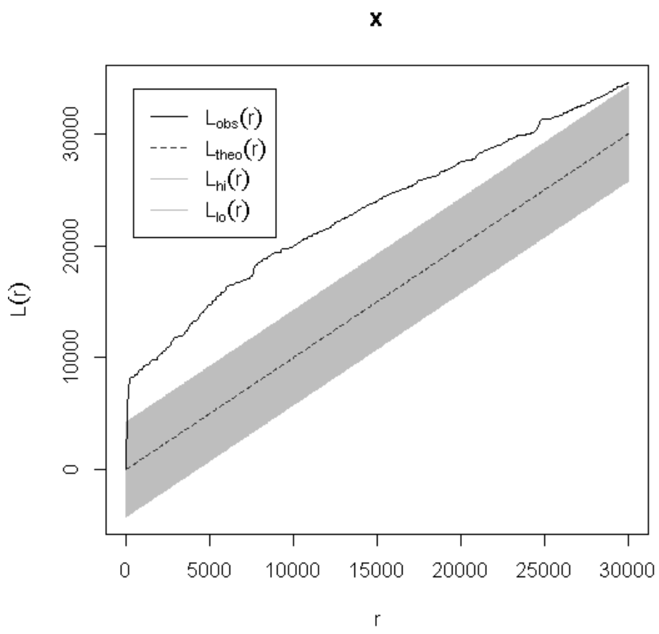

Figure D.6: The output of the Ripley's *K*-function analysis at the regional scale for rock art sites with no associated archaeology showing strong linear aggregation.

Community Scale: Sierra Madre Ridge/San Rafael Wilderness

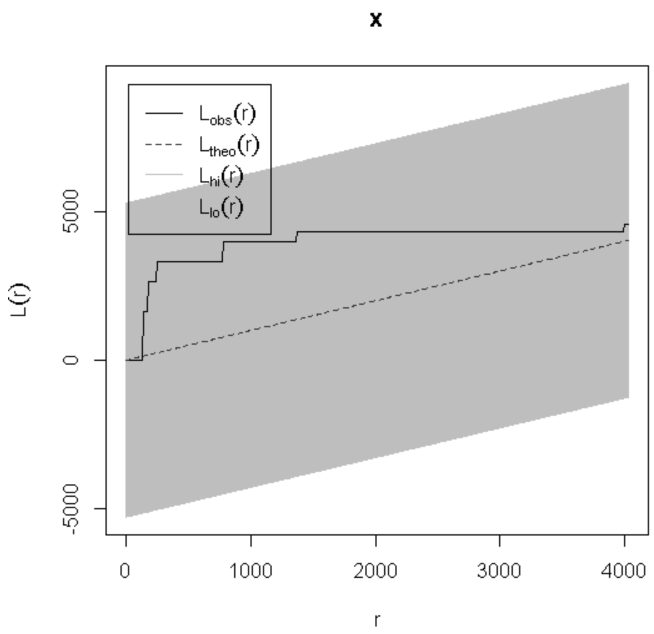

Figure D.7: The output of the Ripley's *K*-function analysis for the Sierra Madre/San Rafael community-scale of analysis for all recorded petroglyphs within the area showing complete spatial randomness.

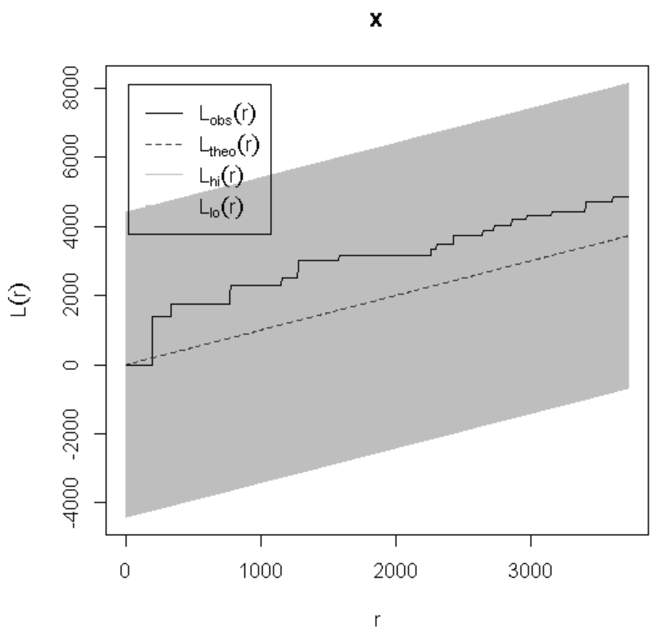

Figure D.8: The output of the Ripley's *K*-function analysis for the Sierra Madre/San Rafael community-scale of analysis for all rock art sites with associated cupules within the area showing complete spatial randomness.

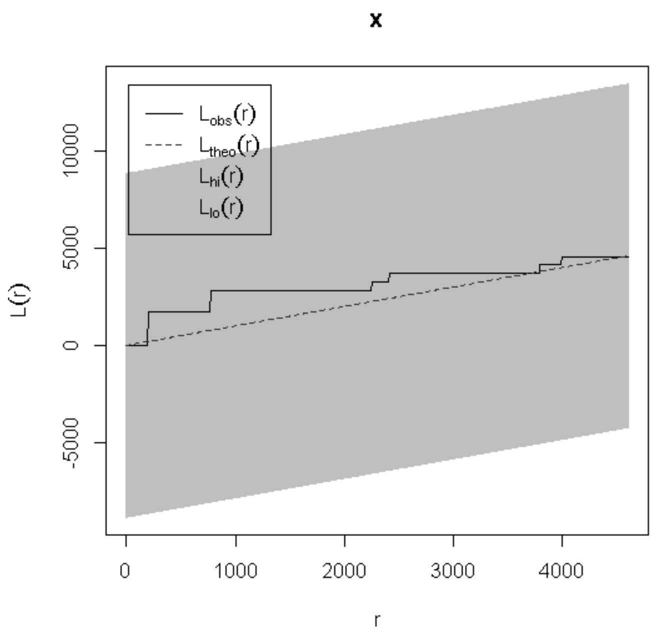

Figure D.9: The output of the Ripley's *K*-function analysis for the Sierra Madre/San Rafael community-scale of analysis for all rock art sites with the bifurcated motif within the area showing complete spatial randomness.

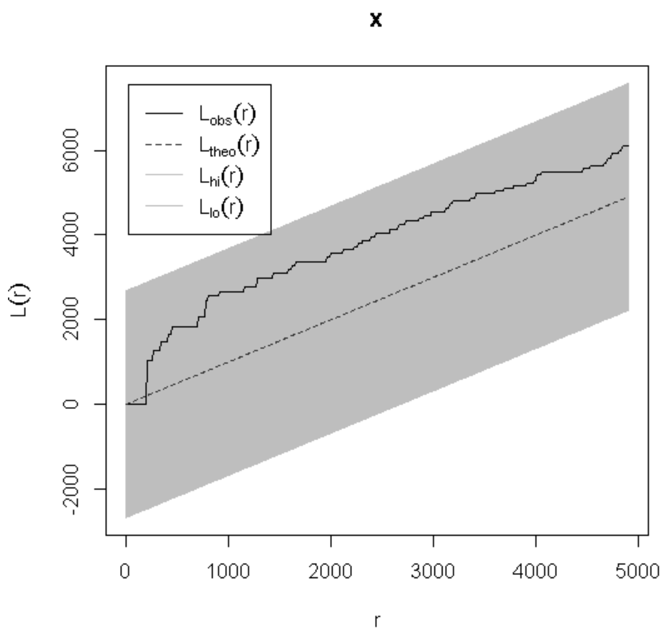

Figure D.10: The output of the Ripley's *K*-function analysis for the Sierra Madre/San Rafael community-scale of analysis for all rock art sites with associated BRMs within the area showing complete spatial randomness.

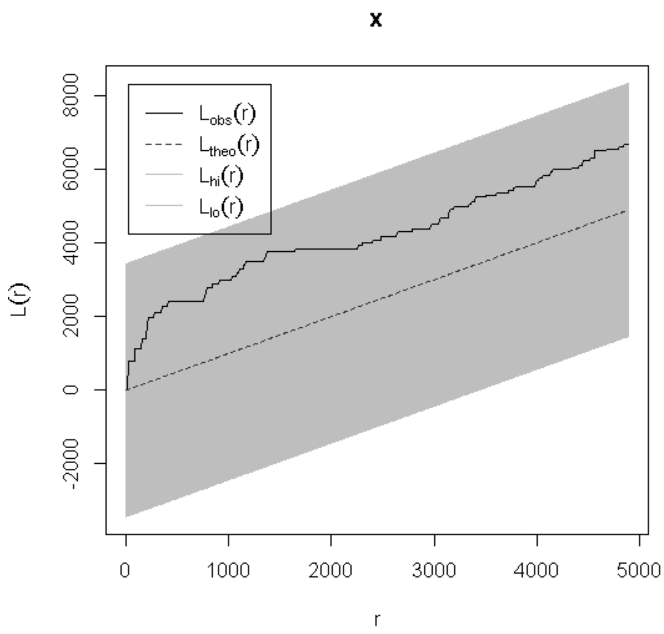

Figure D.11: The output of the Ripley's *K*-function analysis for the Sierra Madre/San Rafael community-scale of analysis for all rock art sites with associated middens within the area showing complete spatial randomness.

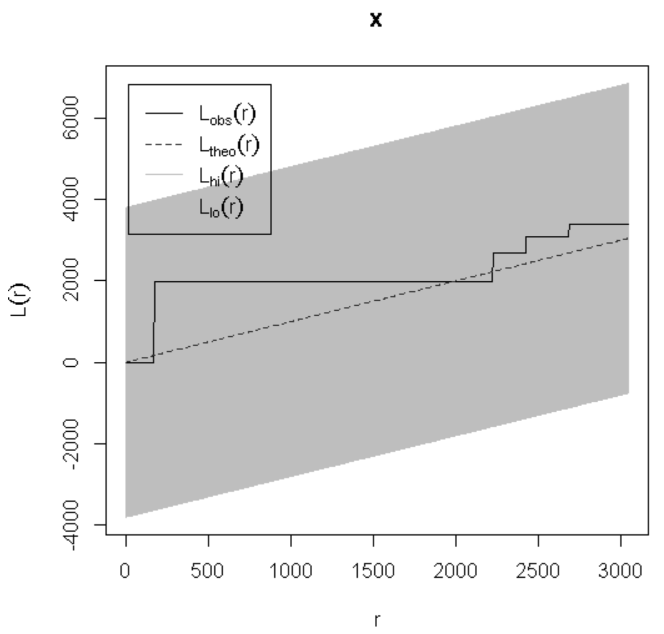

Figure D.12: The output of the Ripley's *K*-function analysis for the Sierra Madre/San Rafael community-scale of analysis for rock art sites with no associated archaeology within the area showing complete spatial randomness.

Community Scale: Simi Hills and Ventura County

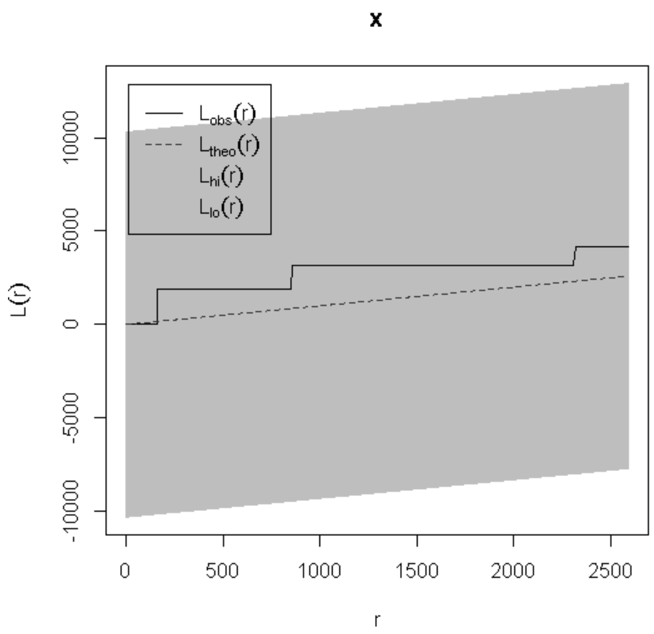

Figure D.13: The output of the Ripley's *K*-function analysis for the Simi Hills/Ventura County community-scale of analysis for all rock art sites with associated cupules within the area showing complete spatial randomness.

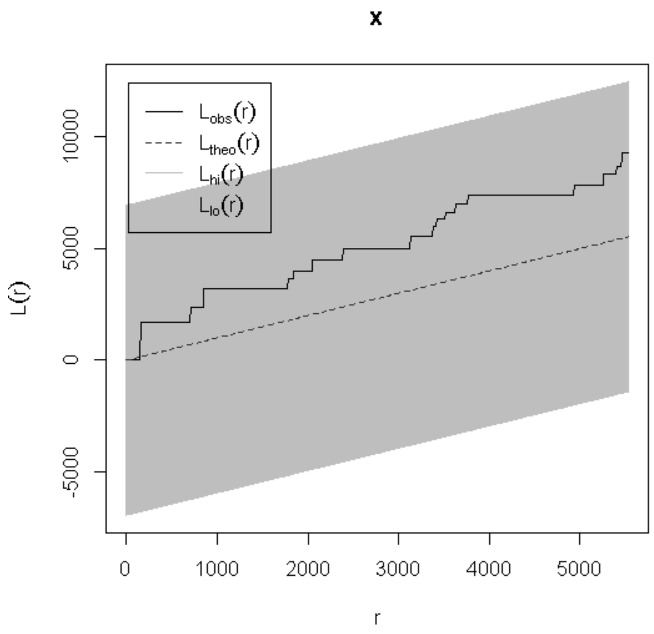

Figure D.14: The output of the Ripley's *K*-function analysis for the Simi Hills/Ventura County community-scale of analysis for all rock art sites with associated middens within the area showing complete spatial randomness.

Community Scale: The Wind Wolves Preserve

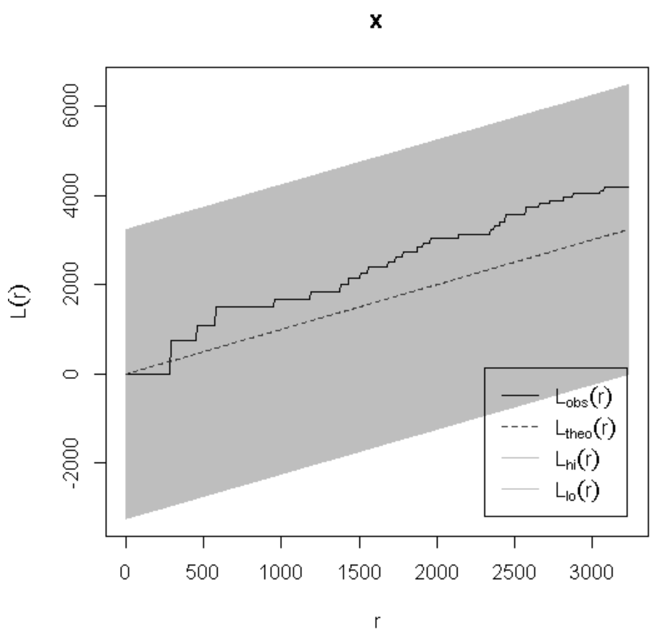

Figure D.15: The output of the Ripley's *K*-function analysis for the Wind Wolves Preserve community-scale of analysis for all rock art sites within the area showing complete spatial randomness.

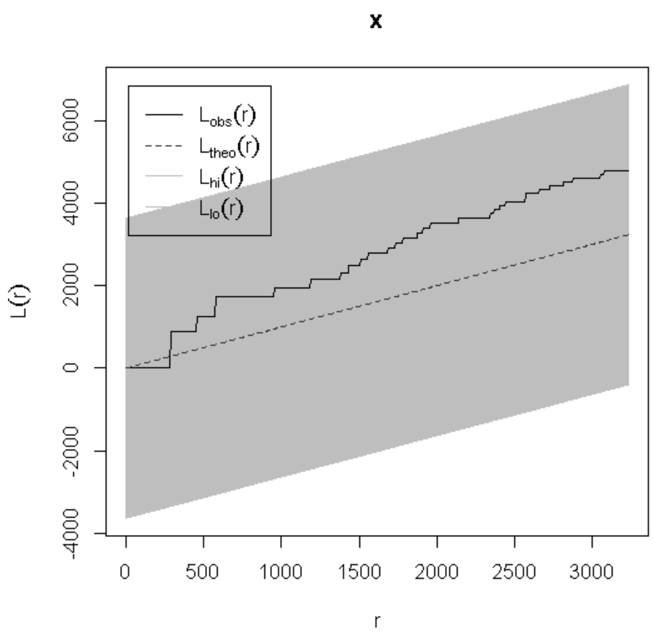

Figure D.16: The output of the Ripley's *K*-function analysis for the Wind Wolves Preserve community-scale of analysis for all pictographs within the area showing complete spatial randomness.

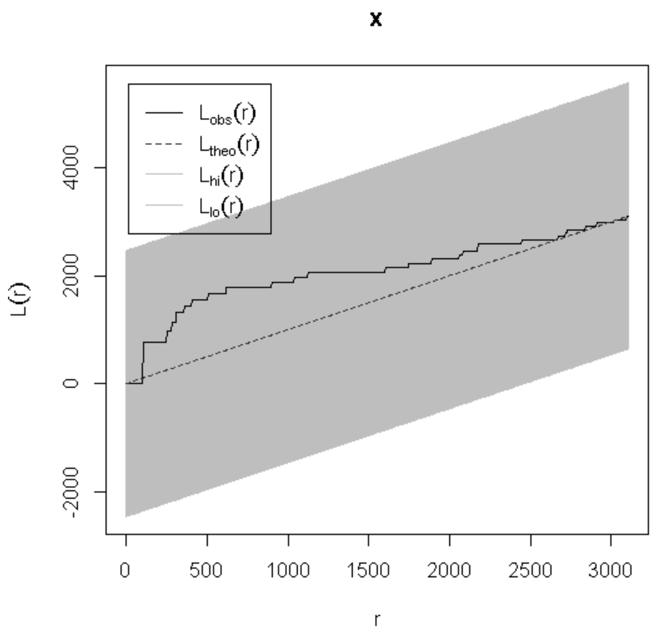

Figure D.17: The output of the Ripley's *K*-function analysis for the Wind Wolves Preserve community-scale of analysis for all stand-alone cupule sites within the area showing complete spatial randomness.

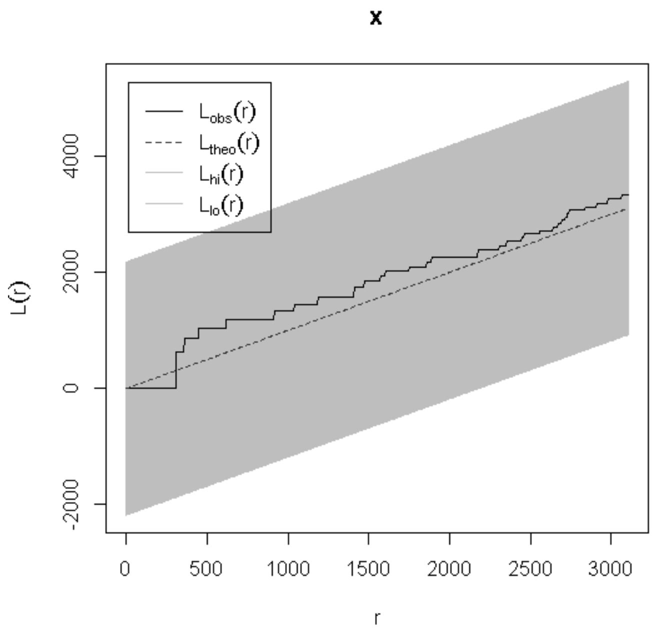

Figure D.18: The output of the Ripley's *K*-function analysis for the Wind Wolves Preserve community-scale of analysis for all rock art sites with associated BRMs within the area showing complete spatial randomness.

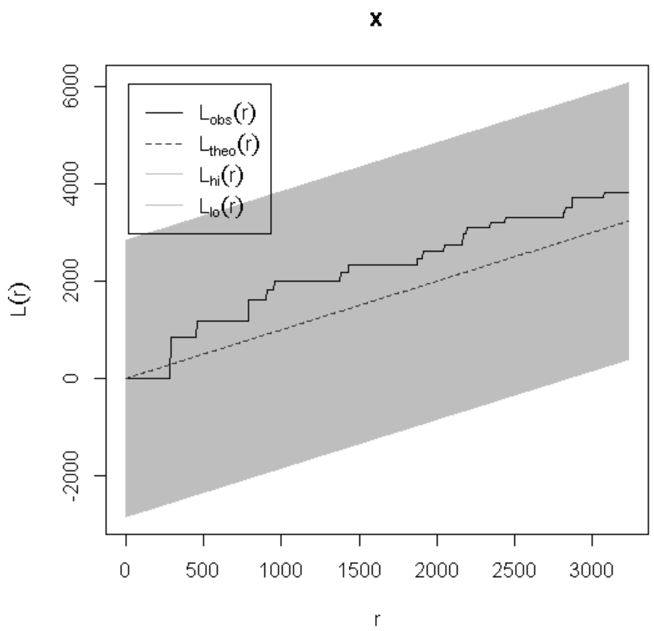

Figure D.19: The output of the Ripley's *K*-function analysis for the Wind Wolves Preserve community-scale of analysis for all rock art sites with no associated archaeology within the area showing complete spatial randomness.

Appendix E Maxent Results

The following figures are the additional outputs of the Maxent model. The response curves, in particular, indicate how each environmental variable affects the predictive model. The response curve graphs reflect how the logistic prediction changes as each environmental input variable is varied, but keeping all of the other environmental input variables at their average sample value (Philips et al.2004; Philips et al. 2006). At the community-scales of analysis the response curves show the mean response of the ten model runs and the mean +/- one standard deviation (*ibid*). Response curve outputs were used to understand the specific information from each environmental variable that were particularly important to the prediction. Furthermore, the jackknife outputs for the community scale are represented. Finally, the predictive surfaces are also shown here in which the areas in red are considered high probability areas and areas in green are considered low probability areas.

Regional Scale

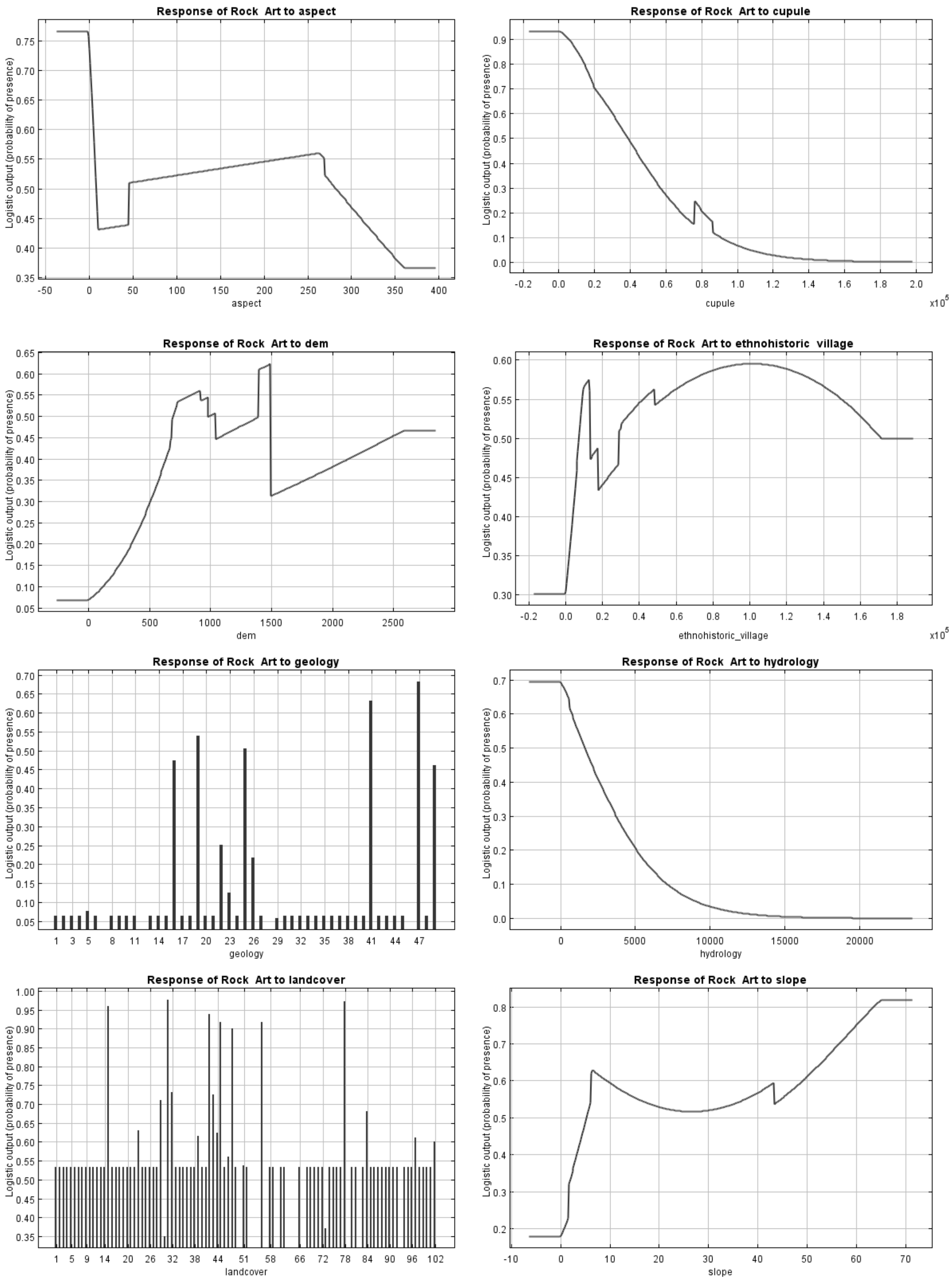

Figure E.1: Marginal response curve for rock art at the regional scale for all variables described in Chapter 8.

Figure E.2: Predictive surface for all rock art sites at the regional scale of analysis created by Maxent. Red represents areas of high probability for rock art site presence while green represents areas of low probability of rock art site presence.

Figure E.3: Predictive surface for pictographs at the regional scale of analysis created by Maxent. Red represents areas of high probability for rock art site presence while green represents areas of low probability of rock art site presence.

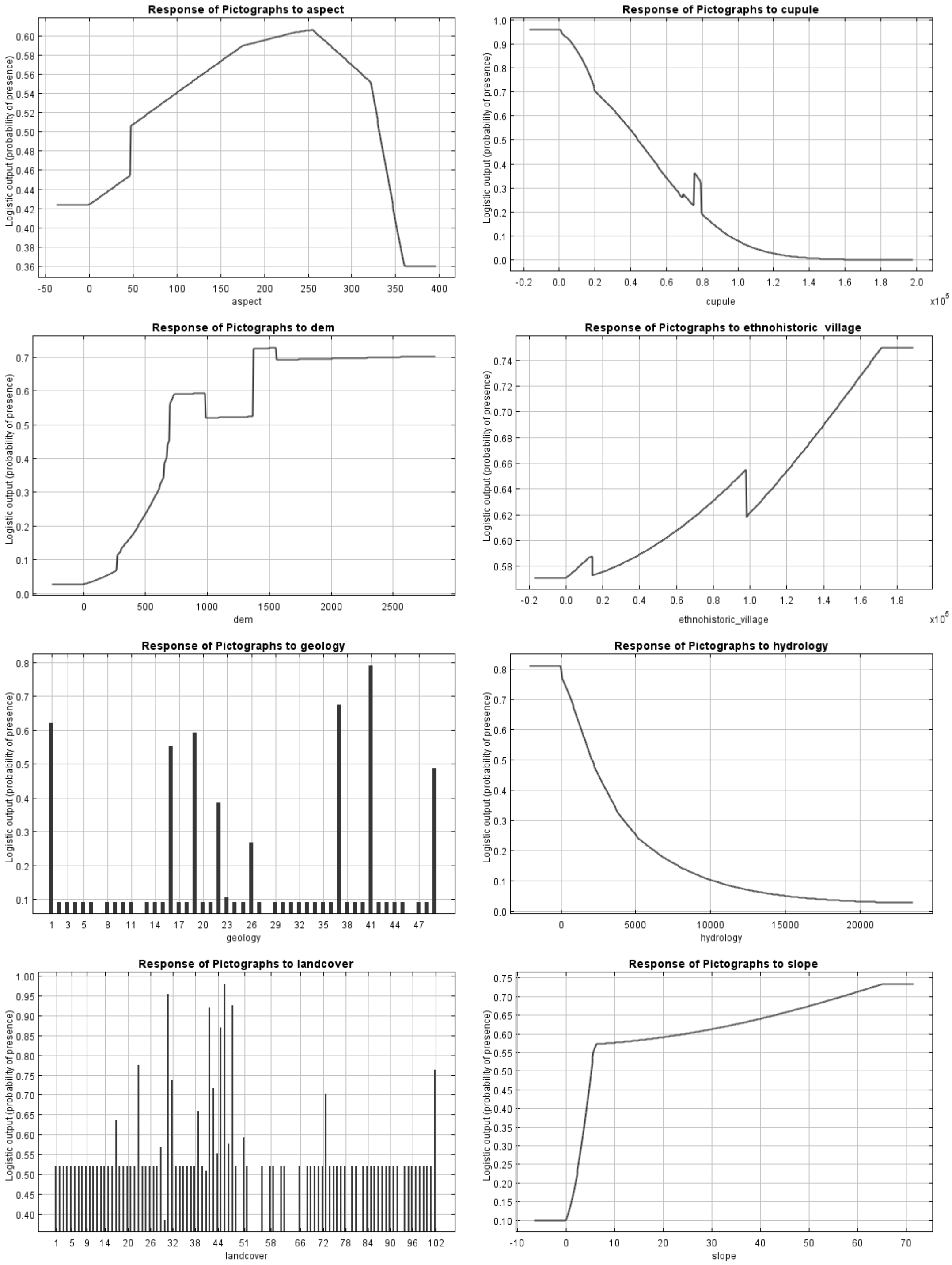

Figure E.4: Marginal response curves for pictographs at the regional scale for all variables described in Chapter 8.

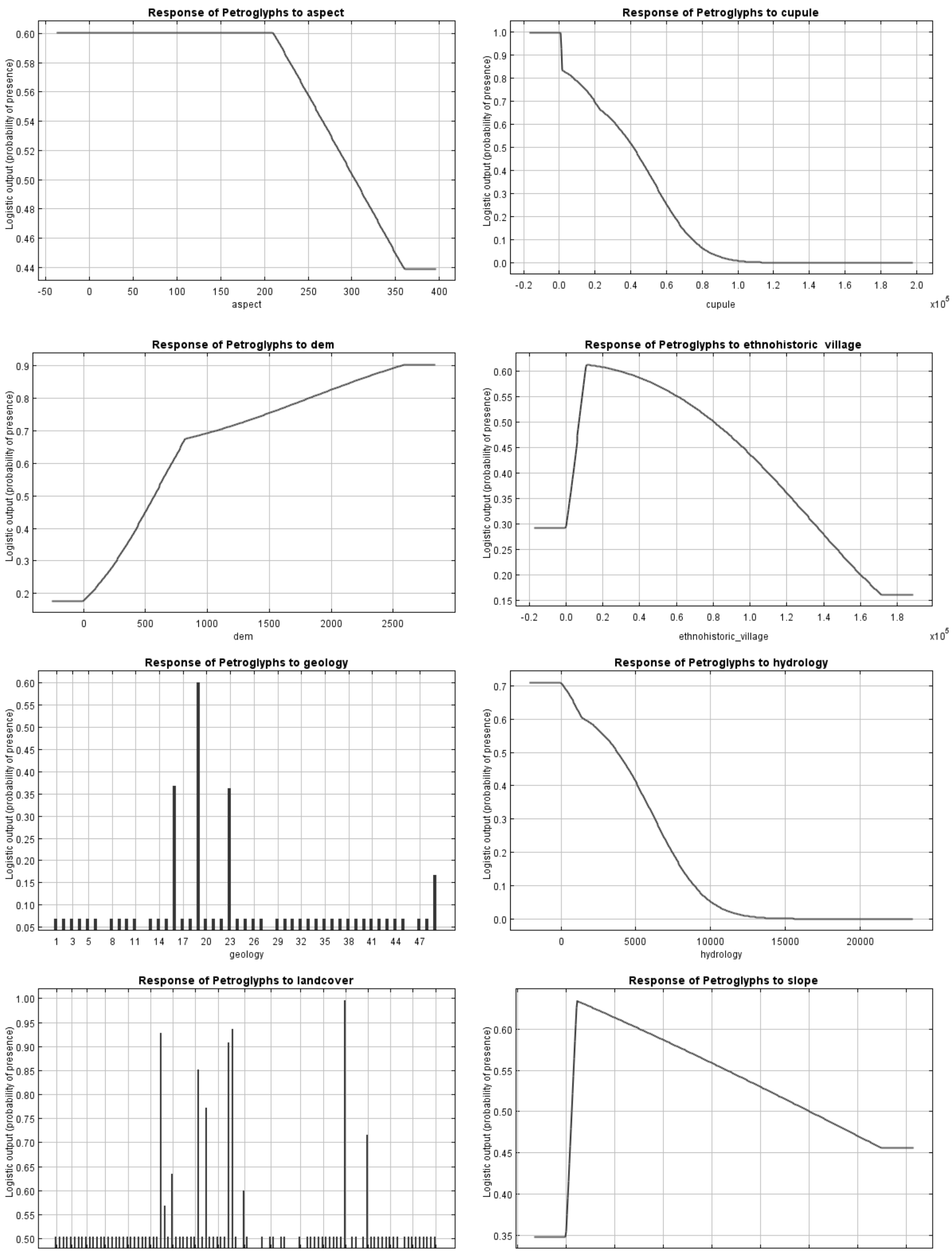

Figure E.5: Marginal response curves for petroglyphs at the regional scale for all variables described in Chapter 8.

Figure E.6: Predictive surface for petroglyphs at the regional scale of analysis created by Maxent. Red represents areas of high probability for rock art site presence while green represents areas of low probability of rock art site presence.

Figure E.7: Predictive surface for rock art with associated middens at the regional scale of analysis created by Maxent. Red represents areas of high probability for rock art site presence while green represents areas of low probability of rock art site presence.

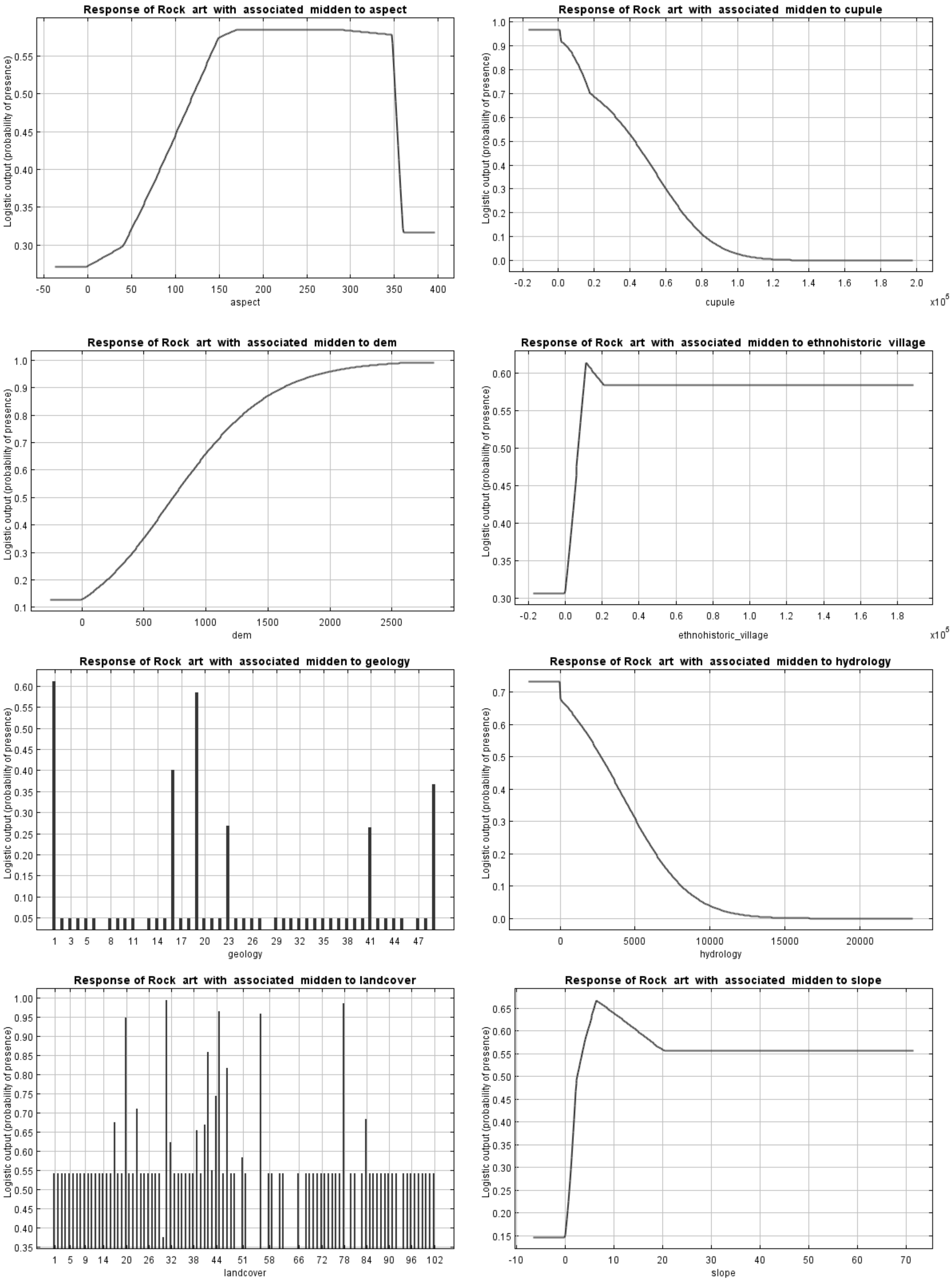

Figure E.8: Marginal response curves for rock art with associated middens at the regional scale for all variables described in Chapter 8.

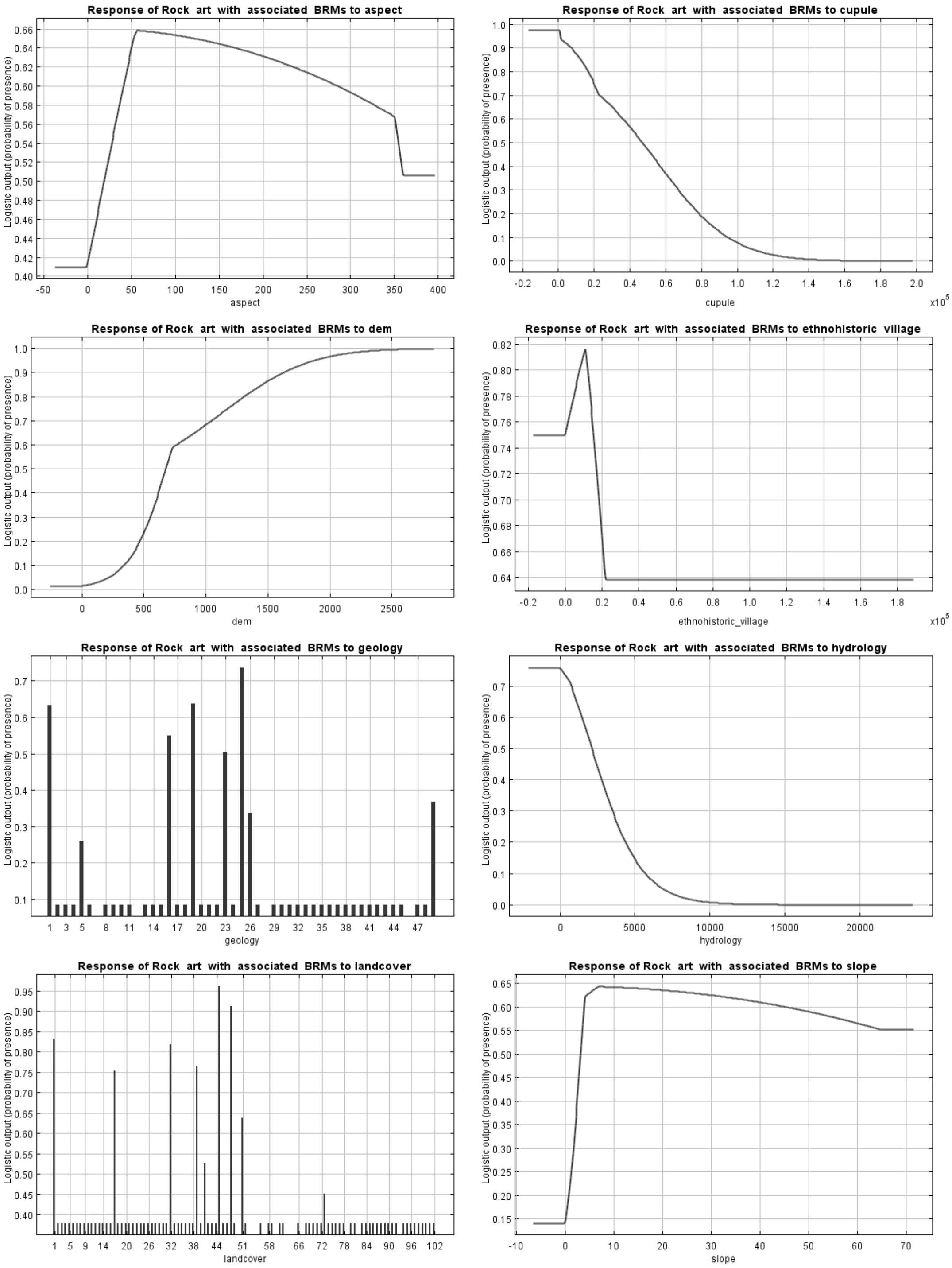

Figure E.9: Marginal response curves for rock art with associated BRMs at the regional scale for all variables described in Chapter 8.

Figure E.10: Predictive surface for rock art with associated BRMs at the regional scale of analysis created by Maxent. Red represents areas of high probability for rock art site presence while green represents areas of low probability of rock art site presence.

Figure E.11: Predictive surface for rock art with associated cupules at the regional scale of analysis created by Maxent. Red represents areas of high probability for rock art site presence while green represents areas of low probability of rock art site presence.

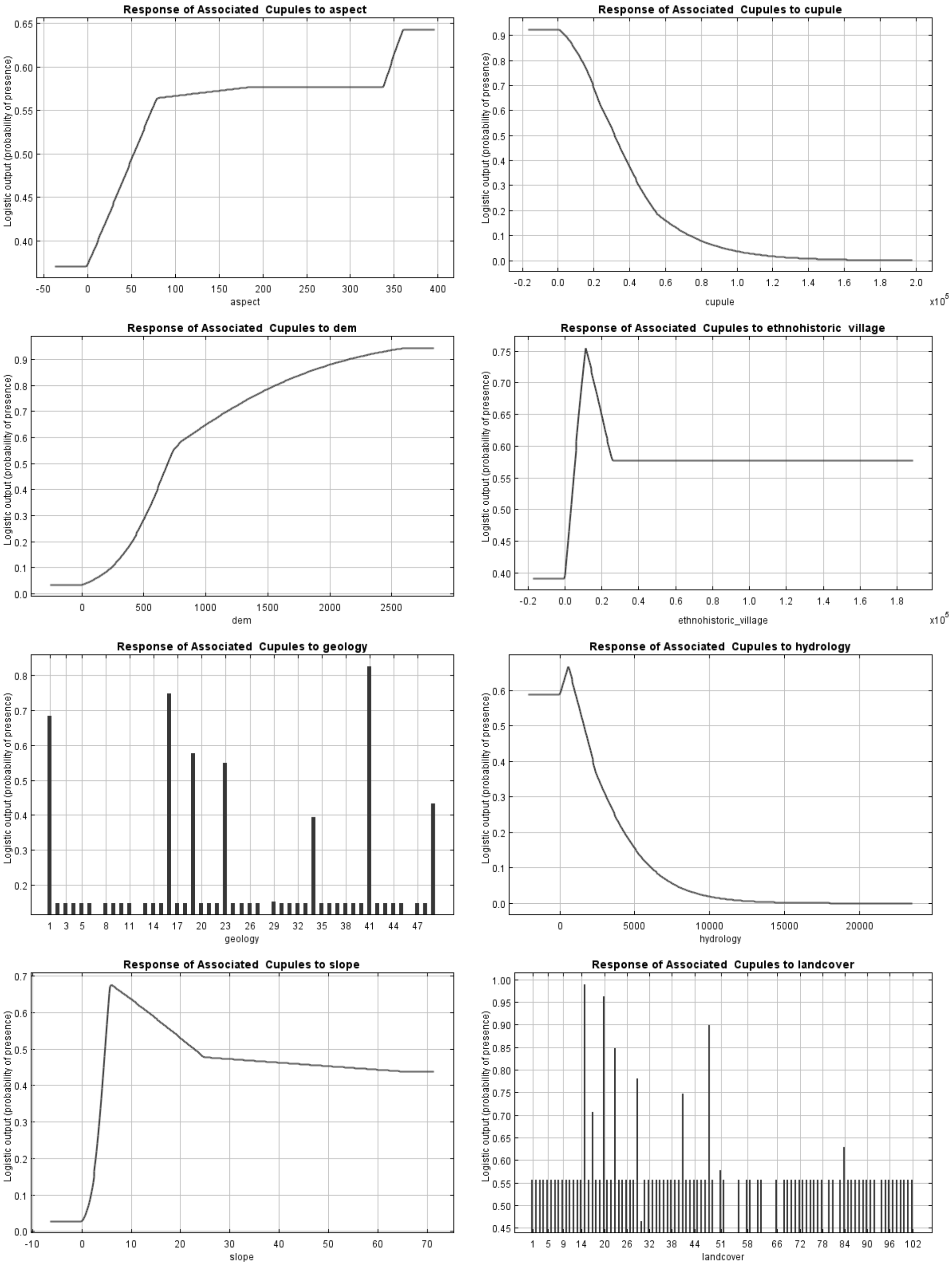

Figure E.12: Marginal response curves of associated cupules at the regional scale for all variables described in Chapter 8.

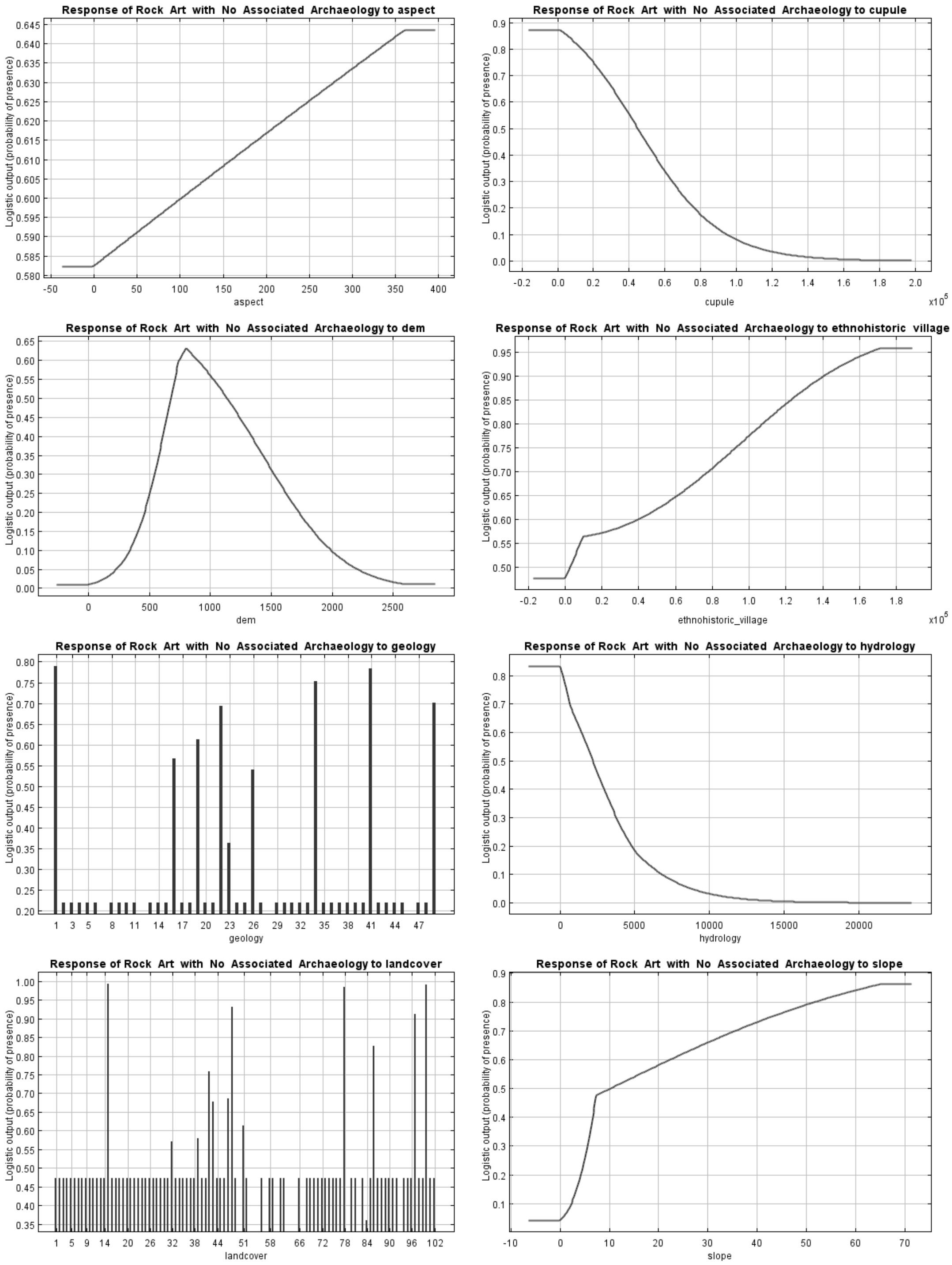

Figure E.13: Marginal response curves of rock art with no associated archaeology at the regional scale for all variables described in Chapter 8.

Figure E.14: Predictive surface for rock art with no associated archaeology at the regional scale of analysis created by Maxent. Red represents areas of high probability for rock art site presence while green represents areas of low probability of rock art site presence.

<u>**Community Scale: Sierra Madre Ridge/San Rafael Wilderness**</u>

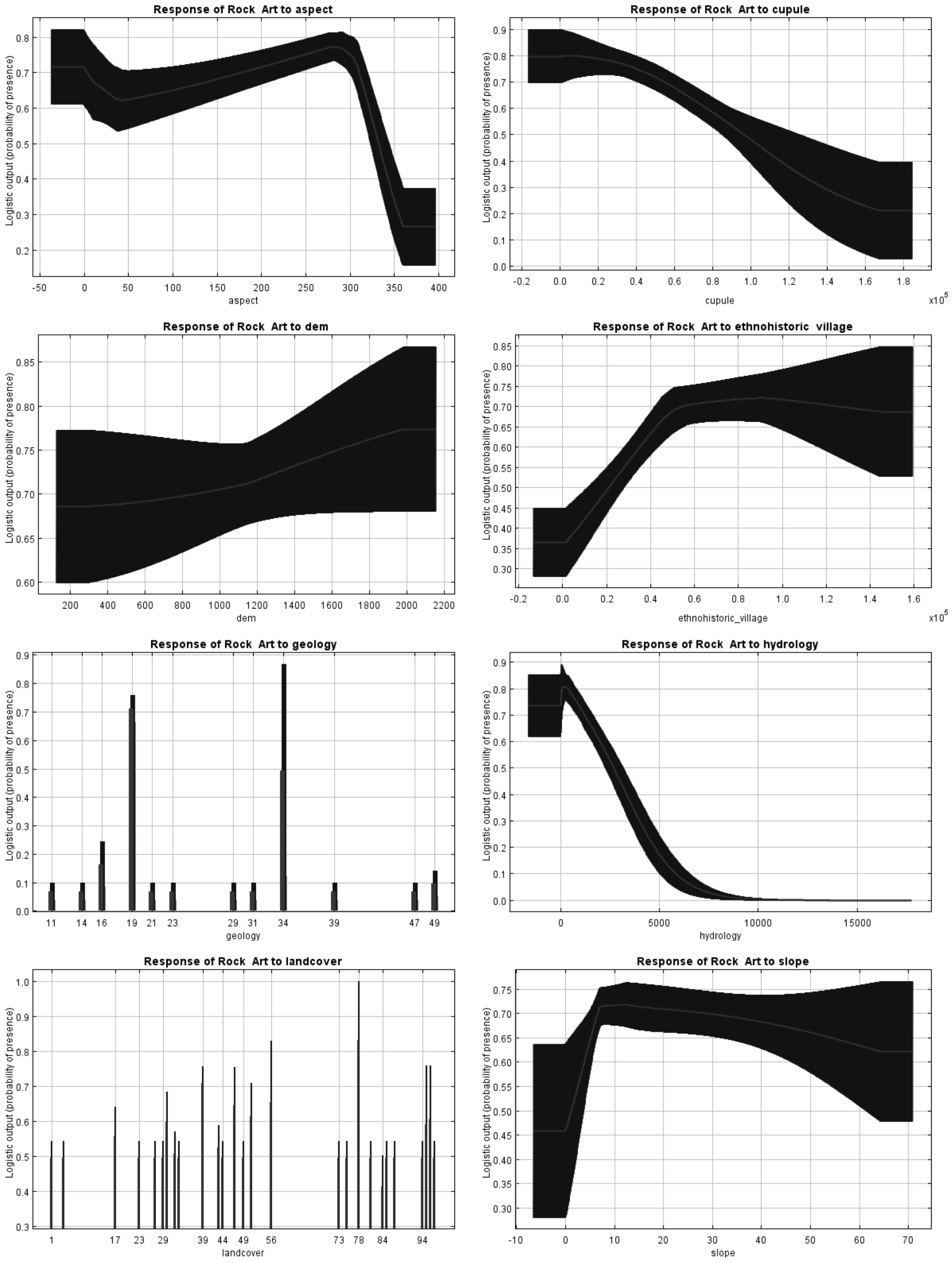

Figure E.15: Marginal response curves for rock art in the Sierra Madre Ridge/San Rafael community-scale of analysis for all variables described in Chapter 8.

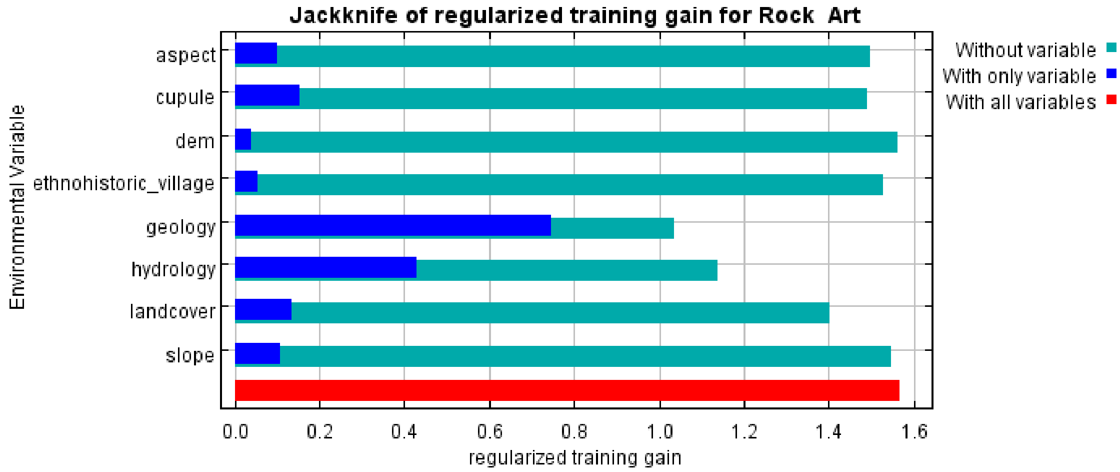

Figure E.16: Jackknife of regularised training gain for rock art showing the most important predictive environmental variables within the Sierra Madre Ridge/San Rafael Wilderness.

Figure E.17: Predictive surface for rock art at the Sierra Madre Ridge/San Rafael Wilderness community-scale of analysis created by Maxent. Red represents areas of high probability for rock art site presence while green represents areas of low probability of rock art site presence.

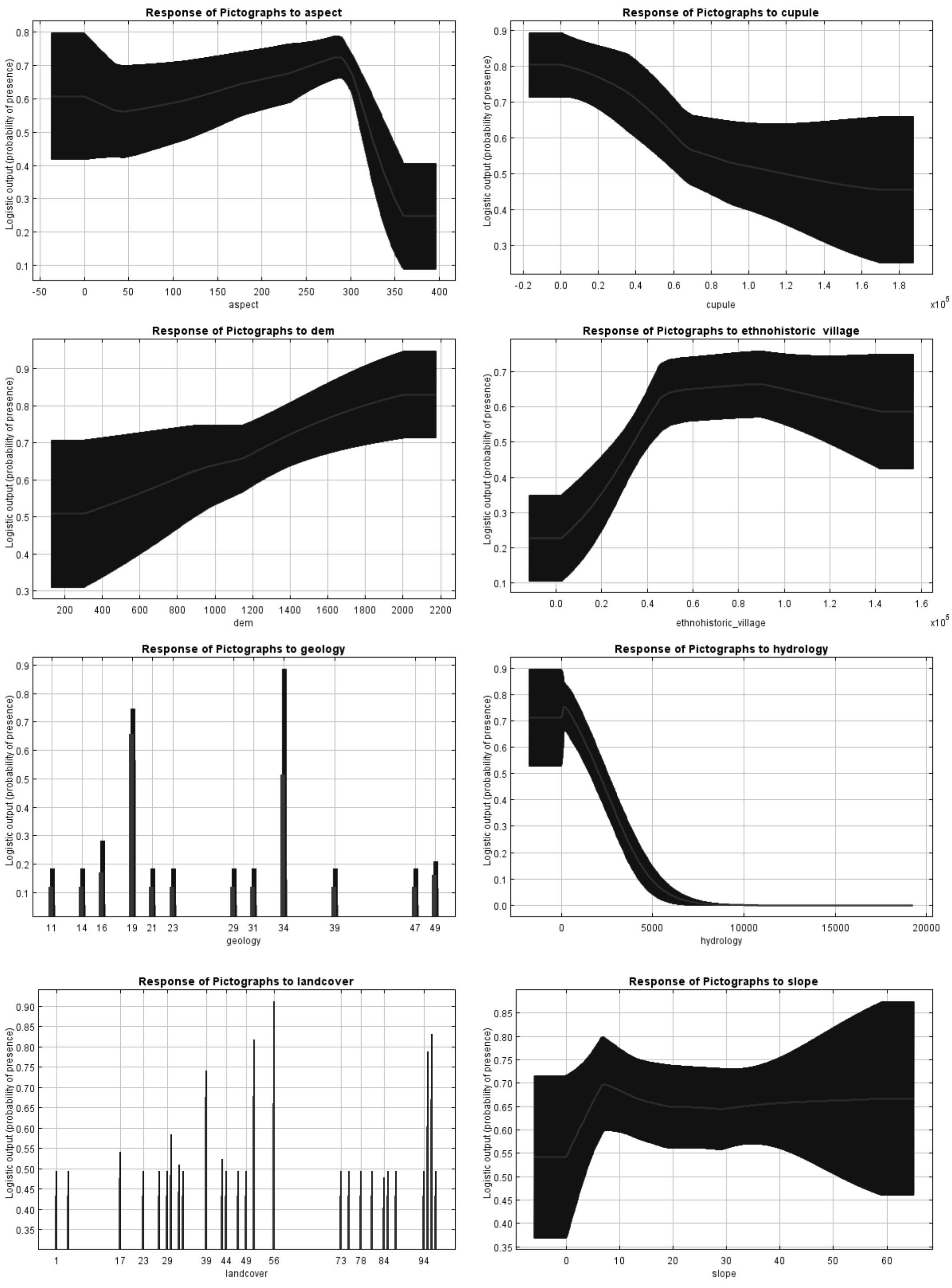

Figure E.18: Marginal response curves for pictographs in the Sierra Madre Ridge/San Rafael community-scale of analysis for all variables described in Chapter 8.

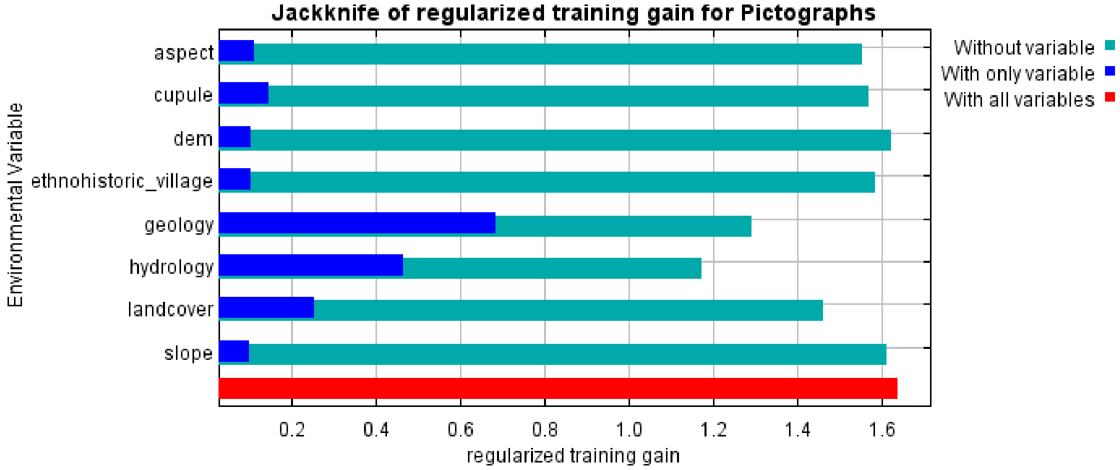

Figure E.19: Jackknife of regularised training gain for pictographs showing the most important predictive environmental variables within the Sierra Madre Ridge/San Rafael Wilderness.

Figure E.20: Predictive surface for pictographs at the Sierra Madre Ridge/San Rafael Wilderness community-scale of analysis created by Maxent. Red represents areas of high probability for rock art site presence while green represents areas of low probability of rock art site presence.

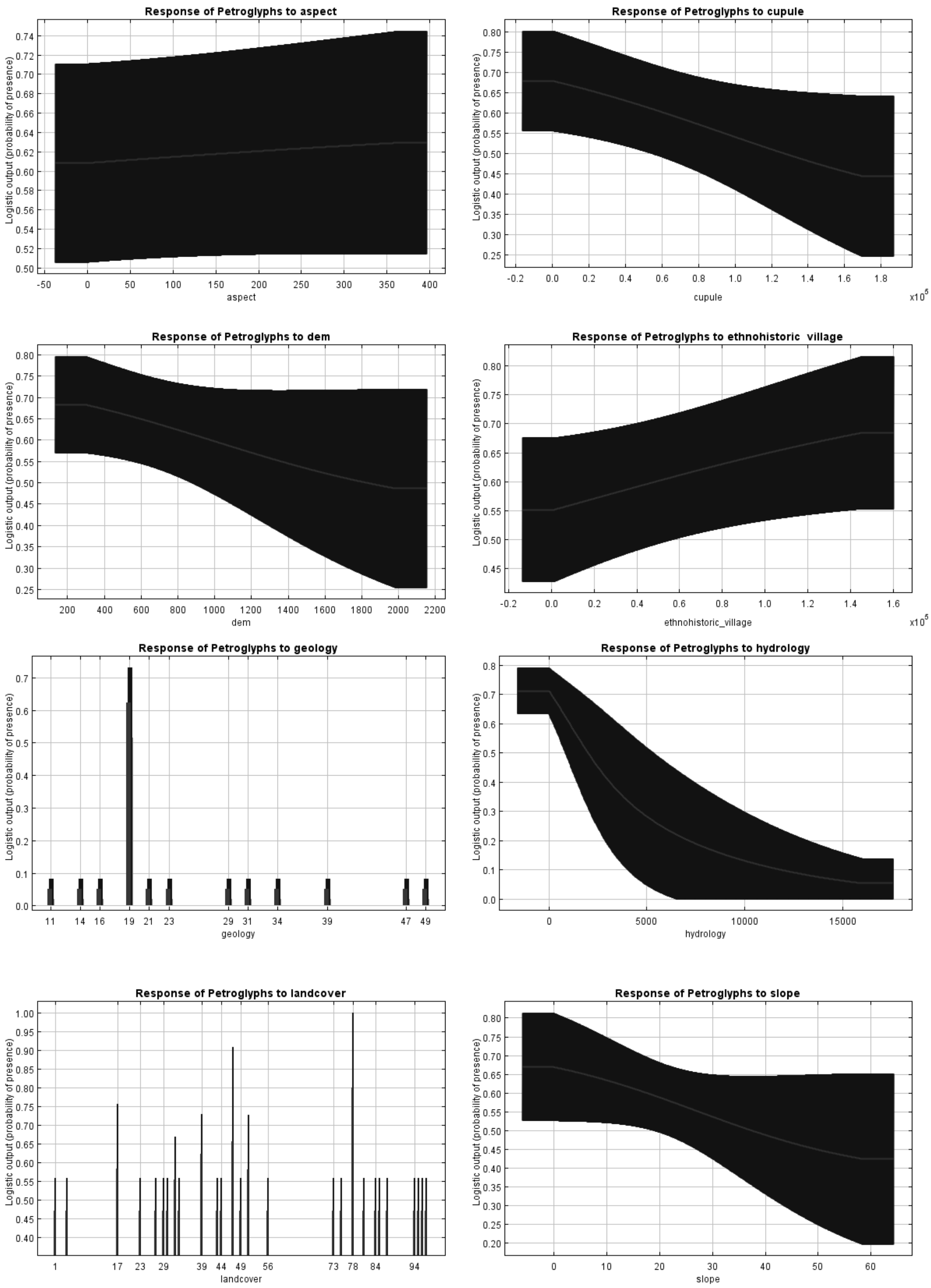

Figure E.21: Marginal response curves for petroglyphs in the Sierra Madre Ridge/San Rafael community-scale of analysis for all variables described in Chapter 8.

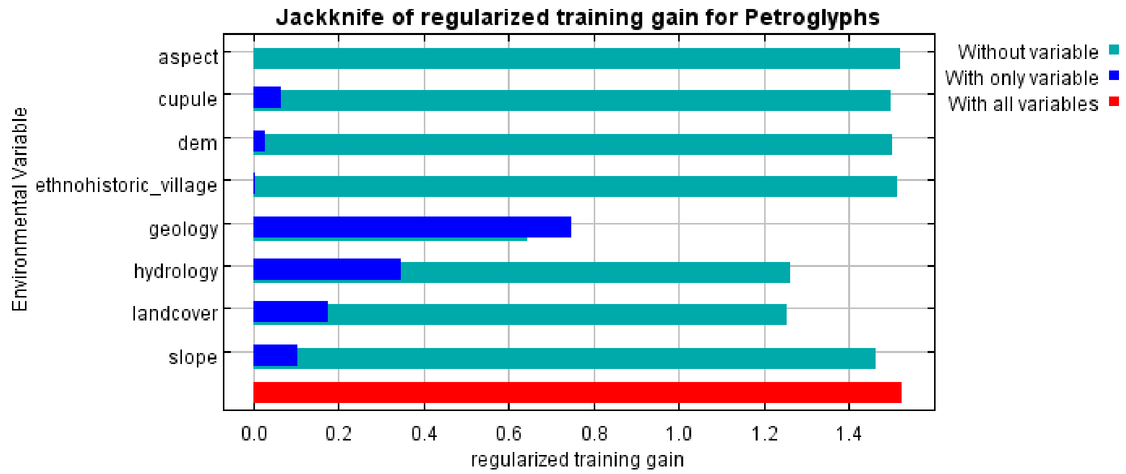

Figure E.22: Jackknife of regularised training gain for petroglyphs showing the most important predictive environmental variables within the Sierra Madre Ridge/San Rafael Wilderness.

Figure E.23: Predictive surface for petroglyphs at the Sierra Madre Ridge/San Rafael Wilderness community-scale of analysis created by Maxent. Red represents areas of high probability for rock art site presence while green represents areas of low probability of rock art site presence.

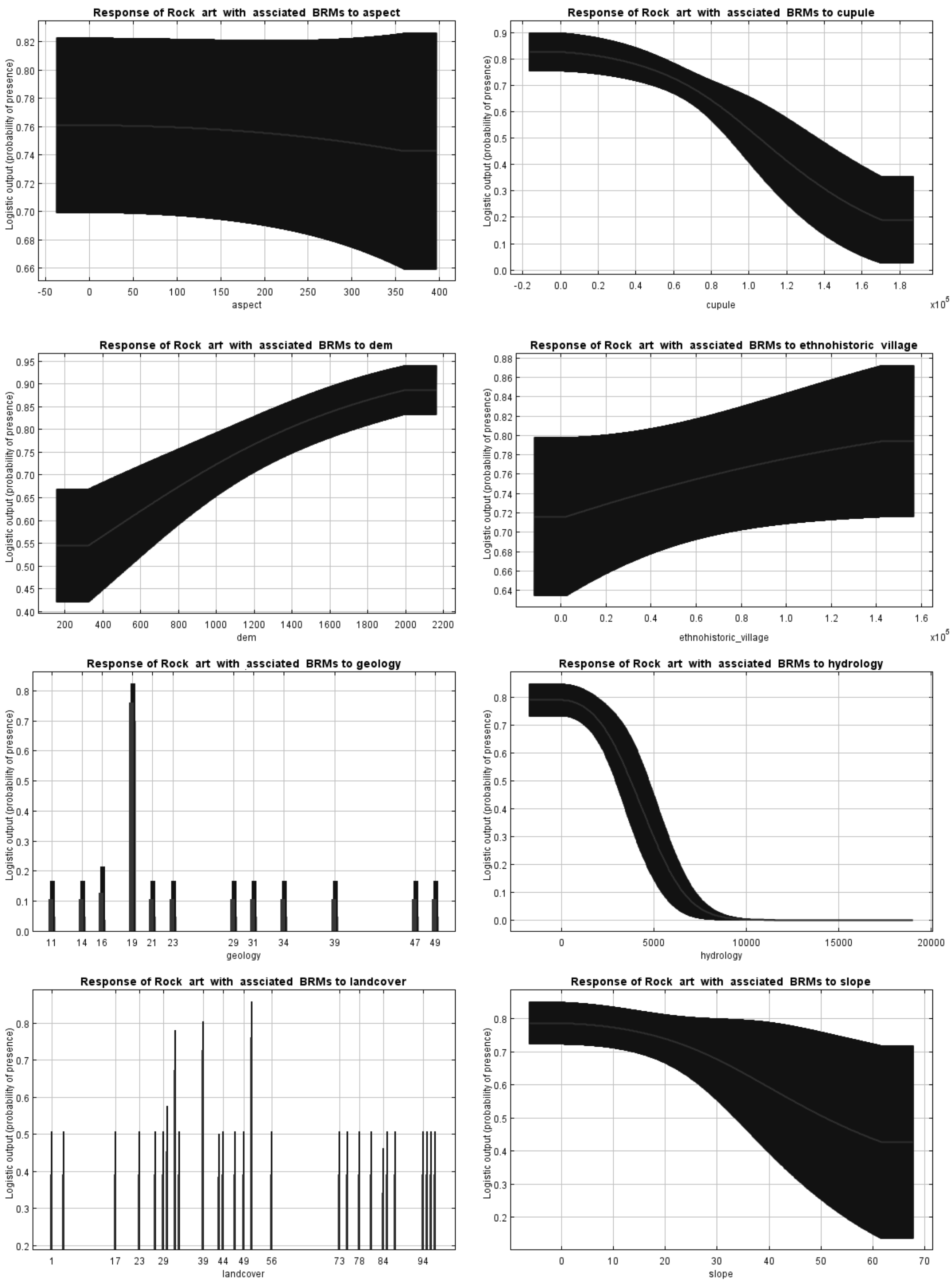

Figure E.24: Marginal response curves for rock art with associated BRMs in the Sierra Madre Ridge/San Rafael community-scale of analysis for all variables described in Chapter 8.

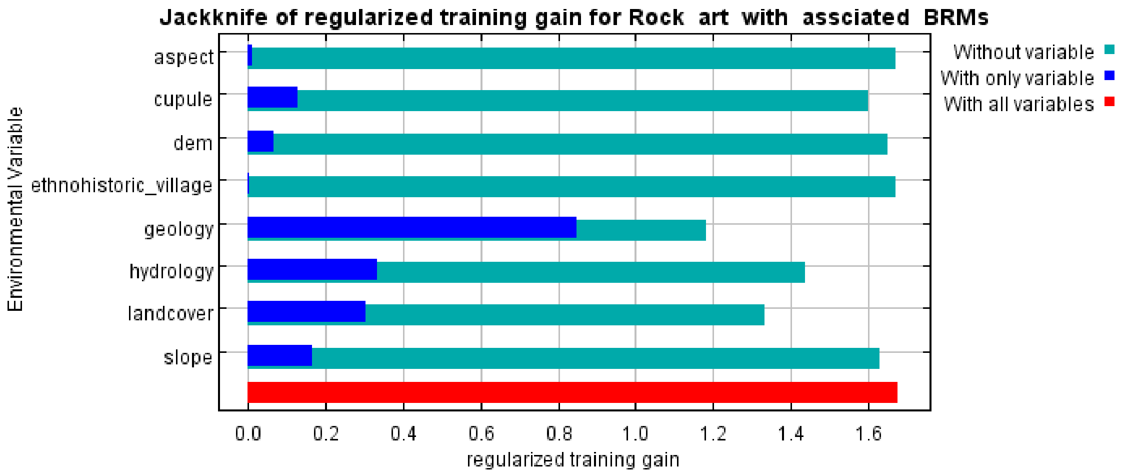

Figure E.25: Jackknife of regularised training gain for rock art with associated BRMs showing the most important predictive environmental variables for within the Sierra Madre Ridge/San Rafael Wilderness.

Figure E.26: Predictive surface for rock art with associated BRMs at the Sierra Madre Ridge/San Rafael Wilderness community-scale of analysis created by Maxent. Red represents areas of high probability for rock art site presence while green represents areas of low probability of rock art site presence.

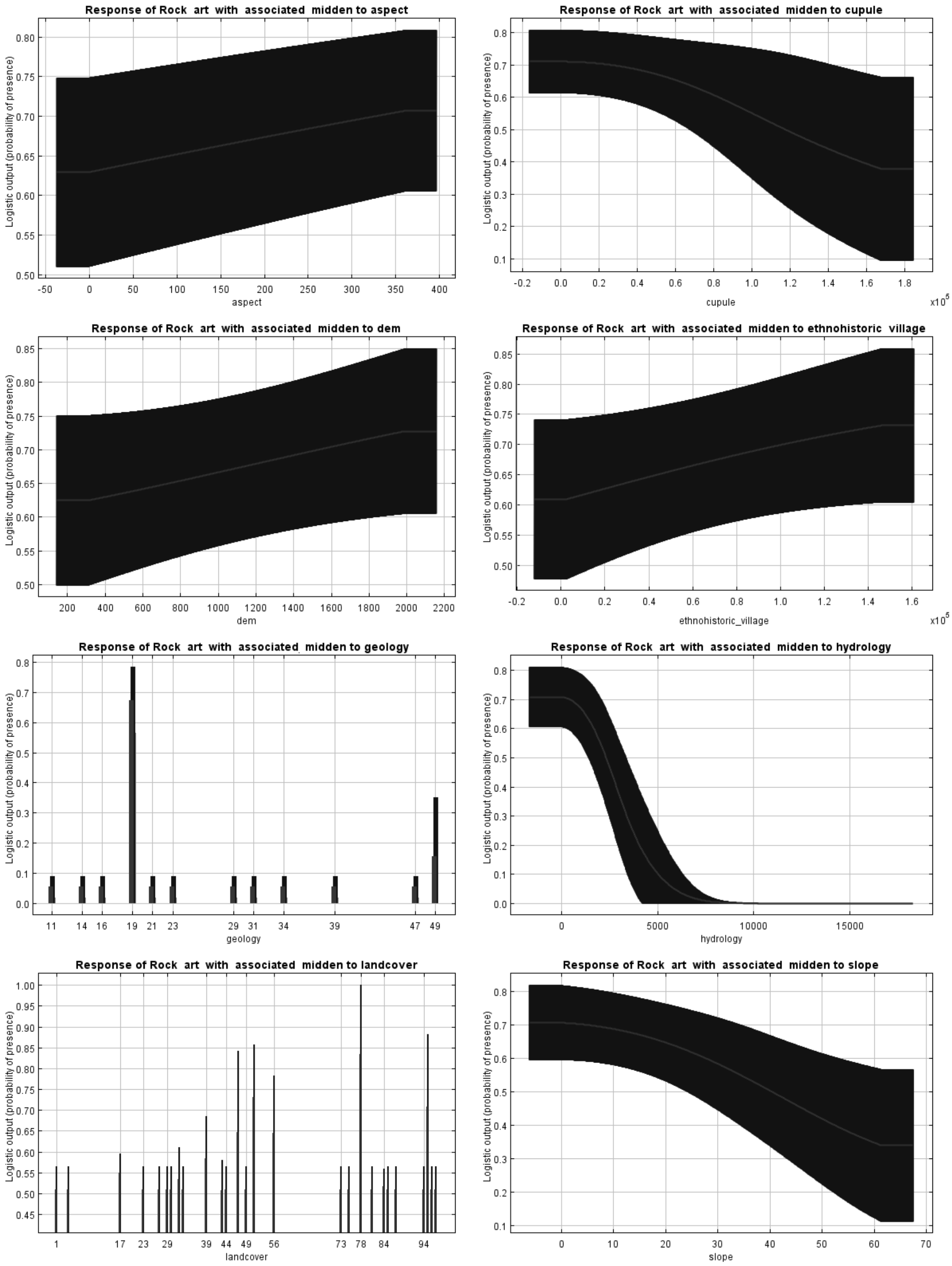

Figure E.27: Marginal response curves for rock art with associated middens in the Sierra Madre Ridge/San Rafael community-scale of analysis for all variables described in Chapter 8.

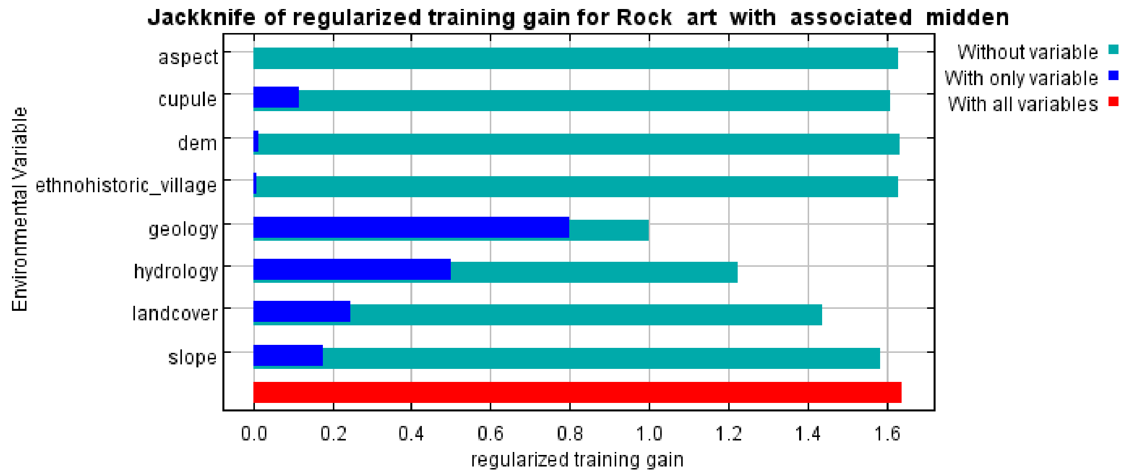

Figure E.28: Jackknife of regularised training gain for rock art with associated middens showing the most important predictive environmental variables within the Sierra Madre Ridge/San Rafael Wilderness.

Figure E.29: Predictive surface for rock art with associated middens at the Sierra Madre Ridge/San Rafael Wilderness community-scale of analysis created by Maxent. Red represents areas of high probability for rock art site presence while green represents areas of low probability of rock art site presence.

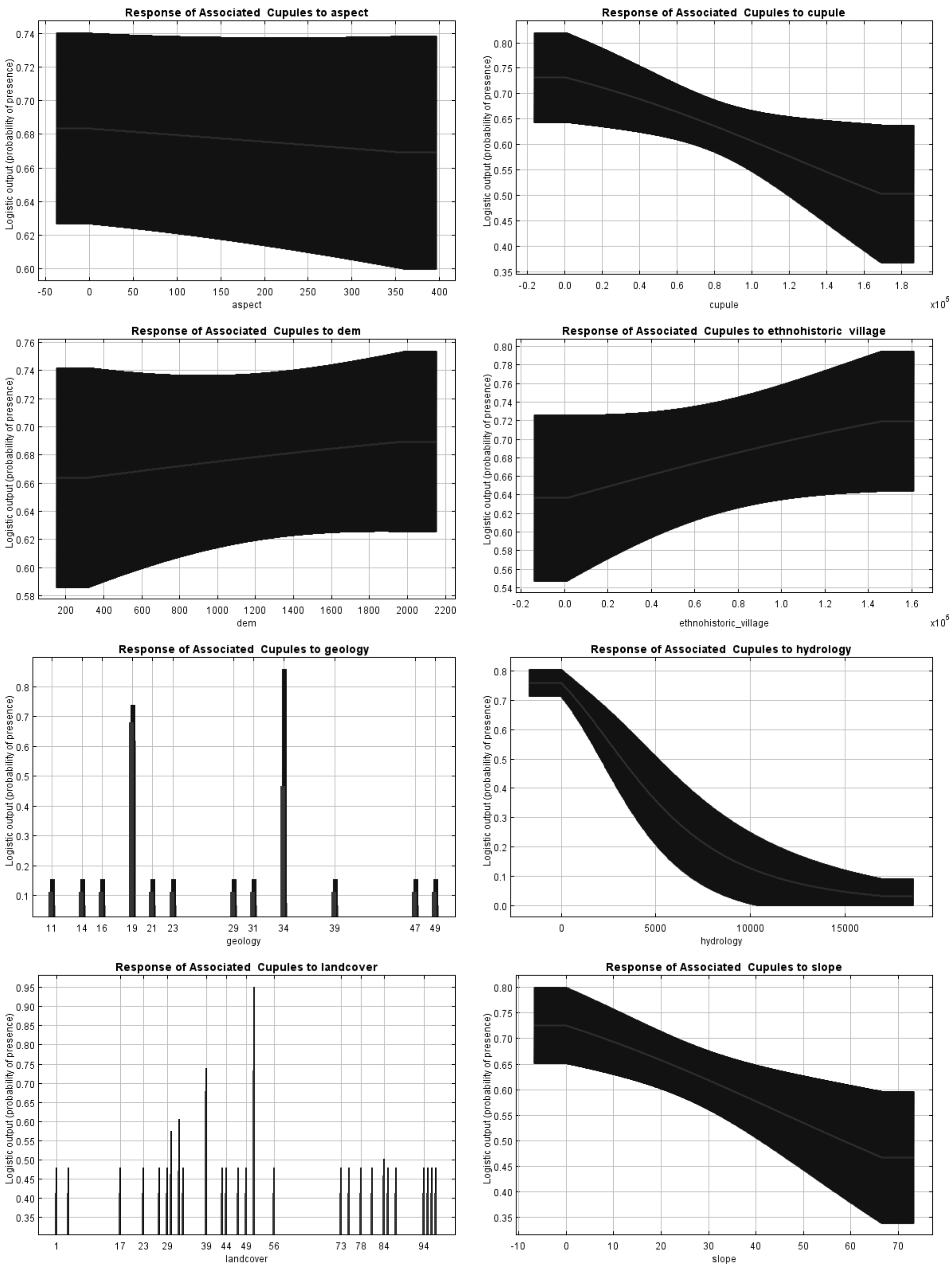

Figure E.30: Marginal response curves for rock art with associated cupules in the Sierra Madre Ridge/San Rafael community-scale of analysis for all variables described in Chapter 8.

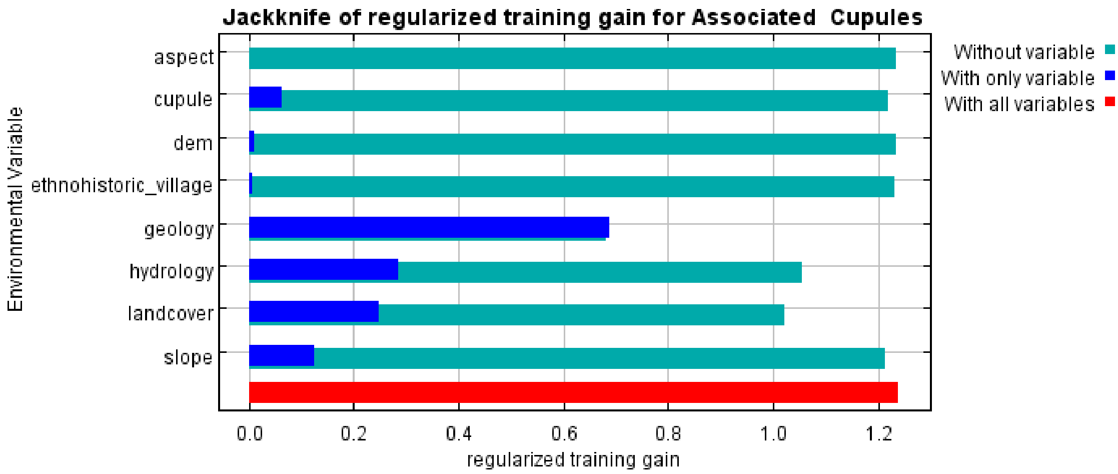

Figure E.31: Jackknife of regularised training gain for rock art with associated cupules showing the most important predictive environmental variables within the Sierra Madre Ridge/San Rafael Wilderness.

Figure E.32: Predictive surface for rock art with associated cupules at the Sierra Madre Ridge/San Rafael Wilderness community-scale of analysis created by Maxent. Red represents areas of high probability for rock art site presence while green represents areas of low probability of rock art site presence.

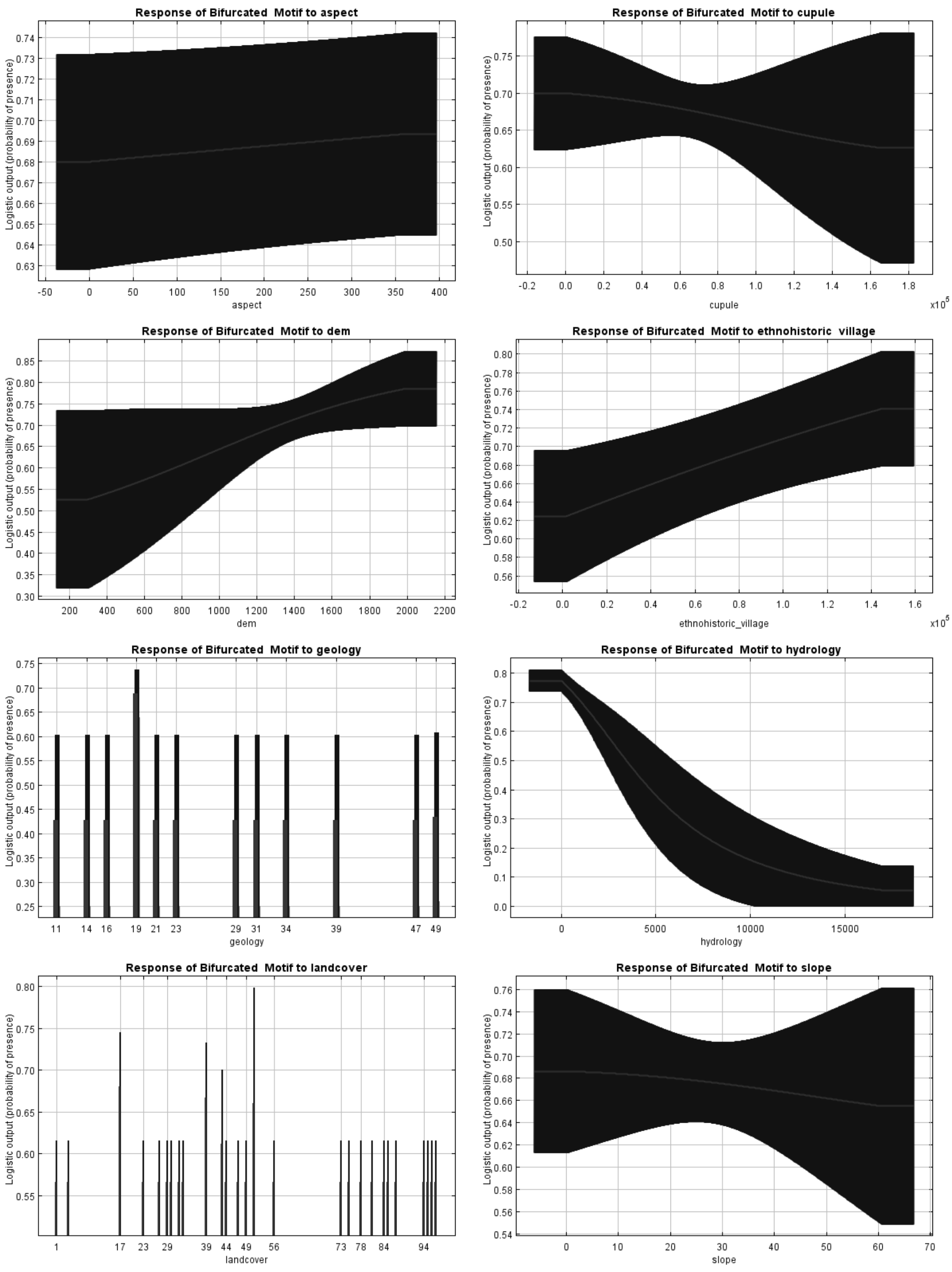

Figure E.33: Marginal response curves for rock art with associated cupules in the Sierra Madre Ridge/San Rafael community-scale of analysis for all variables described in Chapter 8.

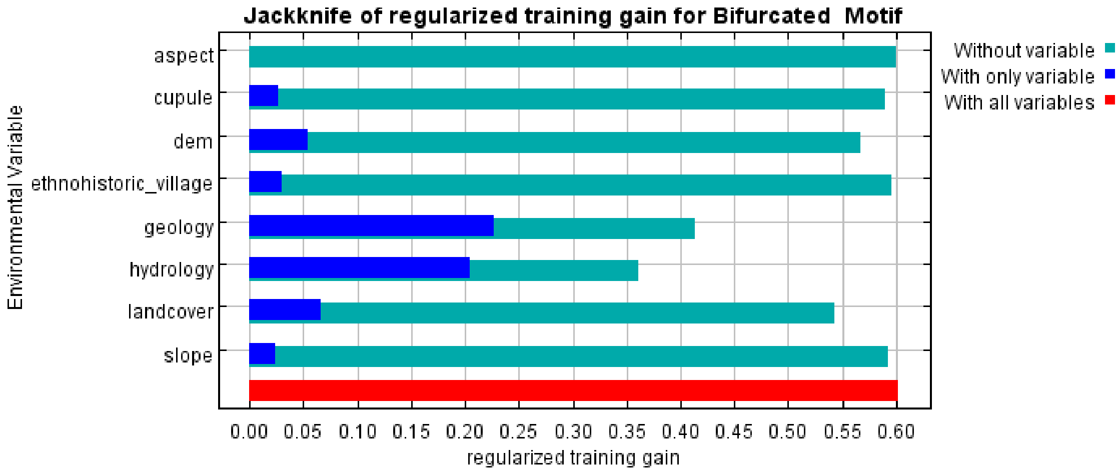

Figure E.34: Jackknife of regularised training gain for rock art with the bifurcated motif showing the most important predictive environmental variables within the Sierra Madre Ridge/San Rafael Wilderness.

Figure E.35: Predictive surface for rock art with the bifurcated motif at the Sierra Madre Ridge/San Rafael Wilderness community-scale of analysis created by Maxent. Red represents areas of high probability for rock art site presence while green represents areas of low probability of rock art site presence.

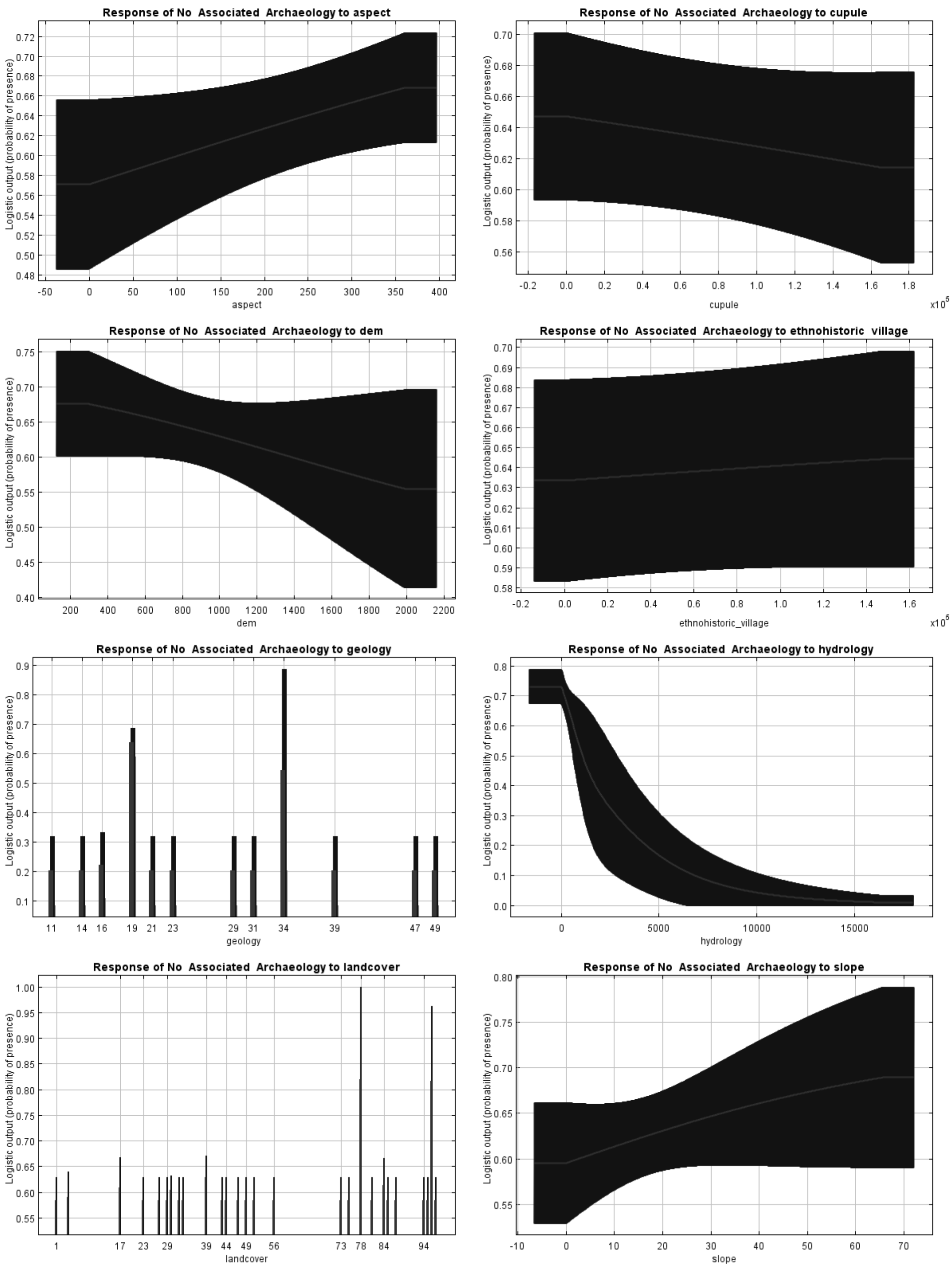

Figure E.36: Marginal response curves for rock art with no associated archaeology in the Sierra Madre Ridge/San Rafael community-scale of analysis for all variables described in Chapter 8.

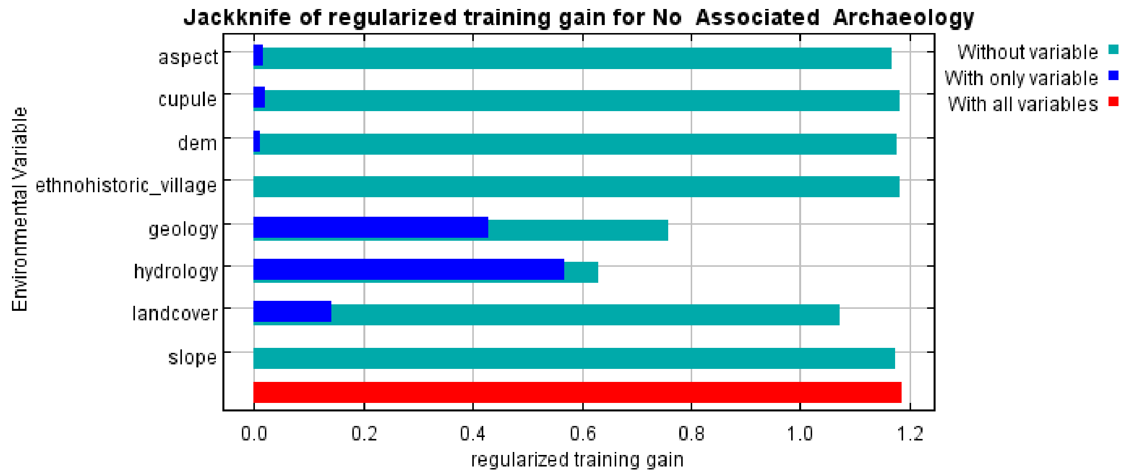

Figure E.37: Jackknife of regularised training gain for rock art with no associated archaeology showing the most important predictive environmental variables within the Sierra Madre Ridge/San Rafael Wilderness.

Figure E.38: Predictive surface for rock art with no associated archaeology at the Sierra Madre Ridge/San Rafael Wilderness community-scale of analysis created by Maxent. Red represents areas of high probability for rock art site presence while green represents areas of low probability of rock art site presence.

<u>**Community Scale: Santa Ynez Mountains and Backcountry**</u>

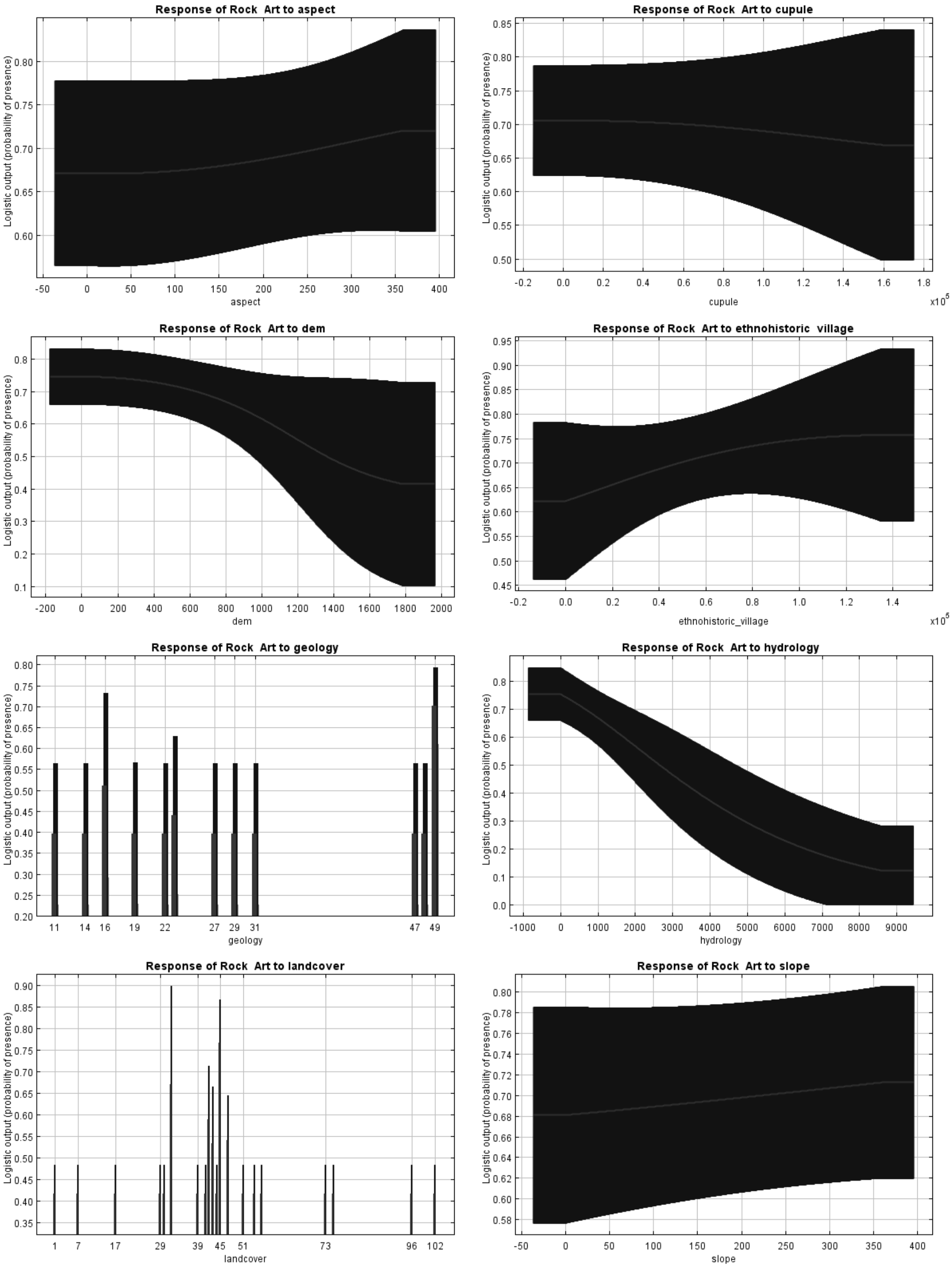

Figure E.39: Marginal response curves for rock art sites in the Santa Ynez and backcountry community-scale of analysis for all variables described in Chapter 8.

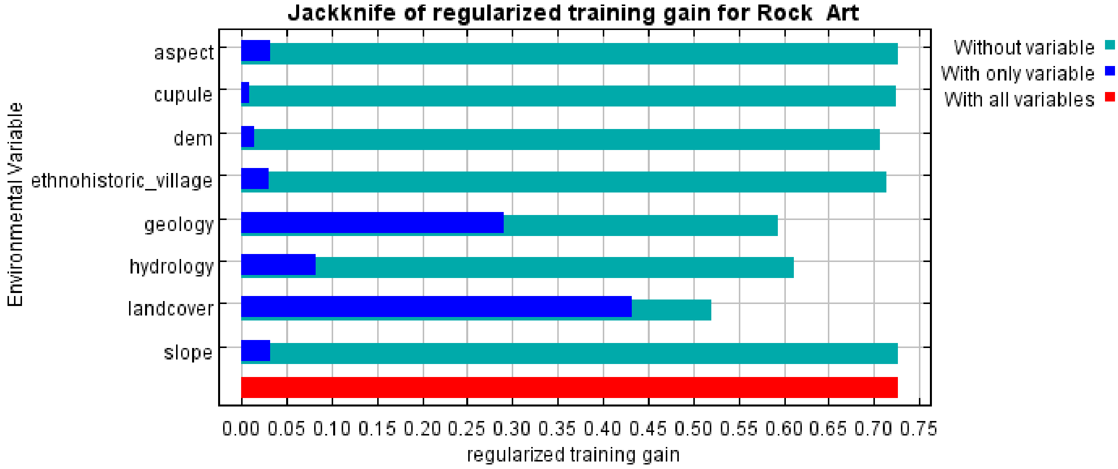

Figure E.40: Jackknife of regularised training gain for rock art sites showing the most important predictive environmental variables for all rock art sites within the Santa Ynez and backcountry.

Figure E.41: Predictive surface for all rock art sites at the Santa Ynez and backcountry community-scale of analysis created by Maxent. Red represents areas of high probability for rock art site presence while green represents areas of low probability of rock art site presence.

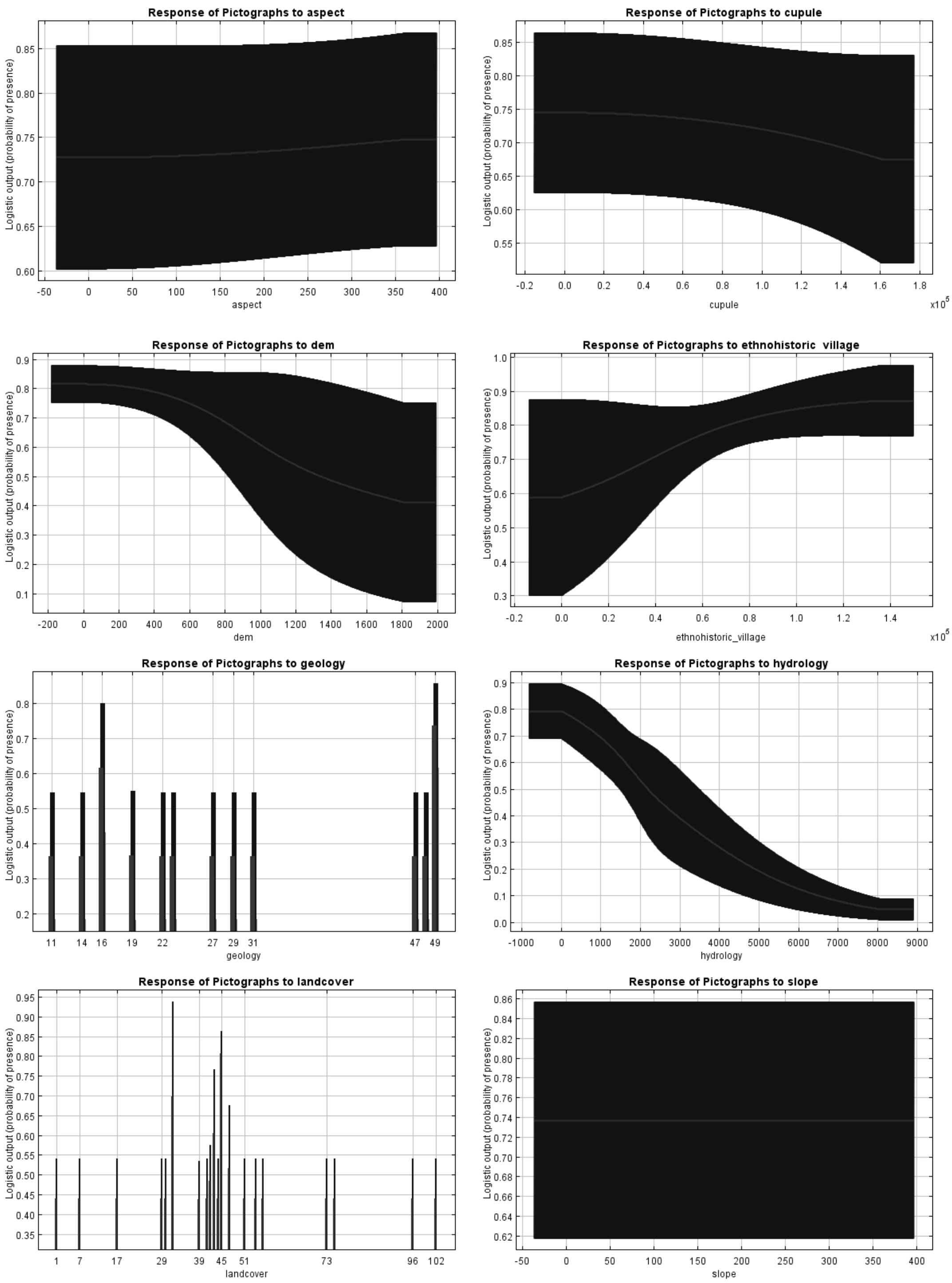

Figure E.42: Marginal response curves for pictographs in the Santa Ynez and backcountry community-scale of analysis for all variables described in Chapter 8.

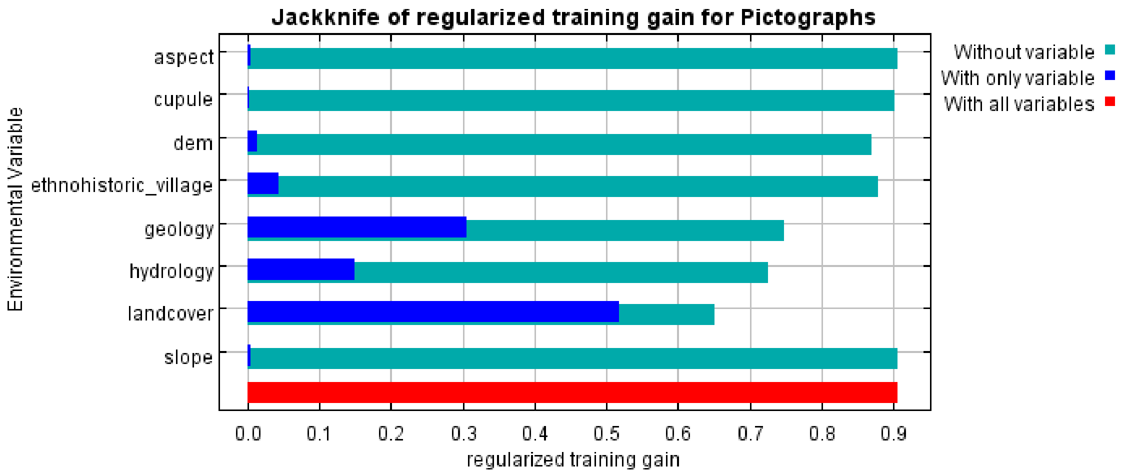

Figure E.43: Jackknife of regularised training gain for pictographs showing the most important predictive environmental variables within the Santa Ynez and backcountry.

Figure E.44: Predictive surface for pictographs at the Santa Ynez and backcountry community-scale of analysis created by Maxent. Red represents areas of high probability for rock art site presence while green represents areas of low probability of rock art site presence.

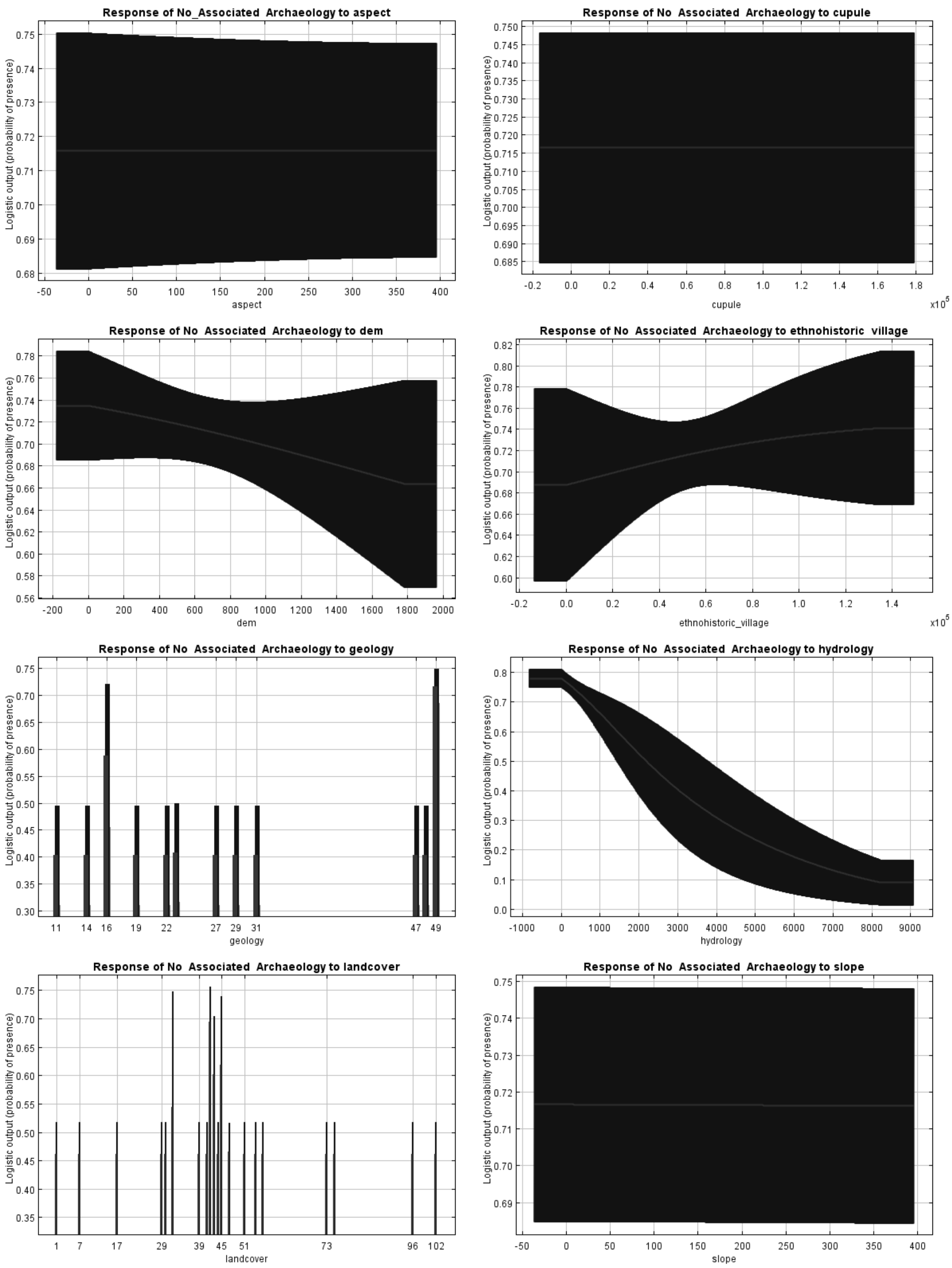

Figure E.45: Marginal response curves for rock art with no associated archaeology in the Santa Ynez and backcountry community-scale of analysis for all variables described in Chapter 8.

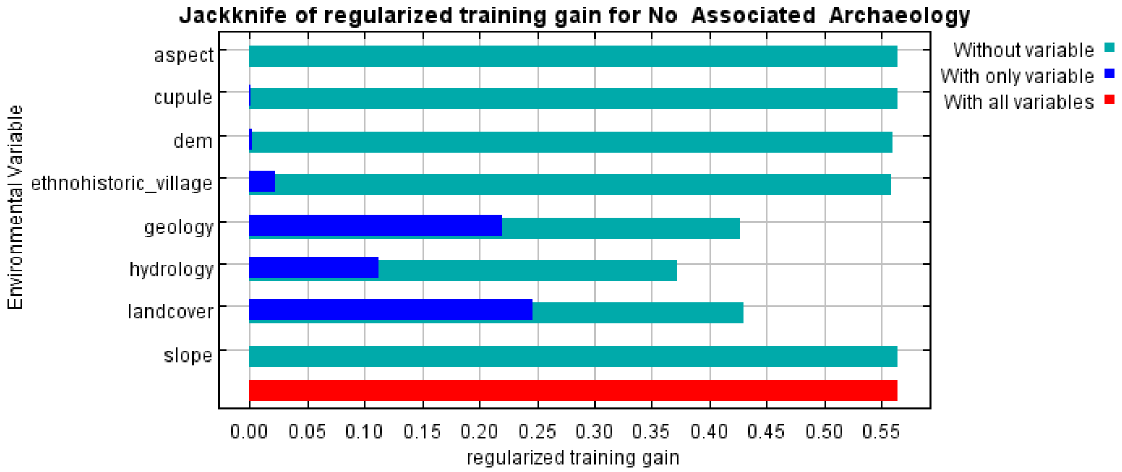

Figure E.46: Jackknife of regularised training gain for rock art with no associated archaeology showing the most important predictive environmental variables within the Santa Ynez and backcountry.

Figure E.47: Predictive surface for rock art with no associated archaeology at the Santa Ynez and backcountry community-scale of analysis created by Maxent. Red represents areas of high probability for rock art site presence while green represents areas of low probability of rock art site presence.

Community Scale: Simi Hills and Ventura County

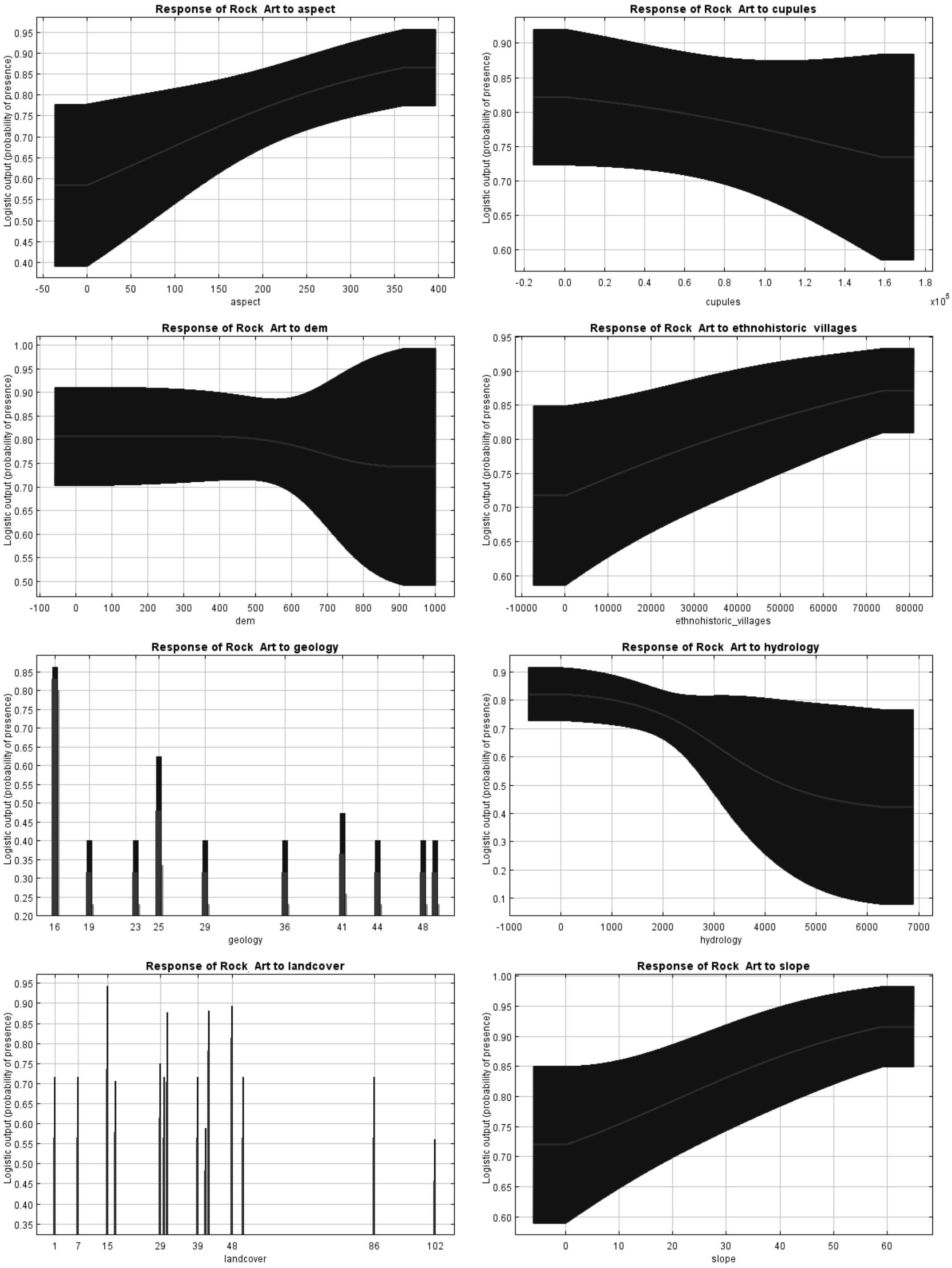

Figure E.48: Marginal response curves for all rock art sites in the Simi Hills and Ventura County community-scale of analysis for all variables described in Chapter 8.

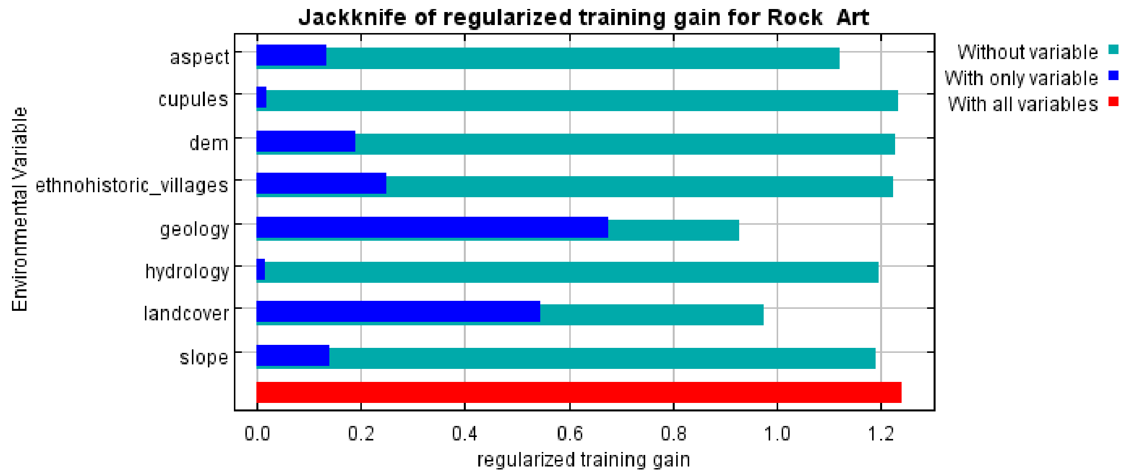

Figure E.49: Jackknife of regularised training gain for all rock art sites showing the most important predictive environmental variables within the Simi Hills and Ventura County.

Figure E.50: Predictive surface for all rock art sites at the Simi Hills and Ventura County community-scale of analysis created by Maxent. Red represents areas of high probability for rock art site presence while green represents areas of low probability of rock art site presence.

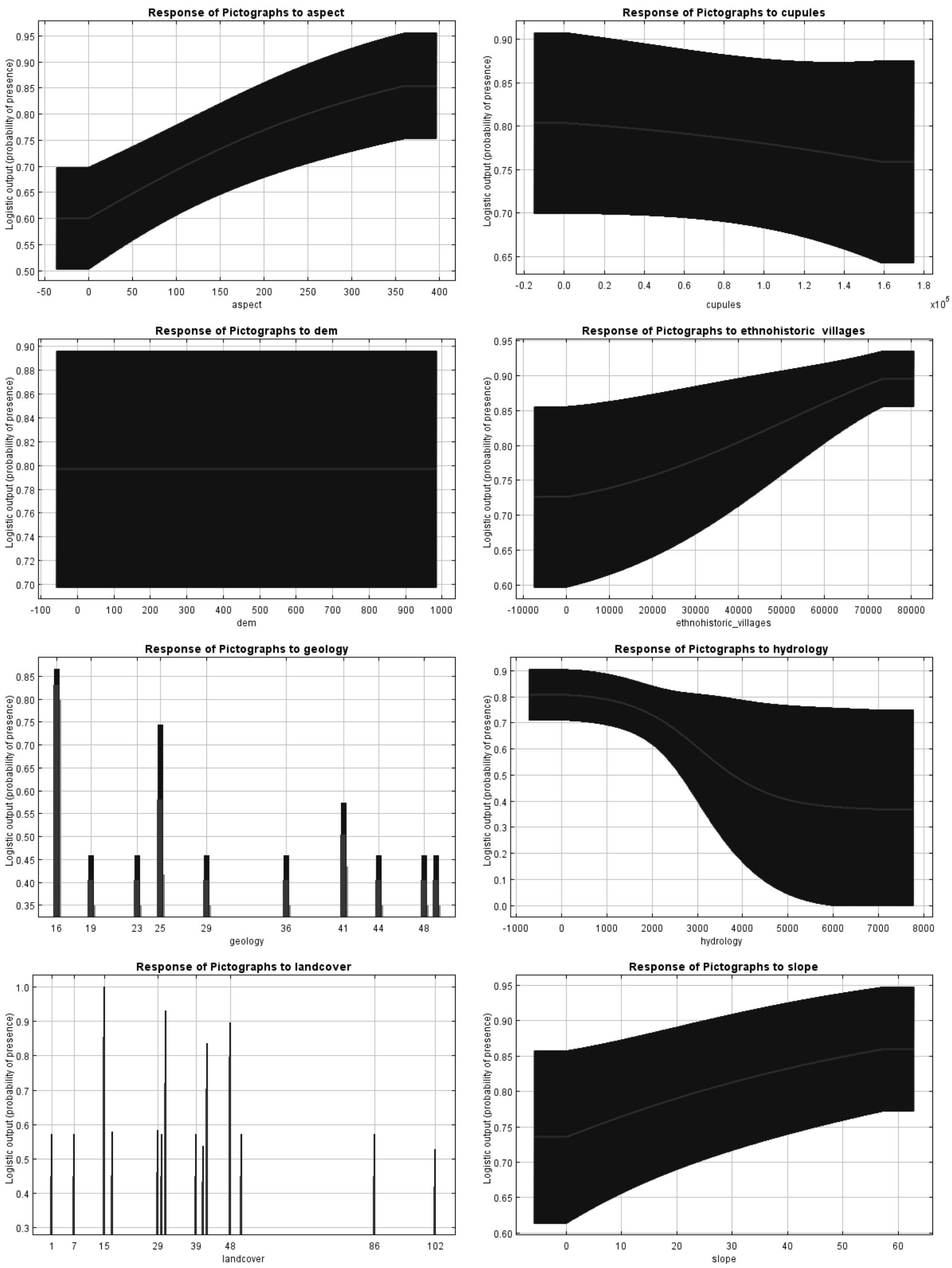

Figure E.51: Marginal response curves for pictographs in the Simi Hills and Ventura County community-scale of analysis for all variables described in Chapter 8.

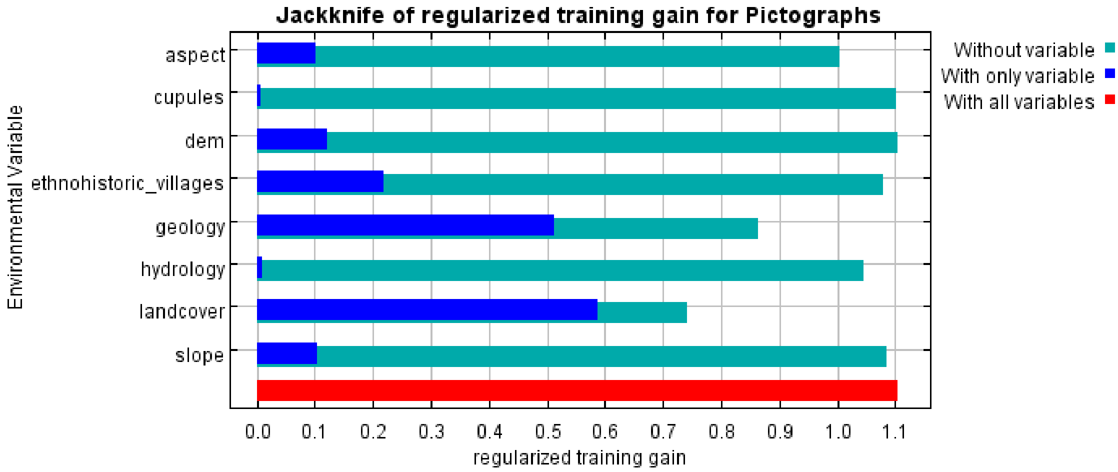

Figure E.52: Jackknife of regularised training gain for pictographs showing the most important predictive environmental variables within the Simi Hills and Ventura County.

Figure E.53: Predictive surface for pictographs at the Simi Hills and Ventura County community-scale of analysis created by Maxent. Red represents areas of high probability for rock art site presence while green represents areas of low probability of rock art site presence.

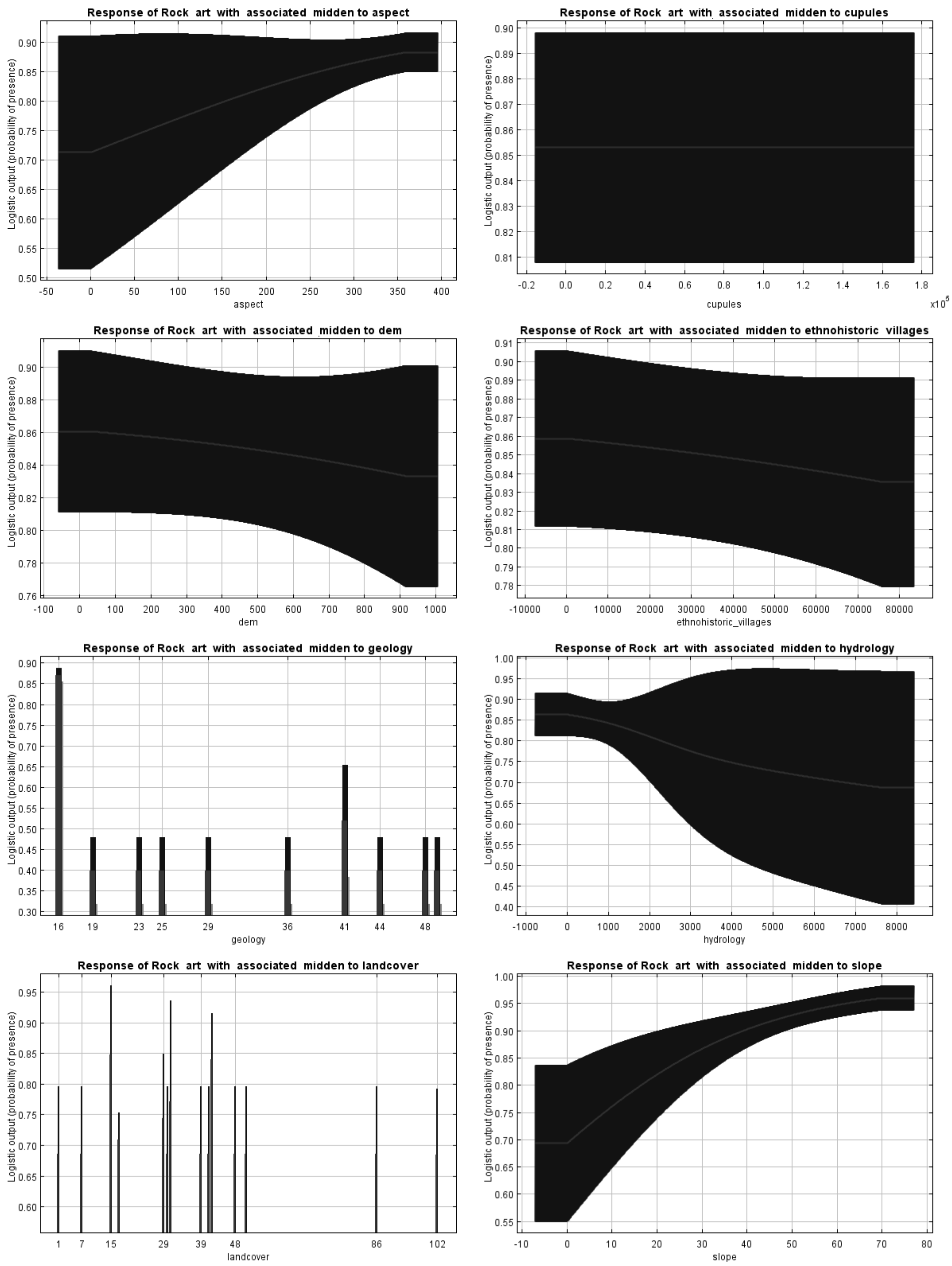

Figure E.54: Marginal response curves for rock art with associated middens in the Simi Hills and Ventura County community-scale of analysis for all variables described in Chapter 8.

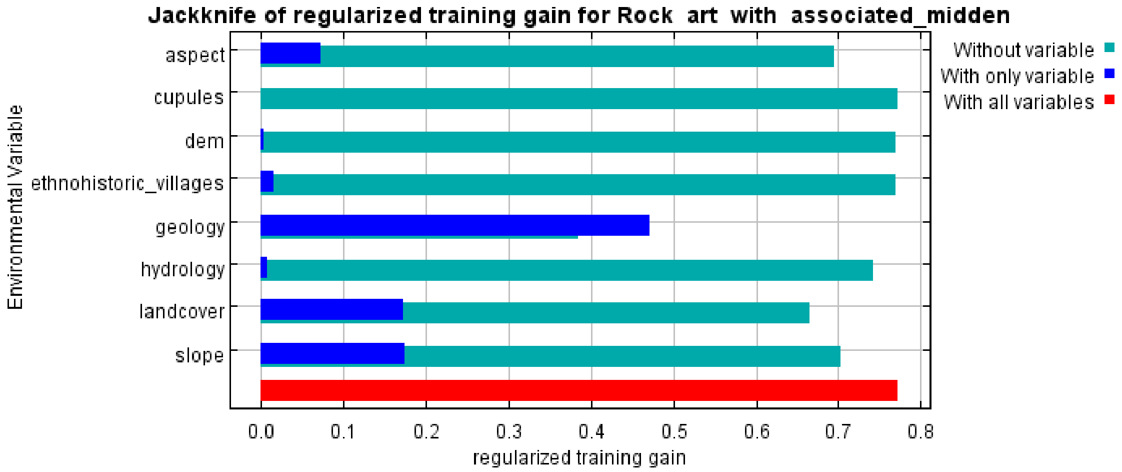

Figure E.55: Jackknife of regularised training gain for rock art with associated middens showing the most important predictive environmental variables within the Simi Hills and Ventura County.

Figure E.56: Predictive surface for rock art with associated middens at the Simi Hills and Ventura County community-scale of analysis created by Maxent. Red represents areas of high probability for rock art site presence while green represents areas of low probability of rock art site presence.

Community Scale: Wind Wolves Preserve

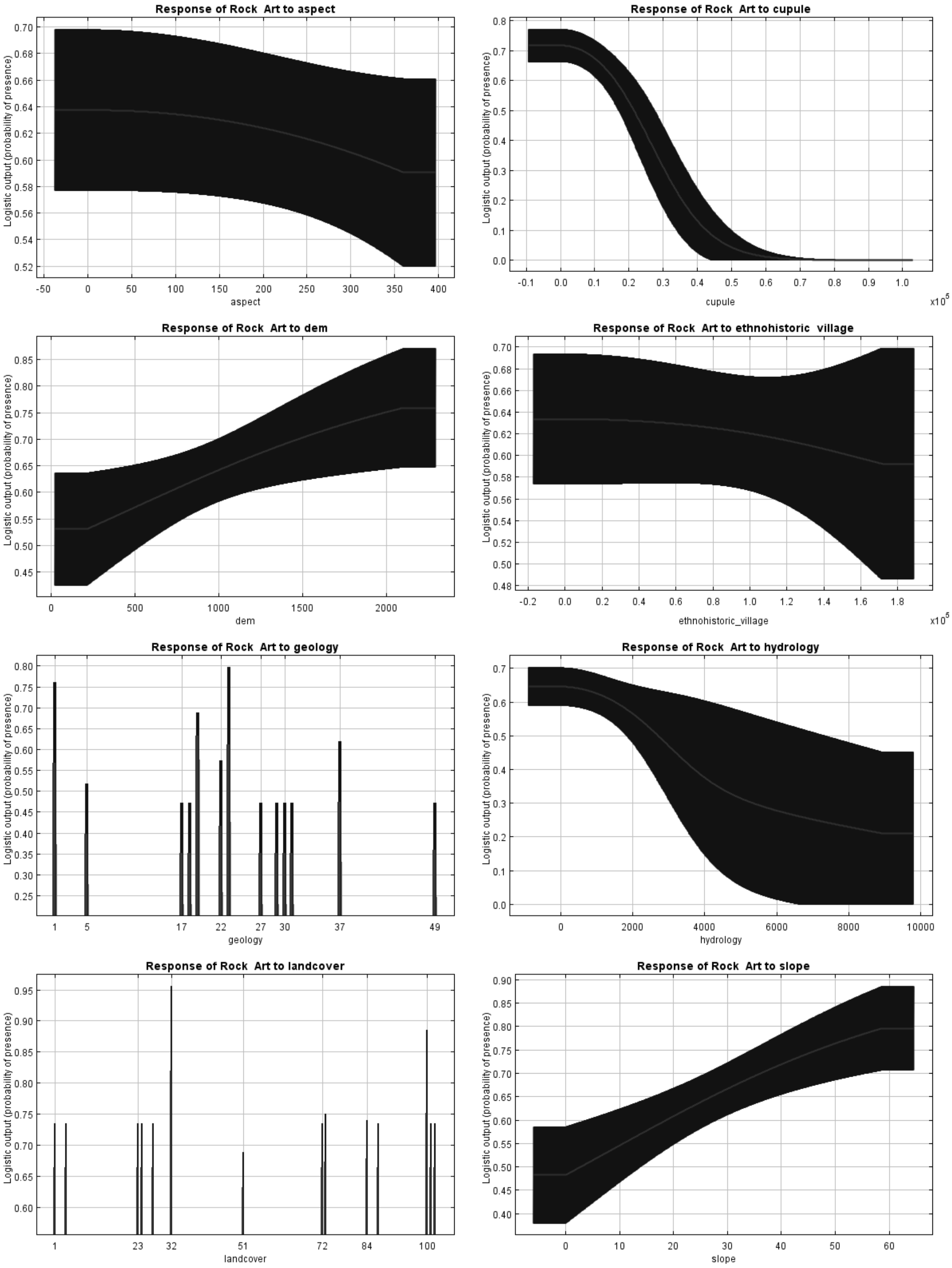

Figure E.57: Marginal response curves for all rock art sites in the Wind Wolves Preserve community-scale of analysis for all variables described in Chapter 8.

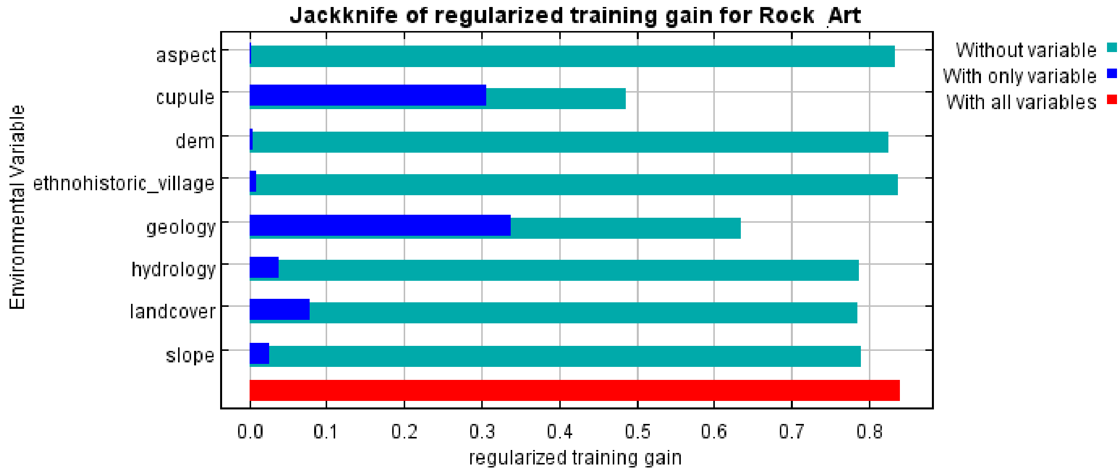

Figure E.58: Jackknife of regularised training gain for all rock art sites showing the most important predictive environmental variables within the Wind Wolves Preserve.

Figure E.59: Predictive surface for all rock art sites at the Wind Wolves Preserve community-scale of analysis created by Maxent. Red represents areas of high probability for rock art site presence while green represents areas of low probability of rock art site presence.

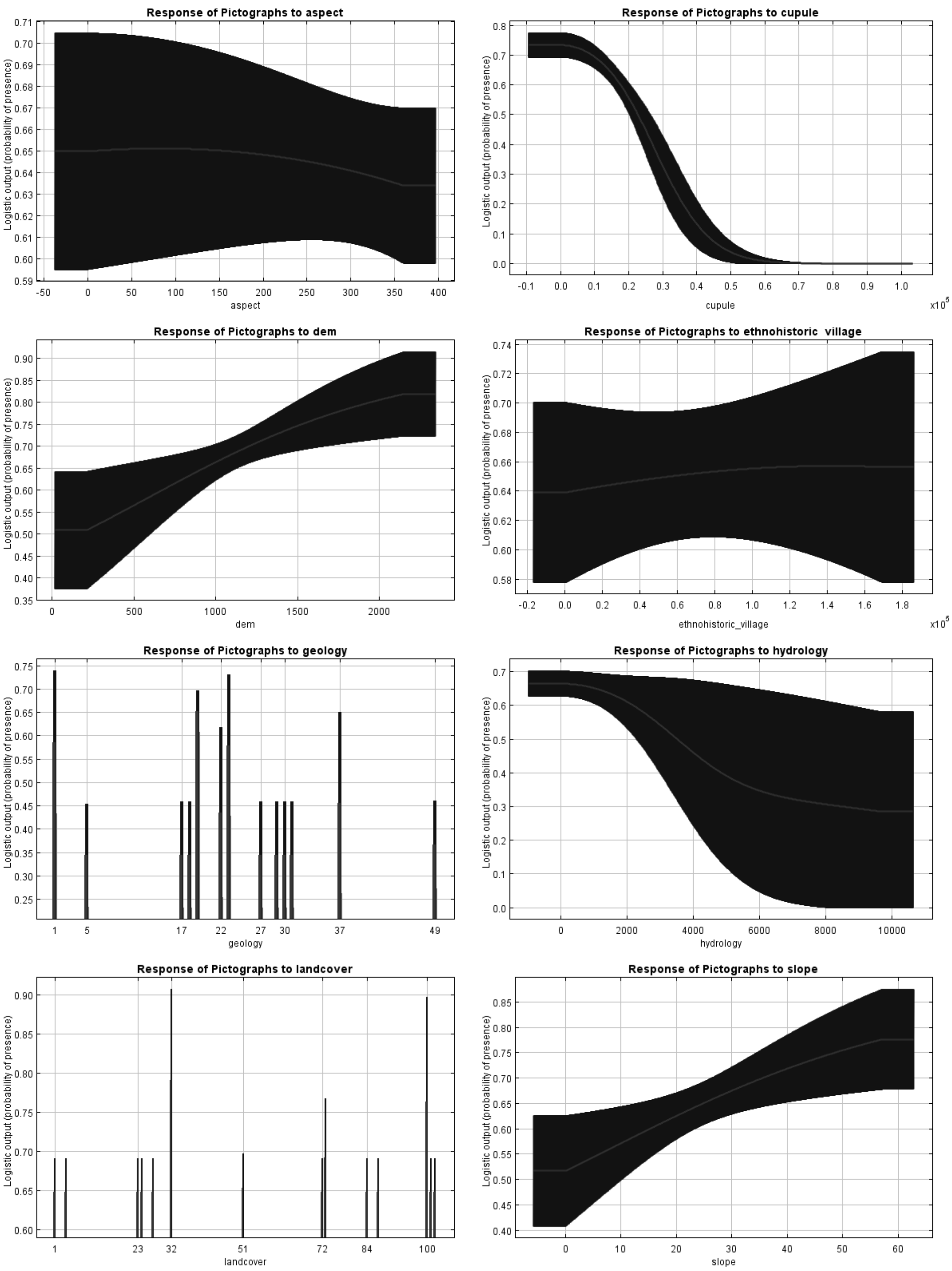

Figure E.60: Marginal response curves for pictographs in the Wind Wolves Preserve community-scale of analysis for all variables described in Chapter 8.

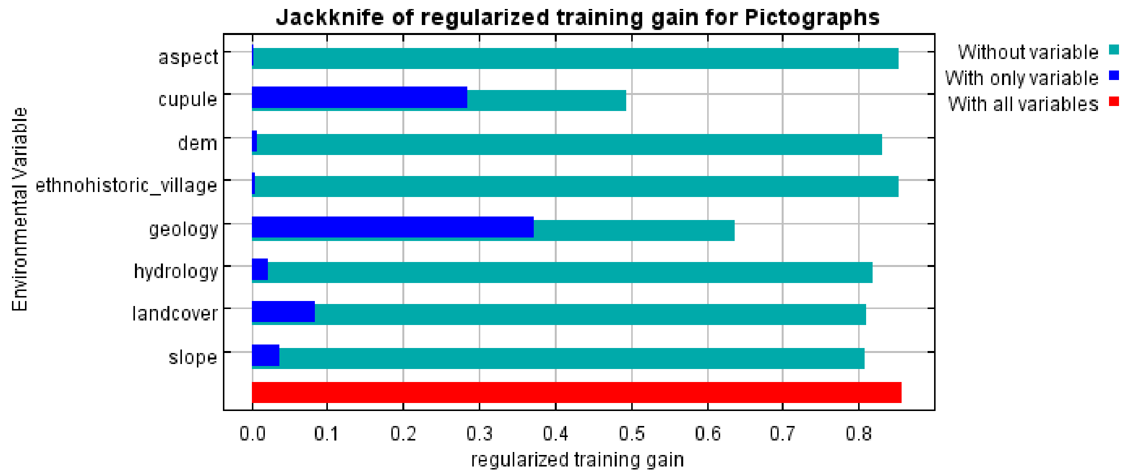

Figure E.61: Jackknife of regularised training gain for pictographs showing the most important predictive environmental variables within the Wind Wolves Preserve.

Figure E.62: Predictive surface for pictographs at the Wind Wolves Preserve community-scale of analysis created by Maxent. Red represents areas of high probability for rock art site presence while green represents areas of low probability of rock art site presence.

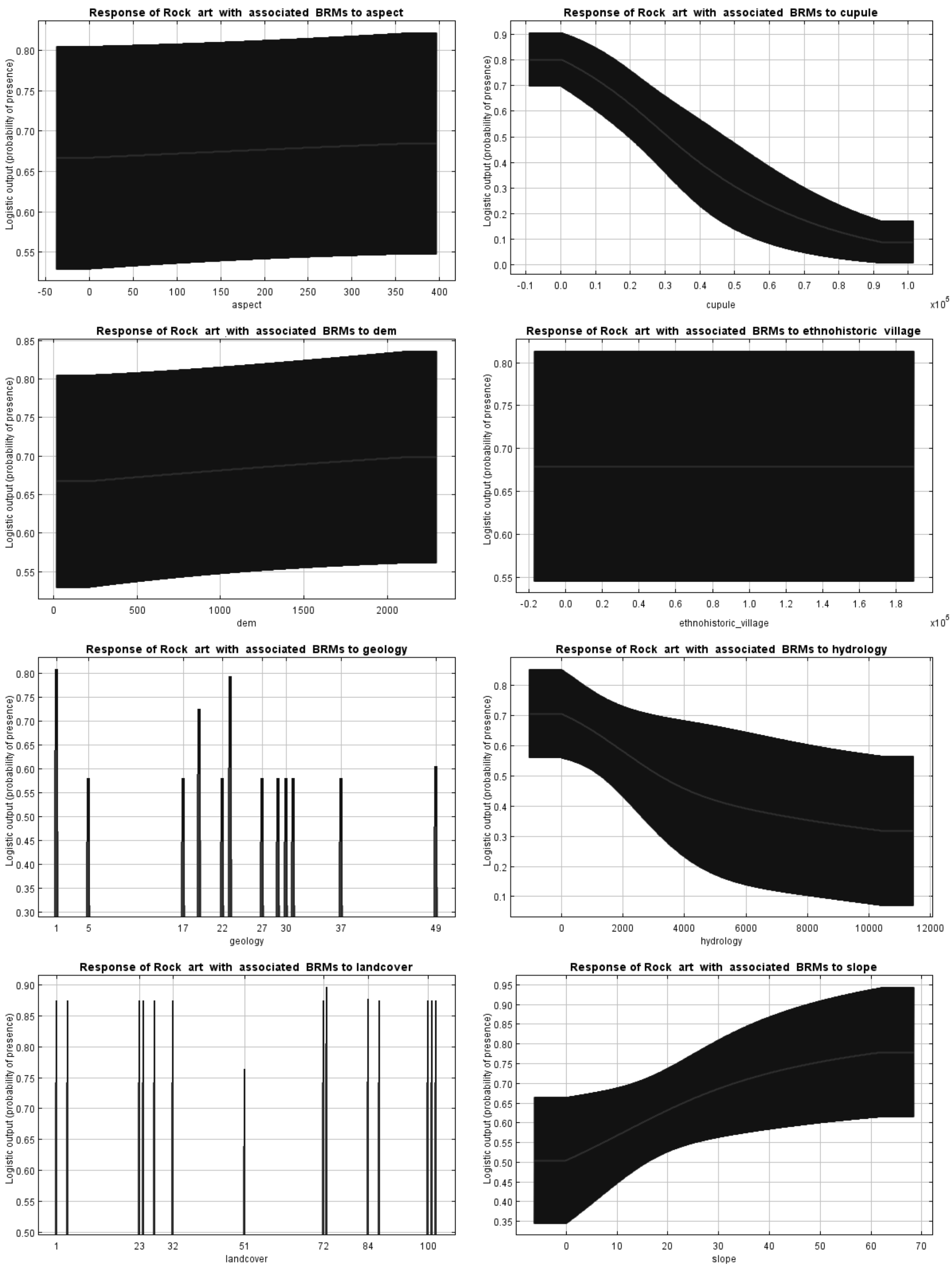

Figure E.63: Marginal response curves for rock art with associated BRMs in the Wind Wolves Preserve community-scale of analysis for all variables described in Chapter 8.

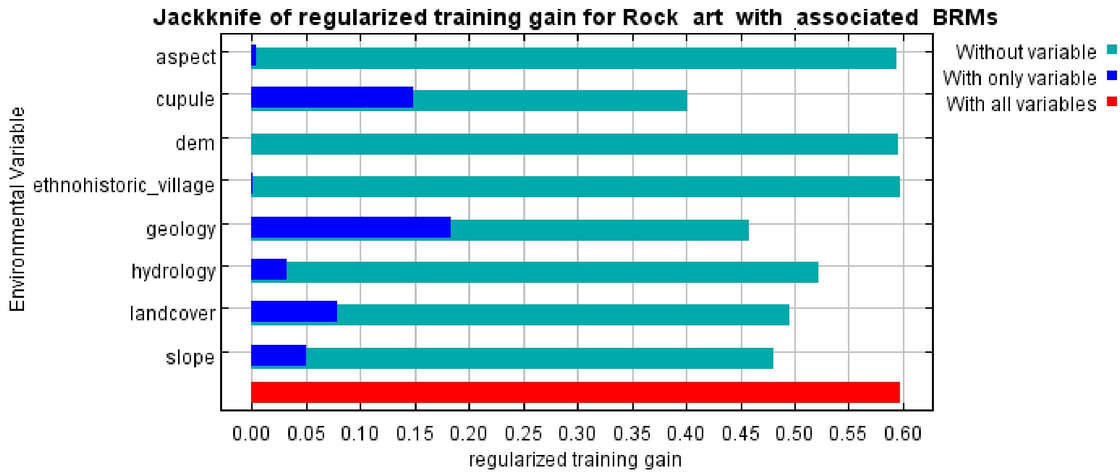

Figure E.64: Jackknife of regularised training gain for rock art with associated BRMs showing the most important predictive environmental variables within the Wind Wolves Preserve.

Figure E.65: Predictive surface for rock art with associated BRMs at the Wind Wolves Preserve community-scale of analysis created by Maxent. Red represents areas of high probability for rock art site presence while green represents areas of low probability of rock art site presence.

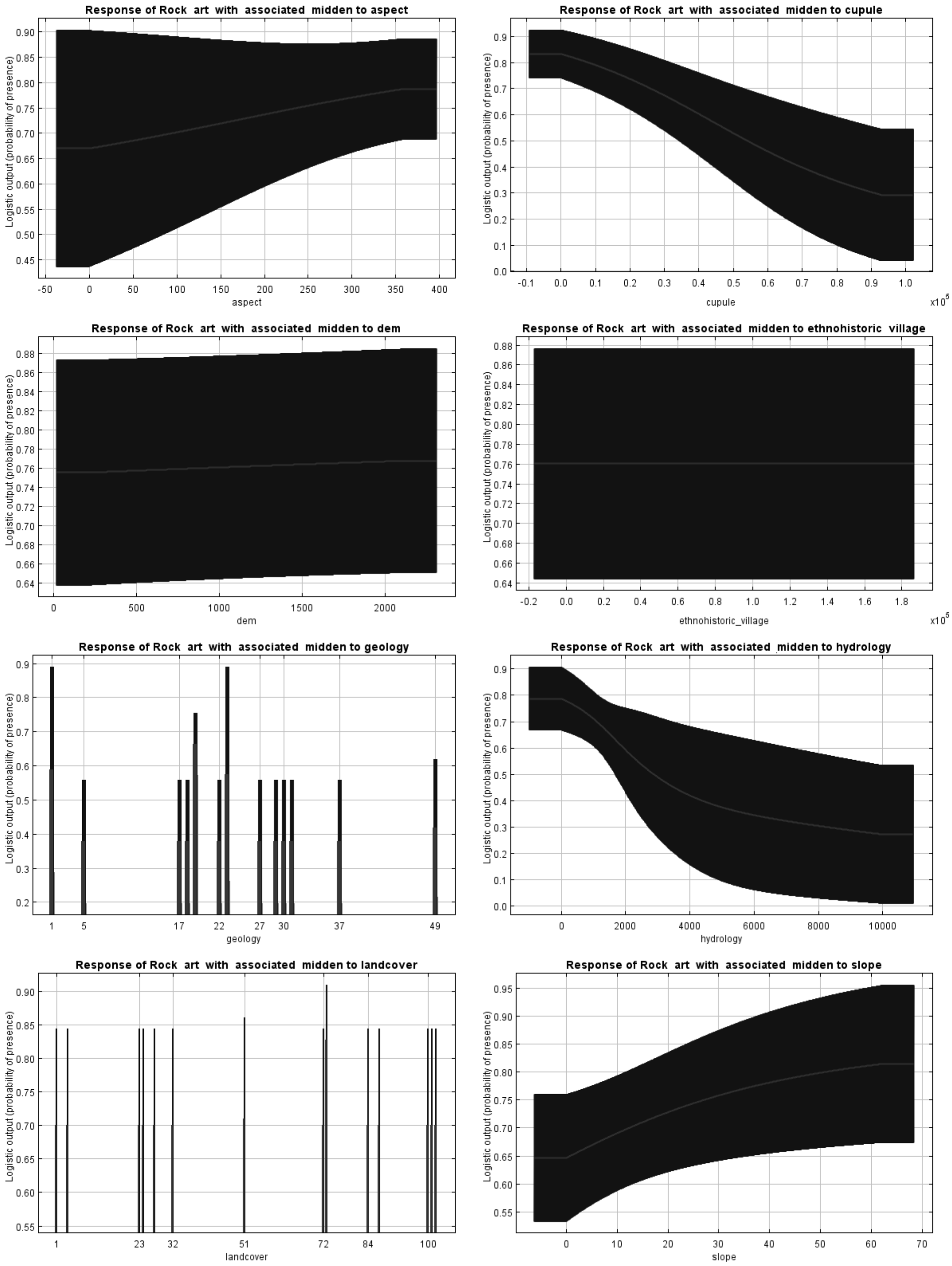

Figure E.66: Marginal response curves for rock art with associated middens in the Wind Wolves Preserve community-scale of analysis for all variables described in Chapter 8.

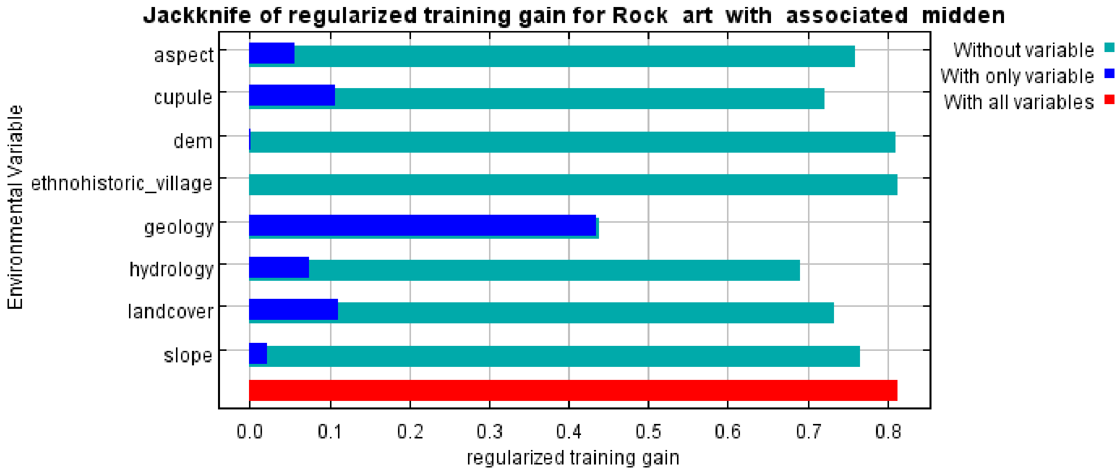

Figure E.67: Jackknife of regularised training gain for rock art with associated middens showing the most important predictive environmental variables within the Wind Wolves Preserve.

Figure E.68: Predictive surface for rock art with associated middens at the Wind Wolves Preserve community-scale of analysis created by Maxent. Red represents areas of high probability for rock art site presence while green represents areas of low probability of rock art site presence.

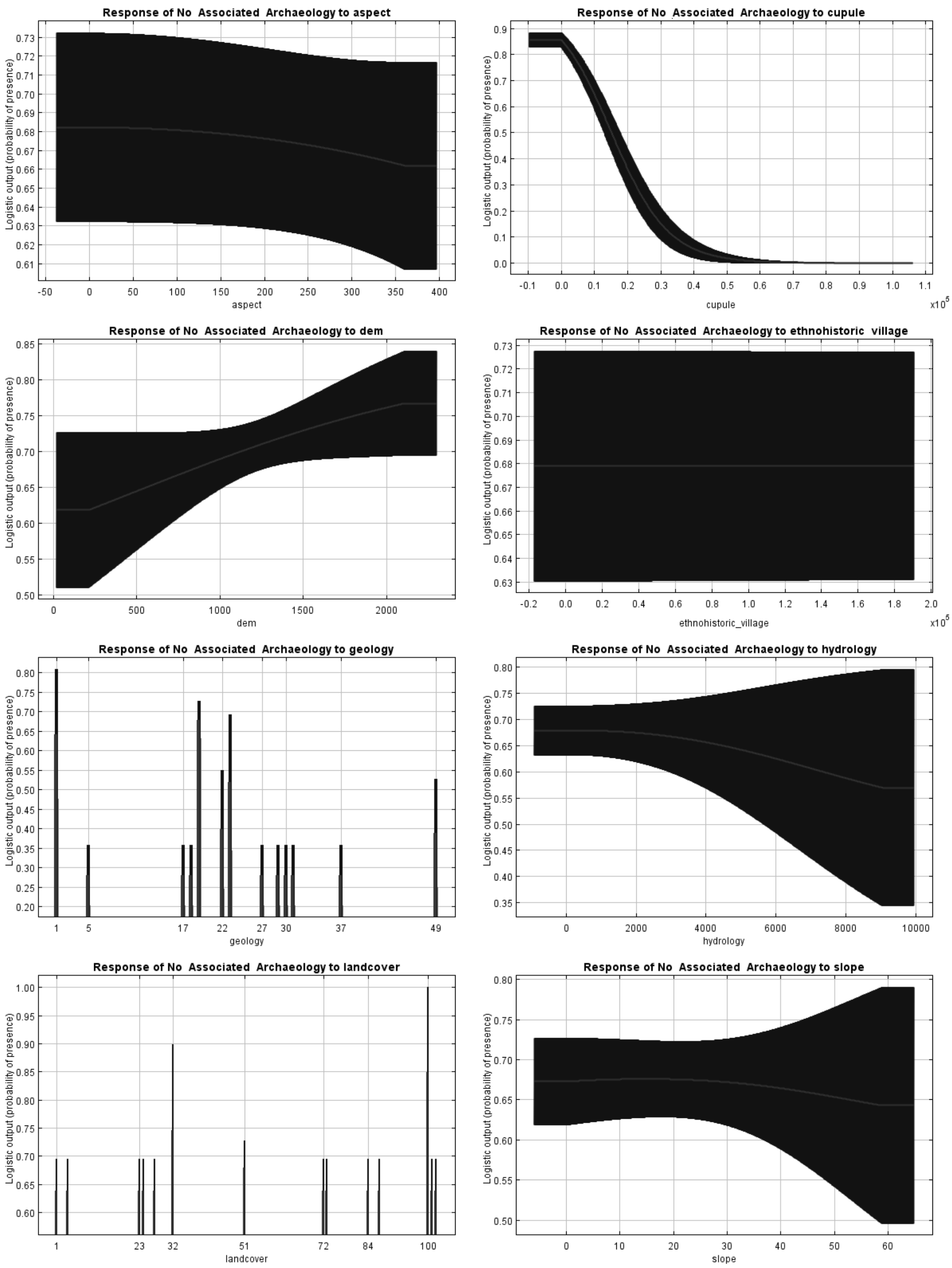

Figure E.69: Marginal response curves for rock art with no associated archaeology in the Wind Wolves Preserve community-scale of analysis for all variables described in Chapter 8.

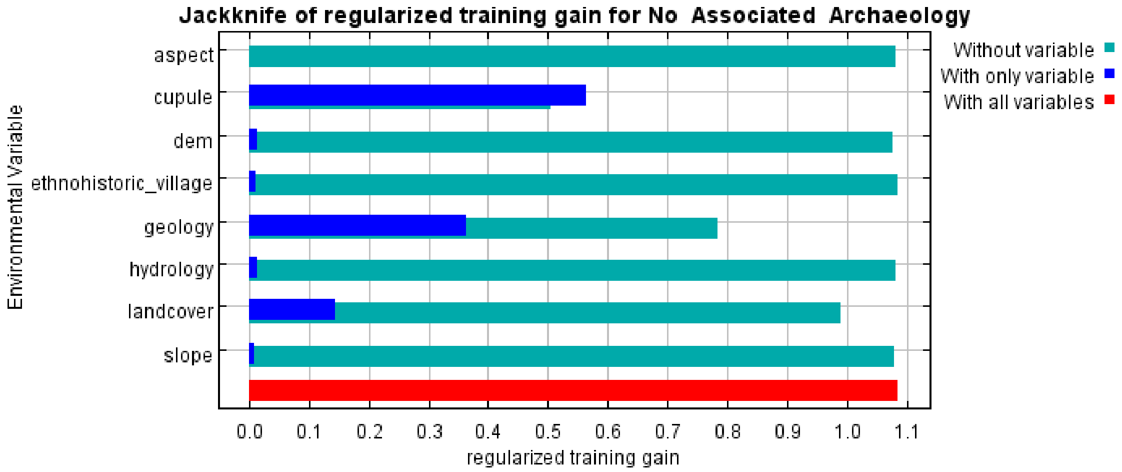

Figure E.70: Jackknife of regularised training gain for rock art with no associated archaeology showing the most important predictive environmental variables within the Wind Wolves Preserve.

Figure E.71: Predictive surface for rock art with no associated archaeology at the Wind Wolves Preserve community-scale of analysis created by Maxent. Red represents areas of high probability for rock art site presence while green represents areas of low probability of rock art site presence.