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THE IMPACT OF THE MEDIEVAL CLIMATIC ANOMALY ON THE ARCHAEOLOGY AT EDWARDS AIR FORCE BASE

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THE IMPACT OF THE MEDIEVAL CLIMATIC ANOMALY ON THE
ARCHAEOLOGY AT EDWARDS AIR FORCE BASE

A Thesis
Presented to the
Faculty of
California State University,
San Bernardino

In Partial Fulfillment
of the Requirements for the Degree
Master of Arts
in
Applied Archaeology

by
Jessica Amanda Porter-Rodriguez

June 2017

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ABSTRACT

A series of severe and prolonged droughts occurred throughout the Northern Hemisphere between approximately 1150 BP to 600 BP. This phenomenon is referred to as the Medieval Climatic Anomaly and has been shown to have differentially impacted various regions of the world. Previous studies have suggested causal links between the Medieval Climatic Anomaly and observed culture change.

The goal of this study was to examine the Antelope Valley region of the Mojave Desert for evidence of impacts on human populations related to the Medieval Climatic Anomaly. To achieve this goal, a sample selection of archaeological sites was chosen from lands within Edwards Air Force Base. These sites represented occupations which occurred immediately before, during, and after the Medieval Climatic Anomaly. Site assemblages were analyzed and compared by cultural period, with cross-comparisons made of artefactual and ecofactual constituents. Site densities and areal extents were also examined and compared.

These analyses showed the emergence of trends concurrent with the introduction of the Medieval Climatic Anomaly. The data supports the hypothesis that humans who populated the Antelope Valley region of the Mojave Desert during this period may have engaged in population aggregation, with a tethered nomadism subsistence strategy. The data also shows evidence that upon the

amelioration of the environment after the Medieval Climatic Anomaly, site characteristics within the region saw a significant shift.

While the evidence generated by this study does suggest a link between climatic change experienced during the Medieval Climatic Anomaly and change observed within the archaeology of the Antelope Valley, it does not suggest climate as a sole, or even primary, causal factor. Rather, the intent of this study was to identify one possible variable responsible for observed change that occurred in the region. With this in mind, the Medieval Climatic Anomaly was found to have been significant enough to have either directly or indirectly impacted the prehistoric occupants of the study region.

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Individuals associated with the Cultural Resources program at Edwards Air Force Base provided me with support and resources which were essential for bringing this project to fruition. I owe many thanks to Tom Rademacher, Osmar Alaniz, and Cliff Knesel for allowing me access to the Installation's records and collections. I must especially thank Roscoe Loetzerich for encouraging me to pursue a graduate degree and for giving me his permission to conduct this research within Edwards Air Force Base. I have been fortunate to have had many colleagues during my time at Edwards who have shown me support. Among them are Cole Parker, whose encouragement during this project was greatly appreciated.

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DEDICATION

To my mother, Susan, a fearless woman who taught me to appreciate the thrill of exploration and the joy of being outdoors. I miss you every day.

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CHAPTER ONE

INTRODUCTION

In 1939, Malcolm Rogers noted the importance of understanding climate in order to place a site in its proper context. He lamented that without understanding the geology and climate of the region, all you have is the technological sequence in which to place a site (1939). Recent trends in global climate change have stimulated interest in and prompted numerous studies of climate issues. However, this interest did not begin with the recognition of current climatic events; pioneering dendrochronology studies conducted by Douglass (1929, 1935) in the early twentieth century reported on the potential impacts of climate change within human populations in the Southwest. As a result of his research, Douglass concluded that widespread settlement abandonment during the thirteenth century was the result of severe drought. The drought Douglass identified falls within the period occupied by the Medieval Climatic Anomaly (MCA).

Evidence for the MCA has been identified throughout California (see Chapter Two), though its effects were not uniform across all regions. A point of debate regarding the occurrence of the MCA is the degree to which it impacted the environment of individual regions and their associated populations. Various studies (including dendrochronology, pollen analysis, radiocarbon, and paleohydrology) have been conducted throughout southern California and the Great Basin providing evidence that the MCA did indeed occur in the region (see

Anderson and Smith 1991; Graumlich and Lloyd 1996; MacDonald 2007; and MacDonald *et al.* 2007). In spite of this evidence, there remains much debate regarding the impact of the MCA on the Mojave Desert.

Prior to the recognition, and general acceptance, of the MCA, Antevs (1948) proposed a much broader warming trend for the Great Basin, which he called the Altithermal and defined it as being a warm and dry period about 7,000-4,500 years ago. Although Antevs' climate model focused on a warming trend which he believed occurred approximately 3,000 years prior to the MCA, he did address a topic with which archaeologists who study the MCA are concerned. Antevs (1948) theorized that any change in the climate within the Mojave Desert would affect the prehistoric people occupying the region. This hypothesis has not been without its critics. Madsen (2002) notes that Antevs' temporal categories are much too broad, with the Holocene having experienced moist intervals within its warm, dry periods. The archaeological record also shows that low elevations throughout Great Basin did not sustain regional abandonment during warm periods as Antevs would suggest.

Regarding the MCA, individuals such as Basgall (1987, 1999) and Bettinger (1991a, 1999) argue against climate change as a causal factor for Late Holocene changes in subsistence and settlement strategies, while Hale *et al.* (2010) question whether or not the MCA had any effect on the Mojave since the desert is, by its nature, a drought-tolerant environment. Jill Gardner (2006) conducted a fairly extensive study throughout the western Mojave Desert with the

purpose of determining the impacts of the MCA on prehistoric populations. Gardner's work resulted in findings which suggest shifts in settlement and exploitation of resources that are correlated to environmental stresses of the MCA, a point which Hale *et al.* do however concede (2010:27). Even if Gardner's data were discounted or proven false, Hale *et al.* do not appear consider another factor with their suggestion that the paleoenvironment of the Mojave was not impacted by the MCA: the surrounding environs (mountain and coastal regions) were impacted by the MCA. With this in mind, if it is the case that the Mojave Desert was not adversely affected (or only minimally) by the MCA, then it is likely that the resources it contained became more desirable and saw increased exploitation by prehistoric populations. In this way, the MCA would have an impact on the Mojave Desert.

This ongoing discourse related to the validity of the MCA and its impacts within the Mojave Desert is what this research attempts to address. In addressing this, the study attempts to fill in areal gaps regarding the current knowledge of the MCA's impact on prehistoric populations in Southern California. Specifically, the project focuses on the Antelope Valley region of the Mojave by studying a series of sites located within Edwards Air Force Base. Gardner's dissertation work (2006) focused primarily on sites in the extreme western portion of the western Mojave Desert (Figure 1). Her sample also included two locations within Edwards Air Force Base; however, these locations were not ideal for the purposes of her study. The majority of the sites she studied near Rosamond

Lake had no chronometric data. Where there were dates, the majority of sites at both Rosamond and Rogers Lakes were defined as single occupation events and contained very limited artifact assemblages, resulting in few materials for analysis.

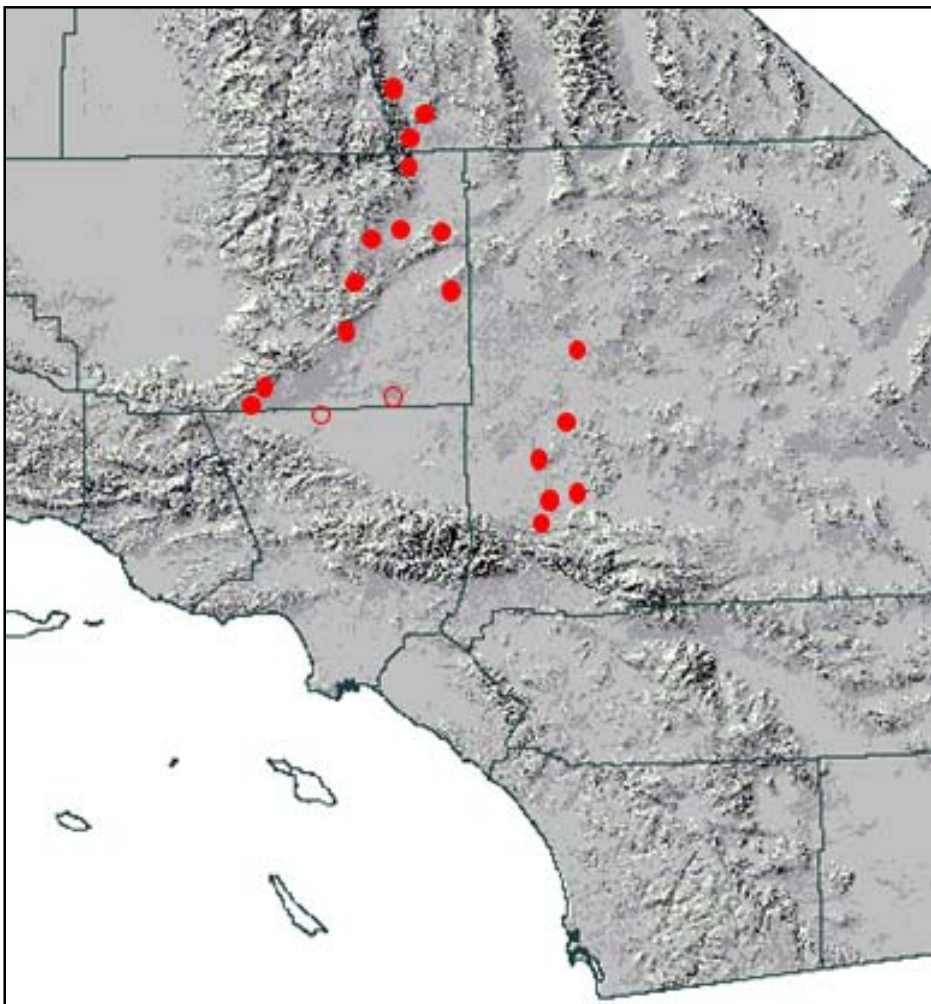


Figure 1. Map Depicting Approximate Locations of Gardner's (2006) Previous MCA Study Sites within the Western Mojave Desert. Hollow Circles Denote Edwards Air Force Base Sites.

Overview of the Medieval Climatic Anomaly

While the climatic event being experienced today includes warming at a rate that far exceeds anything that has been previously documented (Mann *et al.* 2008; Diffenbaugh and Field 2013), it is not the first time significant warming has occurred. The period of time spanning approximately 1150 BP to 600 BP marks one such cycle. Referred to as the Medieval Climatic Anomaly (MCA) because of its coincidence with the medieval period in Europe, climate changes associated with this period are posited to have had considerable impacts not only on the environment, but also on its inhabitants.

By 1965, researchers had noticed expressions of the MCA through various sets of proxy data. Most prominent among these was the English climatologist Hubert H. Lamb. In a study titled “The early medieval warm epoch and its sequel”, Lamb coined the phrases “Medieval Warm Epoch” and “Medieval Warm Period” to refer to the period of time between approximately 950 BP to 700 BP in which notably warmer climates were experienced throughout the world (Lamb 1965). Lamb’s findings were based on the analysis of data obtained from ice-cores, tree-rings, harvest yields, treeline studies, precipitation records, and other historical documents (Lamb 1965, 1995). Although Lamb’s work referenced global warming events during the medieval period, he made no argument for global synchronicity of such warming.

Regional variances in occurrence and timing of warming episodes during the medieval period have been recognized by a number of scholars (Jones *et al.* 1999; Jones and Schwitalla 2008; Mann 2002; Millar and Woolfenden 1999; Stine 1994, 1998). These differences have resulted in the use of various names to describe the warming period. In the 1990s, Scott Stine proposed a classification for the prolonged warm, dry conditions that occurred in California and Patagonia. He suggested that the period could be called the “Mediaeval Climatic Anomaly” and identified dates spanning approximately 1058 BP to 600 BP; the date range reflects two warm, dry periods interrupted by a brief cool, wet period which occurred approximately 838 BP to 741 BP (Stine 1994). Subsequent contributions by other researchers has led to slight adjustments in the start date for Stine’s model. “Medieval Climatic Anomaly” has become the generally accepted name for the California and Patagonia warm, dry period that occurred between roughly 1150 BP to 600 BP.

Medieval Climatic Anomaly and the Mojave Desert

The nature of the environment’s impacts on the cultural evolution of the people of the Mojave Desert has not been well-studied (see Chapter Two). Absent direct correlates, perceived changes in archaeological assemblages have been used to infer environmental impacts upon populations (Gardner 2009). This is made even more difficult in determining true environmental impacts when Mojave populations were spread out sparsely over the landscape. Gardner (2009) does note however, that there were signs of population aggregation within

the Mojave Desert during the MCA. She theorizes that this occurred as a means of forming “more compact settlement units, as a way of ‘joining forces’...to make better use of diminishing resources as a result of environmental deterioration” (Gardner 2009:208).

The paucity of data related to the Mojave Desert makes it clear that there is a need for more study of this region. Some researchers, as noted above, seem to dismiss this need. However, the wealth of data gleaned from areas in which effort has been expended, such as the Santa Barbara Basin (discussed in Chapter Two), provides a strong counterargument against such thinking. The Channel Islands findings show that the environment should not be discounted when investigating the cultural evolution of a people.

CHAPTER TWO

PREVIOUS MEDIEVAL CLIMATIC ANOMALY RESEARCH IN WESTERN NORTH AMERICA

Methods for Determining MCA Occurrence

Detecting evidence for the MCA has been accomplished through the examination of various proxy data. Stine's (1994) research, which led to the recognition of the MCA in California, utilized ^{14}C analysis to date submerged relict tree stumps located in Mono Lake, Tenaya Lake, the West Walker River, and Osgood Swamp (Figure 2). By placing the trees within a temporal context, Stine was able to determine dates for prehistoric low water levels at the various source locations, recognizing that the trees could only grow during dry periods when the lakes, river, and swamp contained less water. The results showed a dry, and presumably warm, period had occurred during the MCA.

Trees have also been used for a number of dendrochronology studies (Douglass 1929, 1935; Herweijer *et al.* 2006; MacDonald and Case 2005; Millar *et al.* 2006). The earliest of these studies were carried out by A. E. Douglass, the individual responsible for establishing the principles of dendrochronology. In the 1920s, Douglass was funded by the National Geographic to carry out studies on the wood beams of ancient pueblo ruins. The results of these expeditions led him to report early references to droughts and site abandonment in the American West (Douglass 1929, 1935). More recent dendrochronology studies have been conducted to determine sea surface temperatures (SSTs) during the MCA. This

is accomplished by analyzing select hydrologically sensitive tree-ring chronologies to generate a reconstruction of the Pacific Decadal Oscillation (PDO). The PDO's strength and variability is a proxy for drought strength and variability, with drought being associated with negative PDO phases. A 2005 study of trees located at opposite ends of the PDO precipitation dipole (in Alberta, Canada and San Geronimo, California) show that a prolonged period of negative PDO values occurred during the MCA, which is indicative of a megadrought (MacDonald and Case 2005).

Core samples have also been collected to reconstruct the paleoclimate of California. These include samples from lake sediments taken from Walker Lake and Owens Lake (see Figure 2) which support the presence of extensive drought during the medieval period by measuring the isotopic composition within cored sediments from the lakes (Yuan *et al.* 2004; Li *et al.* 2000). Offshore samples collected from sediments deposited in the Santa Barbara Basin (SBB) have been the focus of core sampling studies as well (see Figure 2). SBB samples have been used to examine oxygen isotopic compositions as well as the composition of diatoms, silicoflagellates, and pollen (Barron *et al.* 2015; Heusser *et al.* 2015a, 2015b). The results of these offshore sediments have helped to determine not only the occurrence, but the severity of the MCA.

The Channel Islands have also played a role in helping researchers reconstruct past SSTs. Oxygen isotopic analysis of California mussel shells collected from archaeological contexts, which allowed for radiocarbon dating,

have provided evidence that SSTs were cooler during the MCA than during preceding or subsequent periods (Kennett and Kennett 2000). Along with cool SSTs, the Kennett and Kennett (2000) study also suggested that the MCA saw low levels of rainfall.

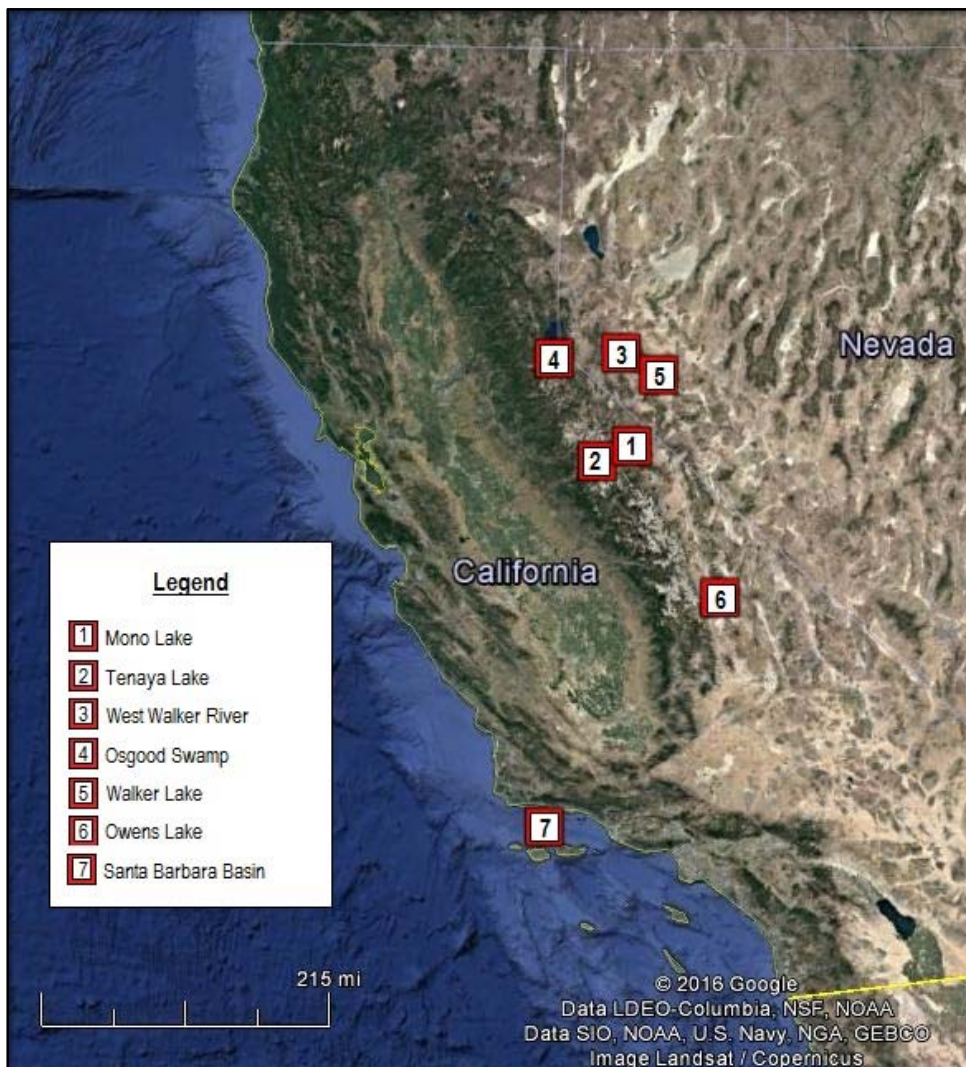


Figure 2. Locations of Study Sites for Regional MCA Research which Aided in Paleoclimate Reconstruction Models for California.

Additional means of determining the presence or intensity of a medieval period drought include a handful of other studies which relied on proxy data. Dillehay (1974) observed a change in the number of bison bones within Native American sites in the Southern Plains dating to the medieval period compared to earlier occupations. Dillehay interpreted the change in faunal assemblage as being directly correlated with environmental conditions. While his work was not focused on California specifically, it nonetheless led him to propose a medieval period drought.

Regional MCA Differences and “Mediaeval Climatic Anomaly Versus “Mediaeval Warm Period”

The importance of applying various methods to determine past climatic conditions, and recognizing the regional differences that exist, is critical to properly understanding weather associated with the medieval period. Global climate changes have been identified which correspond with this time; however, they are not uniform. The Medieval Climatic Anomaly and Medieval Warm Epoch or Period are names for concomitant climatic phenomena which occurred in varying regions of the world during the medieval period.

Since Lamb’s initial identification of the Medieval Warm Epoch/Period, research has been conducted to refine its expressions in Europe, the North Atlantic, and neighboring regions, including North America. Throughout much of Europe, relatively mild conditions were experienced. Agriculture was possible at

higher altitudes and farther north than their pre- and post-medieval ranges. Glaciers retreated substantially, and winters were relatively mild. Unlike those measured in the SBB, SSTs in the subtropical North Atlantic are evidenced to have been warmer during medieval times. Farther north, warm conditions seem to have been more dramatic. Unlike current conditions, Greenland's environment during the medieval period was favorable for settlements to exist with a subsistence strategy that included cattle and sheep. These settlements vanished at the end of the Medieval Warm Period/Epoch with the onset of the Little Ice Age. In Scandinavia and Eastern China, dendrochronology studies suggest that warm conditions existed in the 11th and early 12th centuries only (Mann 2002).

Stine's (1994) defining of the MCA made the distinction between medieval warming that occurred within California and that which occurred elsewhere during the more general Medieval Warm Period/Epoch. While the MCA provides a better outline for California's past climate, it is still a generalization for the region. California is a large landmass that is comprised of several distinct archaeological regions, each with their own ecological diversity and with differential impacts imposed upon them by the MCA. Arnold *et al.* (2004) differentiate between nine regions: San Diego Coastal Area, The Los Angeles/Orange County Coast and Southern Channel Islands, Santa Barbara Channel (South Central Coast and Northern Channel Islands), The Central Coast, San Francisco Bay Area, Northern California, The San Joaquin Valley and Sierra Nevada Foothills, Mojave Desert, and Southern Deserts. These nine

regions are defined by the authors by their “unique culture histories and trajectories of archaeological research” (Arnold *et al.* 2004). While the researchers do note that these regions reflect ecological diversity, they do not necessarily represent individually distinct ecological zones; consolidation of some regions is appropriate when examining areas of the state within their ecological contexts. In Southern California for example, the major ecological areas consist of southern coastal regions and deserts. Even within one region, there may be small variances seen in regards to MCA intensity/effects; however, the differences will be minor compared to those seen between distinct regions.

Stine’s seminal work, “Extreme and persistent drought in California and Patagonia during mediaeval time” (1994), recognized that weather events in California were unique from those previously identified in other regions of the world. Previous definitions of the Medieval Warm Period/Epoch focused on temperature increases in areas such as the British Isles. As mentioned previously, Stine’s analysis of relict tree stumps showed that conditions in California included not only increased temperatures, but also two extremely severe, prolonged droughts from approximately 1058 BP to 838 BP and 741 BP to 600 BP. Stine recognized that “aberrant atmospheric circulation” was likely responsible for causing some regions of the world to experience much greater reductions in precipitation rather than increases in temperature. For this reason, he proposed that “Mediaeval Climatic Anomaly” should be employed to replace “Mediaeval Warm Period” when referring to paleoclimatic studies.

Although Stine's refinement of the MCA when describing medieval climatic conditions in California was an improvement over previous models, it was only a starting point; a model that describes California climate as a whole is far too general. The varying ecological regions within California require their own analyses to accurately assess conditions that existed within the state during the MCA.

MCA Effects on Human Populations

While it is clear the MCA impacted the environment, those impacts were not uniform across all regions. The same is true for the way in which climate change associated with the MCA affected the human populations of the varying regions and how those populations responded to changes in their environment. Studying the paleoenvironments of archaeological sites is a long established practice. The related act of looking at how climate change directly influences cultural change is a relatively new focus within archaeology. Since works by Crumley (1994) and Fagan (2000) on the topic, however, there has been increasing interest in such studies, accompanied by substantial debate regarding the efficacy of their findings. Critics see the application of climatic influences within a cultural context as environmental determinism. This belief that the environment is responsible for the cultural development of populations has been challenged because it is seen as ignoring or dismissing non-environmental causal factors for change and it removes human agency from the discussion. Opponents of environmental determinism include advocates of neo-Darwinism

and postmodernism. As Jones *et al.* (1999:137) note, these opponents perceive “an overemphasis on adaptationism in many ecological studies that ignores the full spectrum of biological and behavioral variability involved in human evolution.” The last twenty years however, has seen an increase in research which suggests a link between environmental change and cultural evolution is not entirely deterministic (Jones *et al.* 1999; Fagan 2008). These studies account for the influence of the environment while still recognizing the possible presence of non-environmental causal factors for cultural evolution.

There can be no doubt that the medieval period saw many cultural changes across the globe. The presence of significant climate change during this period might imply that these changes necessarily had an environmental causal factor. However, the possibility of human agency must not be discounted when considering cultural evolution. Furthermore, the climatic change that occurred during the medieval period was by no means uniform. While some regions were negatively impacted, others saw environmental change that can be argued as being advantageous. Fagan (2008) details many of the societal shifts that occurred during the Medieval Warm Period and illustrates how disparate the effects of climate change were on various populations. More temperate environments in Europe led to increased agriculture. Melting of ice sheets allowed Norse travel to Iceland, Greenland, and beyond where they made contact with Inuit who had also taken advantage of favorable ice-melt to travel east. Trade winds created by El Niño events propelled Polynesian sailors across

the Pacific to populate remote islands. In terms of negative impacts, climate change during the medieval period was seen primarily in the form of significant droughts in the Pacific region, including much of North America, Central and South America, and northern China. Food shortages occurred in China. Chaco Canyon and Angkor Wat were abandoned, and climate stress may have contributed to the partial collapse of the Maya civilization (Fagan 2008).

However, it must be noted that other factors are known to have played important roles in these events, and while climate should not be discounted, it should not cause causal explanations to be overlooked or dismissed.

MCA Studies along the California Coast

When considering climatic conditions, perhaps the most widely studied region within California is the southern coast. This region includes the Santa Barbara Basin south to San Diego. In the 1970s, researchers began to examine the relationships between climate change and cultural evolution in California. These studies were made possible as high-resolution paleoclimatic data for the Southern California coast became available (see Heusser 1978; Pisias 1978, 1979). Much of what was understood for nearly two decades regarding the coastal Southern California paleoclimate was gleaned from Pisias' (1978, 1979) findings. Pisias proposed a model for the paleoceanographic climate of the Santa Barbara Channel in which he determined SSTs based upon observed fluctuations in radiolarian assemblages retrieved from core sediments. Regarding the period of time included within the later defined MCA, Pisias concluded that

SSTs between 1850 BP to 650 BP were higher than current temperatures, with an average temperature of 18°C, and a high of 21°C occurring between 800 BP to 650 BP. Archaeologists responded to Pisias' data which suggested that the MCA saw warm-water conditions along the Southern California coast by inferring that the MCA created an especially harsh marine environment during this period (Arnold 1992; Arnold and Tissot 1993). Kelp beds in particular were thought to have been most affected by the proposed warm-water environments present during the MCA (Arnold 1992; Glassow *et al.* 1988). These beds, or "kelp forests", are composed of the genus *Macrocystis* (giant brown algae) and create a habitat which sustains an abundance of marine life within the Santa Barbara Channel (Raab and Larson 1997).

Research conducted in the 1990s began to challenge Pisias' assumptions regarding increased SSTs during the medieval period and a new picture of southern coastal paleoclimates emerged (Raab and Larson 1997; Kennett and Kennett 2000). A new marine climatic sequence was developed by conducting oxygen isotopic analysis of planktonic foraminifera within sediment core samples from the Santa Barbara Basin (Kennett and Kennett 2000). This new sequence showed the instability of the Holocene climate, as evidenced by fluctuating SSTs. Contrary to Pisias' model, this sequence identifies the years falling within the MCA as representing cold-water years. According to this model, SSTs between 1500 BP to 650 BP are posited to have ranged between 9°C and 13.5°C. One major implication of these findings is that it negates the argument against a harsh

environment for the kelp forests during the MCA. In fact, the cooler temperatures that are suggested provided a more favorable environment for kelp and other marine organisms during the MCA (Kennett and Kennett 2000; Jones and Schwitalla 2007; Rick 2011).

In addition to cooler water temperatures, the coastal climate of Southern California during the MCA was marked by reduced precipitation. Tree-ring analyses from two coastal locations (the transverse ranges of central Santa Barbara County and San Geronio Peak) were used to construct a precipitation record for the region which spanned the last 1,500 years (Michaelson *et al.* 1987; Kennett and Kennett 2000). Shortened tree-ring sequences documented in the coastal records indicates low levels of precipitation during the MCA. A summary of Larson and Michaelson's 1989 dendro-precipitation findings (in Kennett and Kennett 2000) include:

During the first 150 years of the reconstruction, A.D. 500 to 650, climatic conditions were characterized by moderately low precipitation levels. This period was followed by very low rainfall levels which lasted from A.D. 650 to 800. Extreme drought was experienced between A.D. 750 to 770. The succeeding 200 years, A.D. 800 to 1000, was a sustained high-interval unmatched in the entire 1600 year reconstruction ...Between A.D. 1100 to 1250 climatic conditions maintained a sustained low for a period of more

than 150 years. The interval between A.D. 1120 to 1150 was particularly harsh.

These findings show that coastal precipitation levels were in flux but were generally declining prior to the MCA, with extreme droughts occurring concurrent with the MCA.

Additional research supporting the presence of a coastal drought during the MCA was conducted by Davis (2002). His study examined pollen recovered within a core taken from the San Joaquin Marsh, located at the head of Newport Bay in Orange County. Due to the marsh's proximity to the Pacific Ocean, saltwater incursion occurs during periods of low discharge from the freshwater springs that feed the marsh. These low discharge events denote periods of low precipitation, or drought. Saltwater incursion into the marsh during past dry periods resulted in lower pollen deposition and sedimentation rates as well as the increased presence of marine-estuarine organisms. Analysis of pollen from San Joaquin Marsh showed that the occurrence of xeric plants increased approximately 1,800 years BP while mesic plants declined during that period. This trend persisted until approximately 500 years BP (Davis 2002).

The sizable amount of archaeological research that has been conducted within the Southern California coastal region has led to the availability of a number of studies suggesting that the MCA directly impacted the prehistoric occupants of the region (Raab and Larson 1997; Jones *et al.* 1999; Kennett and Kennett 2000; Jones and Schwitalla 2007; Rick 2011). In particular, the

Chumash of the Channel Islands and Santa Barbara Basin experienced significant climate-driven cultural change as a result of the MCA. A defining characteristic of the medieval period was a marked decline in precipitation. On the Channel Islands, this had a direct impact on the presence of predictable water sources and resulted in population aggregation around such resources.

The exploitation of limited water resources is one explanation for changes seen in coastal settlement patterns during the MCA. A number of Channel Island sites dating to this period saw occupational hiatuses or abandonment (Jones *et al.* 1999; Jones and Schwitalla 2007). The aggregation of populations around limited resources may have accounted for these settlement disruptions. Fresh water sources gained increasing importance and influenced settlement patterns. These conditions resulted in fewer coastal and island sites during the MCA, with the limited site occupations of that period exhibiting a marked increase in population density.

A by-product of increased population density within Island Chumash sites during the MCA was the increase in disease brought about by poor living conditions (Jones *et al.* 1999; Jones and Schwitalla 2007). Another factor which contributed to this negative trend was diet; resource stresses resulted in inadequate nutrition which manifested in dental and skeletal pathologies. An examination of human skeletal remains recovered from CA-SRI-2, which dated to the medieval period, indicated that site occupants had high levels of *cribra orbitalia*, probably from anemia. There was evidence of infection due to the

presence of periosteal lesions on the bone. And the decline in dental caries, when compared to earlier sites, suggests that carbohydrate-rich foods were not abundant (Rick 2011).

In addition to population aggregation around limited resources during the MCA, the need to control access to these resources was likely responsible for the establishment of solidified group boundaries and a territorial settlement pattern. It is theorized that violent encounters between groups in competition for food and fresh water resources was a result of these conditions. Osteological indicators of violence within the Santa Barbara Channel reached a peak during the MCA (Jones *et al.* 1999; Jones and Schwitalla 2007). Signs of both lethal and sub-lethal violence are evident in the archaeological record; arrow wounds are interpreted as signs of warfare with the intended outcome of death, whereas compression fractures of the skull are interpreted as representing signs of ritualized sub-lethal combat. While violence was increasing prior to the onset of the MCA, both forms reached their peak during the medieval period.

Climatic change was also believed to have played a role in the rise of social complexity within the Chumash. Arnold (1992) noted several factors related to this increase, all linked to environmental stress associated with the MCA. Archaeological evidence suggests that shell bead production in the Santa Barbara Channel occurred since the Early Holocene; however, a marked increase in production came about during the MCA, after approximately 800 BP on Santa Cruz Island. Arnold attributed this increase to the emergence of craft

specialization, under the direction of elites (Jones and Schwitalla 2007). It is further speculated that island resource shortages were the impetus for the increased shell bead manufacture; beads were traded with the mainland as a way to supplement island resources (Arnold 1992; Jazwa *et al.* 2012). During the MCA, trade of goods from the Pacific coast saw a substantial increase throughout California and into Arizona (Jones *et al.* 1999).

MCA Studies in the Mojave Desert

Along with the southern coast, the other major ecological region of Southern California comprises arid deserts, with the Mojave Desert making up the bulk of this land area. Evidence of climatic conditions in the Mojave Desert during the MCA has been acquired primarily by looking for indicators of springs and past lake levels, as well as by reconstructing the paleovegetation of the region (Jones *et al.* 1999). The medieval period in California is characterized by arid conditions. Although the Mojave Desert is by its nature an arid region, and has been throughout the Holocene, it is not immune to the effects of drought. A significant impact to the Mojave during the MCA was seen in the lack of increased spring activity. The absence of springs during the MCA is especially significant when compared to subsequent periods. De Narvaez identified a spring in the Las Vegas Valley that remained active in modern times even after the aquifer had been heavily utilized by modern pumping (Jones *et al.* 1999). This finding suggests that the natural springs of the Mojave have the capacity to withstand a great amount of stress and still remain active. However, there has

been no evidence of any such springs identified within the Mojave Desert during the MCA (Jones *et al.* 1999).

Determining the occurrence of lake high stands has been another method utilized in the formation of precipitation reconstructions for the Mojave Desert. The Holocene environment of the Mojave has included lakes that are in flux, with the manifestation and desiccation of the hydrologic features occurring throughout time. Stratigraphic, sedimentologic, and pedologic analyses of the Silver Lake playa in the eastern Mojave Desert show that it has held water up to five times since approximately 3620 BP for periods of years or decades (Enzel *et al.* 1992). This indicates that the arid Mojave Desert does experience episodes of increased moisture and cooler temperatures that are significant enough for lakes to appear and persist for extended periods of time. However, there is no evidence that any of these lakes existed in the Mojave during the MCA (Jones *et al.* 1999).

Packrat middens have also been examined to determine the flora present during a given time. By identifying species of plant remains within packrat middens created during the MCA, a picture of conditions that existed during that period can be generated. Analysis of medieval period packrat middens shows that xeric vegetation predominated while mesic vegetation was sparse (Jones *et al.* 1999). These findings indicate that the Mojave Desert was more arid during the MCA than it was during preceding or subsequent years.

Archaeological studies conducted in the Mojave Desert have also provided insight into the lives of prehistoric occupants of the region. For example, trade patterns are believed to have been altered in the Mojave Desert during the MCA. An important item traded from this region was Coso obsidian. Gilreath and Hildebrandt (1997) postulated that a collapse of its production and exchange occurred at the end of the Rose Springs Period, which corresponds with the end of the MCA. Gardner's (2006) research in the Mojave confirmed the timing of Coso obsidian trade reduction with the concurrence of the MCA. However, the mechanisms responsible for this system's collapse, if such a collapse occurred, are not yet fully understood. Likewise, many other aspects of prehistoric occupation within the Mojave Desert during the MCA remain poorly understood.

CHAPTER THREE

REGIONAL BACKGROUND OF THE ANTELOPE VALLEY

To understand the resources being studied and the impact the MCA had on them, it is necessary to understand the environmental context in which they occur as well as the known culture history of the region. The following sections briefly introduce these items for Edwards Air Force Base, which was selected as the study area for the presented research.

Environmental Context

Edwards Air Force Base is a military installation covering over 301,000 acres within the Antelope Valley in the western Mojave Desert. It is located within portions of Kern, Los Angeles, and San Bernardino counties. Antelope Valley is bounded by the Tehachapi and Sierra Nevada mountains on the west and the San Gabriel and San Bernardino mountains on the south (Figure 3).

Geologic Setting

Edwards Air Force Base is comprised primarily of unconsolidated Quaternary alluvium which contains silts, sands, gravels, and poorly developed soils. Local rock outcrops are comprised of granitics (primarily quartz monzonite), rhyolite, sandstone, tuff, limestone, basalt, and small amounts of pegmatite (Hale *et al.* 2010).



Figure 3. Map of the Antelope Valley region of Southern California showing location of Edwards Air Force Base.

The Antelope Valley, and the land that Edwards occupies, is characterized by a Pleistocene lake basin; the remnants of Lake Thompson, which receded approximately 8,000 years BP (Earle *et al.* 1997) have left three large dry lake beds on the Antelope Valley floor which the installation is built around. Rogers

Lake is the largest of the three and contains the majority of the base's flightlines and airfield facilities along its western margin.

Contemporary Climate and Hydrology

Edwards Air Force Base's climate is marked by hot, dry summers and cool, somewhat wet winters. Daily temperatures range from below freezing in winter to 100-110° Fahrenheit in summer. Average annual rainfall totals less than 5 inches per year, with most rain occurring in the winter, at which time the dry lake beds can hold substantial amounts of water (Earle *et al.* 1997).

Paleoenvironment

The climate of Edwards Air Force Base, and the immediately surrounding lands, was cooler and wetter during the late Pleistocene than it is today. The elevation of the base ranges from approximately 2,300-3,500 feet. Piñon-juniper woodland was found throughout the Mojave at 3,000-4,000 feet, and large game consisted of horses, camels, and mammoths. Between approximately 12,000 to 10,000 years BP, the Wisconsin glaciation ended and the region gradually began to take on its current appearance (Hale *et al.* 2010). The middle Holocene saw the vegetation community replaced with that of a mixed saltbush and creosote community during a prolonged warming and drying period, the Altithermal (Antevs 1948). A series of archaeobotanical specimens recovered from *Neotoma* middens at seven localities within Edwards Air Force Base indicate that the plant communities established in the region during the middle Holocene have continued to modern times, with very few differences occurring between modern

vegetation communities and those of the middle Holocene (Rhode and Lancaster 1996). One such *Neotoma* midden was identified within the prehistoric milling site, CA-KER-4403.

Modern Vegetation and Fauna

Edwards Air Force Base's plant community is dominated by Mojave Desert scrub, which includes saltbush scrub, creosote bush scrub, Joshua tree woodland, and mesquite bosque (Earle *et al.* 1997; Vasek and Barbour 1977).

Many fauna are found within the region. Large mammals, such as bighorn sheep (*Ovis canadensis*) and pronghorn (*Antilocarpa americana*), are uncommon within the installation, but are known to inhabit surrounding areas. Medium-sized mammals, such as coyotes (*Canis latrans*) and foxes (*Urocyon cinereoargenteus* and *Vulpes macrotis*), are common. Small-mammals, such as cottontail rabbits (*Sylvilagus audubonii*), black-tailed jackrabbits (*Lepus californicus*), ground squirrels (*Xerospermophilus mohavensis*), kangaroo rats (*Dipodomys deserti*), and reptiles such as lizards and snakes are ubiquitous. There are also many birds and migratory waterfowl present on the installation (Earle *et al.* 1997).

Cultural Context

Various culture chronologies have been proposed for the Mojave Desert (see Giambastiani *et al.* 2000; Sutton 2007; Warren 1984; and Warren and Crabtree 1986). This has resulted in the use of multiple terms used to refer to identical timeframes. Edwards Air Force Base has adopted a prehistoric culture

chronology which has been summarized by Earle *et al.* (1997) and includes seven cultural/temporal periods. In 2010, Hale *et al.* synthesized the installation's chronology to reflect more current research. The periods listed below are summarized from Hale *et al.*'s work (2010).

For the purposes of the research presented here, the Edwards Air Force Base chronology is used (Table 1). Only the periods immediately preceding, including, and immediately following the MCA were examined; therefore, only three of Edwards Air Force Base's seven identified cultural/temporal periods are detailed in this document.

Table 1. Cultural Chronologies Proposed for Edwards Air Force Base.

Approximate Date	Cultural Period
12,000-10,000 BP	Fluted Point Period
10,000-7,000 BP	Lake Mojave Period
7,000-4,000 BP	Pinto Period
4,000-1,500 BP	Gypsum Period
1,500-800 BP	Saratoga Springs Period
800-300 BP	Post-Saratoga Springs or Late Period
300-Present	Contact/Ethnographic Period

Gypsum Period (4,000-1,500 BP)

Sites from this period are associated with Gypsum contracting-stem points, Elko Eared points, and Humboldt points. The lithic assemblage is characterized by bifaces, scrapers, and other flake-based tools. Mortars and pestles are also present, indicating an increased focus on plant processing. Large villages/village complexes appear in the Antelope Valley, reflecting a shift to sedentism in the region (Sutton 1988, 1996). Marine shell artifacts also occur in the Antelope Valley during the Gypsum Period, suggesting economic ties with the coast (Warren 1984).

Saratoga Springs Period (1,500-800 BP)

Sites from this period are associated with side-notched Saratoga Springs, corner-notched Rose Spring, and Eastgate projectile points. By this time the inhabitants of the Mojave Desert had replaced the atlatl with bow and arrow technology (Yohe 1998), therefore smaller points are represented in the artifact record. This period also saw the introduction of Anasazi ceramics into the southern Mojave Desert around 1200 to 110 BP (Hale *et al.* 2010). The increase in millingstone, and inferred intensification of plant resources which began in the Gypsum Period, continued throughout the Saratoga Springs Period. This is evidence of high-cost/high-return subsistence strategies (Gardner 2006) employed by prehistoric Antelope Valley inhabitants during the MCA.

Post-Saratoga Springs or Late Period (800-300 BP)

Sites from this period are associated with Cottonwood Triangular and Desert Side-notched points. Ground stone continues to be seen in abundance, with mortars and pestles seen in significant quantities, continuing the trend toward high-cost/high-return subsistence. Trade patterns established during the Saratoga Springs Period continue as Antelope Valley inhabitants continue to acquire goods from the Mojave River region and relationships with coastal California grow stronger than those with interior groups (Hale *et al.* 2010).

CHAPTER FOUR

THEORY AND HYPOTHESES

Theoretical Framework

There are a variety of archaeological theories or models which can be applied to the study of hunter-gatherer populations (see Barnard 2004; Bettinger 1991b; Binford 1980; Bonzani 1997; Broughton 1994; Chatters 1987; Charnov 1976; Kaplan and Hill 1992; Kelly 1983, 1985, 1995; Orians and Pearson 1979; Price and Brown 1985; Steward 1936, 1938, 1955). The movement of prehistoric peoples throughout the Great Basin has been studied under varying theoretical frameworks in order to understand decisions related to the occupation of this arid environment. As Binford (1980) suggests, foragers such as those likely to have occupied the extreme southwestern Mojave Desert region of the Great Basin, engaged in differing levels of residential mobility, with more mobile groups leaving a less visible archaeological record. The lack of evidence for complex hunter-gatherers in the Mojave Desert, with relatively little in the way of material culture for study, evinces the need for a theoretical framework that addresses the adaptive behavior of past peoples in their environments. Human behavioral ecology (HBE) approaches have been frequently used to this end. The introduction of behavioral ecology models resulted from the inability of cultural ecology to adequately explain individual hunter-gatherer's decision-making and changes in response to the environment as a whole (Jordan 2008). Human

behavioral ecology incorporates the concept of natural selection to consider how evolution shapes societies (Gardner 2006). In its most basic terms, HBE focuses on the relationship humans have with the environments they inhabit and the “relative reproductive success of their sociocultural adaptations” to those environments (Jordan 2008:455).

Human Behavioral Ecology

Human behavioral ecology is a theoretical framework of human adaptation derived from Darwinism¹. As such, it has its roots in concepts of evolution. In order to adequately define HBE, we must start with its own evolution from that of cultural ecology. When Julian Steward (1955) first wrote about cultural ecology, he set out to develop a heuristic device to understand the effect of the environment on culture. Steward began by offering both his definition and the Webster *New International Dictionary* (2nd ed., unabridged, 1950) definition of ‘ecology’. They are, respectively, “adaptation to environment” and “the mutual relations between organisms and their environment.” It is this relationship with the environment which HBE looks to investigate. However, while Steward sought to develop the concept of human ecology for the purpose of examining environmental effects on *culture*, practitioners of HBE seek to determine how *behavior* evolves in response to the environment (Bird and O’Connell 2006; Winterhalder 2002; Nettle *et al.* 2013).

Behavioral ecology (BE), from which HBE is directly derived, is a subset of evolutionary ecology (Bird and O’Connell 2006) and represents “the classical

Darwinian view” (Shennan 2002) in that it assumes humans are similar to other animals in regards to evolutionary trajectories. This view stresses the importance of natural selection and its role in reproductive success and fitness, with the optimal outcome being a situation in which an organism will choose behaviors that maximize their individual reproduction and fitness (Bird and O’Connell 2006; Broughton *et al.* 2010; Broughton and O’Connell 1999; Shennan 2002; Winterhalder 2002). In contrast to the cultural ecology view, culture is not seen as being important in BE; it is not viewed as a significant factor because there is a recognition that any cultural behavior which is detrimental to reproductive success or fitness will not be sustained for long (Shennan 2002).

Although BE is a product of biological concepts of evolution, under this framework it is immaterial whether behavioral changes have a biological basis (Bird and O’Connell 2006). Logically, this argument can be extended to HBE as well. Unlike biological evolutionary studies, the unit of study within HBE is not the gene. Currently, there is no consensus regarding a belief that changes in gene frequencies result in changes in behaviors. Therefore, human behavioral ecologists operate under the assumption that all people possess the same capacity for behavioral change, and genes are not taken into consideration. HBE thus examines the interaction between the environment and people, expressed through phenotypes (Coddington and Bird 2015; Smith and Winterhalder 1992; Winterhalder and Smith 2000). For the purposes of BE, and by extension HBE, phenotypes include behaviors and are defined as “products of the interactive

effects of complex biological, social, and physical environments” (Bird and O’Connell 2006). The examination of these phenotypes through BE models is not intended to identify modes of inheritance, hence the lack of focus on the gene, but rather the models utilized in BE are meant to help generate testable hypotheses related to trade-offs made by individuals in regards to their fitness in socio-ecological contexts (Bird and O’Connell 2006).

HBE is more focused than BE in that it looks exclusively at ways in which *humans* adapt to their environment. In a recent review of major HBE literature, Nettle *et al.* (2013) note that humans have an ability to adapt to new ecological niches much faster than genetic change can occur. HBE recognizes this phenomenon being a product of phenotypic (behavioral) diversity and endeavors to explain both the observed diversity and resulting rapid adaptation (Nettle *et al.* 2013).

Adaptation is central to all BE models, including HBE variants. The guiding principle for human behavioral ecologists is an expectation that humans will engage in behavior which optimizes their fitness, or reproductive success, in relation to the ecological conditions they face (Broughton and O’Connell 1999; Broughton *et al.* 2010; Nettle *et al.* 2013; Shennan 2002). The principles of natural selection provide support for this adaptationist stance. Various optimality models are employed within HBE in pursuit of the goal to answer questions related to behavior and the environment; key models are discussed below.

Optimal Foraging Theory. Throughout the development of HBE, various scholars have referred to optimizing, optimality, or optimal foraging models by an assortment of closely related terms. Much of this variety is associated with the terms' applications to various related subfields; however, for the purposes of HBE these models, or more appropriately, the suite of models they represent, can be classified under the banner of the more generally used term 'optimal foraging theory' (OFT). OFT is concerned with subsistence behaviors. It makes predictions about those behaviors which operate under the assumption that there are relationships between resource acquisition and fitness, and that organisms will make trade-offs when deciding whether or not to pursue resources (Bird 1997; Bird and O'Connell 2006; Shennan 2002). Within the framework of HBE, OFT is the most commonly applied theoretical approach (Bird and O'Connell 2006; Shennan 2002). It is important to note however, that despite its name, optimality models do *not* imply an optimal, or "best imaginable", design or behavior (Broughton and O'Connell 1999; Bird 1997). Optimality models are meant to generate hypotheses from which to test predicted behaviors. These models suggest that natural selection will tend to favor optimal solutions, but they do not suggest that behavior will be exhibited in any particular manner. OFT is a broad theoretical tent under which a number of models are found which are utilized by human behavioral ecologists. For the purposes of this study, three of the more widely applied models (prey and patch choice, and central place foraging) are described below.

Prey and Patch Choice Models. Described as the “classic workhorse of HBE” (Coddling and Bird 2015), the prey choice (or diet breadth) model is the most widely used within the discipline (Bird 1997; Bird and O’Connell 2006; Coddling and Bird 2015). The prey choice addresses a simple question regarding optimization; it asks whether an individual should pursue a resource upon encounter, or whether he or she should pass it up in hopes of a more profitable resource down the line (Coddling and Bird 2015). There is an assumed potential risk built into the behavior of the forager in this model. The ecological context in which the forager is placed informs the risk involved. Byers and Broughton (2004) use a prey choice model in their HBE study of Holocene hunting strategies of the Great Basin. Using this OFT model, they posit resource exploitation which runs counter to “optimal” strategy, and suggest ecological variables as causal factors for their findings.

Related to prey choice are patch choice models, which predict the manner in which individuals will exploit resource patches. Patch choice models assume that foragers will make decisions regarding patch selection related to return rates associated with those patches (Bettinger 1991b; Bird and O’Connell 2006; Kelly 1995; Smith and Winterhalder 1992; Jordan 2008). While prey choice models are concerned with the decisions involved with seeking individual prey, patch choice models are concerned with the decisions involved with seeking patches which contain those prey. As Coddling and Bird (2015:12) describe it, the difference between the models “is one of scale”.

Central Place Foraging. Central place foraging examines the trade-offs involved in resource procurement and logistical mobility. This model analyzes ways in which individuals can travel through resource patches and maximize returns while maintaining a connection to a home base (Orians and Pearson 1979; Winterhalder 2001; Zeanah 2002). Issues such as field processing vs. transport (Winterhalder and Smith 2000) and food caches vs. food storage (Coddington and Bird 2015) are explored.

Central place foraging models especially apply to the prehistoric occupants of the Edwards Air Force Base region of the Antelope Valley where there appear to lack significant archaeologically identifiable village sites. One interpretation of seasonally occupied areas of the base follows a central place foraging model with permanent encampments located elsewhere with the Edwards installation lands exploited for resources such as mesquite, rabbit, and water fowl (Budinger and Spinney 2004; Earle *et al.* 1997; Hale *et al.* 2010; Hector *et al.* 1988; Wade and Hector 1989).

Examples of previous work within the Great Basin include the study of ground stone using the central place foraging approach (Zeanah 2002). Results of this study led Zeanah to make conclusions regarding pinyon exploitation and settlement patterns within the Owens Valley. Gumerman (1985) conducted excavations within the Coso Junction and applied optimal foraging theory to determine subsistence patterns. Recently, Gardner (2006) and Cowie (2014)

applied various behavioral ecology approaches to determine the impacts of the MCA on prehistoric populations in the western Mojave Desert.

Criticisms and Limitations

Long before the inception of actual HBE models, the principles and theories upon which HBE was built were being critiqued. In a critical assessment of the New Archaeology, of which Julian Steward's cultural ecology belonged, Ian Hodder (1982) finds numerous deficiencies. In particular, his critique of functionalism is especially germane to the works of human behavioral ecologists. Suzanne Joseph has referred to a "hyperfunctionalism" within HBE² which is seen as a product of the hypothetico-deductive method employed by HBE practitioners. By creating predictive models related to the perceived connections between humans and the environment and then testing the models to "confirm" the predictions, Joseph contends that the positive findings are viewed as sufficient explanation for the behaviors in question with no allowance made for alternate explanations (Joseph 2000).

In his post-processual commentary on functionalism of the New Archaeology, Hodder remarks that one of the weaknesses which results is the assumption that a homeostatic state is the natural state of being for a system, and therefore any changes which occur must originate from outside the system (Hodder 1982). This view places the system in a passive role, one in which forces act upon it. It assumes no change will occur without an outside motivator or trigger.

Hodder also comments on the dichotomy created within the functionalist perspective between culture and utility. The movement away from cultural 'wholes' advocated by the normative approach resulted in New Archaeologists such as Binford taking a functional approach wherein the focus was no longer on culture *per se*, but rather the functional variability of cultural groups. This approach allowed archaeologists to study relationships (and behaviors) absent cultural context. More recent commentaries have acknowledged similar critiques regarding the lack of attention paid to culture within HBE (Bird and O'Connell 2006; Joseph 2002). However, Hodder notes that,

“All daily activities, from eating to the removal of refuse, are not the results of some absolute adaptive expedience. These various functions take place *within a cultural framework*, a set of ideas, or norms, and we cannot adequately understand the various activities by denying any role to culture.” (Hodder 1982:4; emphasis mine)

In this, Hodder is reminding us that we cannot escape culture; it is in everything we do and so it must be considered in order to understand the behaviors under observation.

Like Joseph, Hodder also finds the great reliance with which the New Archaeologists place on the hypothetico-deductive method to be problematic. He notes that the application of mathematical and statistical formulae cannot substitute for an understanding of the causal links or context of human behavior (Hodder 1982).

Although HBE scholarship, as reflected in published works, is still not prolific, it has elicited its own analyses and critiques. Some critics find fault with the very foundations upon which HBE is built. Andrew Vayda notes that human behaviors are reduced “to Darwinian prediction[s] that Darwin never made!” (Smith 2010). This critique is echoed by Joseph (2000). Joseph also takes issue with the universality of HBE and its methods’ applicability to both human and non-human animals. She views this as an obvious weakness resulting from the lack of clearly delineated boundaries or a domain of investigation for HBE studies (Joseph 2000, 2002). Joseph further contends that “no single theory can account for the entire range of variation and change in human socio-cultural behaviors, structures, interactions, and flows across time and space” (2000:12), suggesting that without a well-defined domain of inquiry, this is exactly what HBE theories assume to do. In fact, Joseph does state that providing a single general model is the ultimate goal of HBE (Joseph 2000).

Another critique HBE faces is related to the assumption that human behavior is adaptive. Bettinger (1991b) notes a weakness of neofunctionalism³ is that it does not possess a theoretical basis upon which behaviors can be tested. Without this, predictions regarding ways in which hunter-gatherers *ought* to behave in order to adapt require one to “make a leap of faith” (Bettinger 1991b). The lack of attention given to culture within the HBE approach results in similar leaps of faith. Researchers utilizing this method must interpret behavior, which Hodder (1982) has shown to be imbued with culture, in purely adaptive terms.

Furthermore, without any cultural context and with a belief that all change is stimulated by a trigger originating outside the studied system (see Hodder 1982), the only explanation possible for perceived changes in behavior is adaptation. This application of HBE does not account for instances in which behaviors are not adaptive. Codding and Bird (2015) warn that the danger in assuming a function for traits and behaviors *a priori* is that it can amount to story-telling.

Despite these limitations, optimality models of human behavioral ecology continue to be the most commonly employed when studying foraging societies. While Hodder (1982) challenges HBE based upon its reliance on the hypothetico-deductive method, others find a strength in its methodological rigor (see Broughton and O'Connell 1999; Nettle *et al.* 2013; Winterhalder and Smith 2000). HBE studies rely upon empirical data and therefore employ methods not always utilized in other anthropological studies. This focus on methodology and empiricism results in theory that provides predictive success (Broughton and O'Connell 1999; Winterhalder and Smith 2000). Although criticized for being reductionist and discounting culture (see Hodder 1982; Joseph 2000, 2002; and Smith 2010), HBE models are well-suited for the study of populations such as the prehistoric occupants the Mojave Desert. The simple, methodological approach employed by optimal foraging models allows for the study of non-complex foraging societies. They provide a framework from which to create hypotheses for analyses as well as a baseline to measure against if observed behaviors deviate from the predicted "optimal" behavior.

Hypotheses

Shifting settlement and subsistence strategies exhibited by occupants of the western Mojave Desert over the past 4,000 years have been proposed which include movement out of villages during times of climatic stress (see Sutton 1990, 1991a, 1991b). The lowering of lake levels during periods of severe drought may have provided an impetus for this change.

Sutton noted evidence for seasonal occupation at Koehn Lake and theorized that this movement was a subsistence strategy in response to annual climatic variation which impacted the lake; in the summer months inhabitants of the region moved away from the lake into the cooler, wetter upland areas, returning during the wet winter months when floral and faunal populations at the lake could be better exploited. This pattern could be maintained as long as climatic shifts remained within seasonal norms. The occurrence of a severe climatic event such as the MCA could prevent the ability of lakes and other water sources in the region to be replenished during the usually wet winter months, thereby making them undesirable for resource exploitation and disrupting the cycle of seasonal round occupation. Gardner (2006) explored the relationship between the MCA and the settlement shift proposed by Sutton at Koehn Lake and found evidence giving validity to Sutton's model.

Given the paucity of existing MCA research in the Antelope Valley, and the fact that Edwards Air Force Base is centered around a significant lake basin, the Koehn lake findings for settlement shifts during the MCA represented data

with the most potential for applicability for the region. However, the conditions experienced in the Antelope Valley, and the responses to those conditions, may have been considerably different from what was experienced at Koehn Lake. This study aims to better understand the response to MCA period changes in the environment. It looks at whether prehistoric occupants engaged in settlement shifts similar to those proposed for the Koehn Lake region, or adapted to climatic stress through other means. Two hypotheses are presented below to address these competing settlement strategies.

Hypothesis 1: Seasonal Habitation

Climatic stresses experienced during the Medieval Climatic Anomaly resulted in a settlement strategy shift within the Antelope Valley region of the western Mojave Desert, with village abandonment seen in favor of seasonal rounds with smaller site habitations.

Theoretical Framework. The model Sutton (1990, 1991a, 1991b) proposed for settlement and subsistence in the western Mojave Desert fits a behavioral ecology model in response to the impacts of the MCA on the region's inhabitants. It posits a pattern in which people shifted settlement strategies from one that focused on village habitation during the Gypsum Period⁴ to one that saw an increased occupation of temporary sites during the Rose Spring Complex/Saratoga Springs Period⁵. The move away from permanent desert villages was thought to have been facilitated by a subsistence strategy that utilized seasonal rounds during the arid conditions of the MCA. These

occupations were also suggested to have included smaller populations than was present in the Mojave prior to the onset of the MCA (Sutton 1991a, 1991b; Gardner 2006). Sutton's model was based largely on evidence for village abandonment in the Fremont Valley at the Koehn Lake site (CA-KER-875), which was attributed (at least in part) to environmental fluctuations related to the MCA (Sutton 1990, 1991a, 1991b; Gardner 2006, 2009; Faull 2006).

The movement away from complex permanent village sites within the Western Mojave Desert during the MCA, with villages remaining along the fringes of the arid desert region and smaller MCA-dated occupations occurring within the desert itself, suggests the possibility of a central place foraging model for the period. Under this model, prehistoric desert occupants abandoned previous permanent settlements such as the Koehn Lake village site and shifted habitation to more favorable environments. Gardner (2006) proposed the nearby El Paso Mountains as one such location for resettlement due to more abundant water sources. However, despite declining environmental conditions, resources remained within the Mojave Desert throughout the MCA, and the presence of archaeological sites in the region which date to the MCA show that people were exploiting those resources. This may be indicative of a central place foraging strategy.

Test Implications. Sites within the western Mojave Desert dating to the Saratoga Springs Period can be expected to lack attributes of village sites, which

are known to have occurred in the region prior to the onset of the Medieval Climatic Anomaly (Sutton 1990, 1991a, 1991b; Gardner 2006, 2009).

1. Edwards Air Force Base sites within the Antelope Valley region of the Mojave Desert from this period should show:
 - a. Artifact assemblages indicative of special purpose sites (e.g., lithic reduction stations, milling sites, hearth features, etc.).
 - b. An absence of well-defined midden. The presence of midden does not automatically indicate the presence of a village site; an occupational deposit can form through numerous seasonal visits (Sutton 2017). However, depositional processes and subsequent erosional forces within Edwards Air Force Base are generally not conducive to midden formation. As a result, a well-formed midden is a decent indicator of significant occupation.
 - c. Lack of manufacturing tools and waste within the assemblage.
 - d. Lack of trade items within the assemblage.

Hypothesis 2: Population Aggregation

Climatic stresses experienced during the Medieval Climatic Anomaly resulted in population aggregation within the Antelope Valley region of the western Mojave Desert wherein small groups of foragers mapped onto and tethered themselves to persistent resource patches (Binford 1980), resulting in sustained occupation of the region during the Saratoga Springs period.

Theoretical Framework. Although some research suggests that population within the Mojave Desert was suppressed during the MCA (see Jones *et al.* 1999; Gardner 2006, 2009; Sutton 1991a, 1991b), the region was by no means abandoned. Rather than exhibiting a gross exodus from the region with a shift toward a seasonal occupation, an alternative hypothesis may be found by applying the patch choice model. This model is potentially useful in understanding resource exploitation in the Western Mojave Desert during the MCA. When people are faced with limited critical resources, as is the case during times of environmental stress, Binford (1980) notes that people engage in settlement behaviors in which they “tether” themselves to available resource patches. Under such conditions, people congregate to exploit those patches and are less likely to move on and seek out new patches due to limited resource availability and the diminished returns and energy expenditure involved in such a search (Bettinger 1991b).

A number of sites identified on Edwards Air Force Base have been interpreted as hunting camps for rabbit drives (Greenwood *et al.* 1980). It is possible this activity may have increased during times of climatic stress when larger game was not available; climatic changes associated with the MCA negatively affected artiodactyl populations in the Antelope Valley and resulted in a shift away from the exploitation of larger game such as pronghorn and antelope toward the increased incorporation of more small game such as rabbit or rodent.

While rabbit exploitation is provided as an example, and no claim is made for sole causality, patch choice optimality models applied to these behaviors, may provide an explanation for posited settlement shifts in the western Mojave Desert during the MCA. Occupants of the Antelope Valley during the Saratoga Springs Period “mapped onto” resource patches available on the valley floor. These resources may have been faunal, floral, or very possibly, water resources such as springs or wells associated with the remnant Lake Thompson basin. Occupations in this scenario may have defied usual seasonal rounds if resource patches in the Antelope Valley remained productive despite the harsh climatic conditions. In these instances, sites may contain assemblages similar to what would be expected at a village site, while maintaining a discrete footprint due to the limits imposed by scarce resources.

Test Implications. Sites within the western Mojave Desert dating to the Saratoga Springs Period can be expected to display attributes similar to both village sites and seasonally occupied camps.

1. Edwards Air Force Base sites within the Antelope Valley region of the Mojave Desert should show:
 - a. Diverse artifact assemblages, though increased artifacts indicative of specific resource exploitation (e.g., projectile points, ground stone) may be present
 - b. Presence of well-defined midden. An occupational deposit can form through numerous seasonal visits (Sutton 2017). However,

depositional processes and subsequent erosional forces within Edwards Air Force Base are generally not conducive to midden formation. As a result, a well-formed midden is a decent indicator of significant occupation.

- c. Presence of manufacturing tools and waste within the assemblage.
- d. Presence of trade items within the assemblage.

Research Questions

To address the identified hypotheses, the following research questions were developed to help guide the proposed project.

Can indicators of the MCA be identified within the archaeological record at Edwards Air Force Base? Are there observable changes in material types or quantities? Is there evidence for changing settlement and subsistence patterns? Can changes in population dynamics/density be detected?

Previous studies on the impacts of the MCA have been conducted on the California coast and Channel Islands, in the desert Southwest, in the Owens Valley region of the Great Basin, and in the western Mojave Desert. Gardner's (2006) dissertation provides a good synopsis of known MCA studies which examined the ways that the MCA potentially impacted prehistoric populations.

As Jones and Schwitalla (2007:54) note, “The case for human response to droughts during the MCA is ultimately reliant on temporal correlations, which in the end cannot prove causality.” A trait common among MCA studies is that they have as their objective the attempt to correlate trends in quantifiable variables, such as artifact expression or occupation patterns, with the MCA in order to make inferences about more abstract cause-effect relationships. The coincidence of a particular aspect of cultural change with the MCA is not enough to declare causation. Perhaps this is why many researchers (see Basgall 1987; Baumhoff and Heizer 1965; and Broughton 1994) opt instead for models that focus on the continuation of processes in place before and after the occurrence of the MCA with explanations for cultural change that do not account for environmental factors (Schwitalla 2013).

It was not the goal of this project to make definitive declarations regarding causal factors for cultural change in the Antelope Valley. Rather, the intent was to shed light on an area that had little prior study (i.e., the impact of the MCA within the Antelope Valley region of the Mojave Desert). The project sought to provide insights into issues related to settlement, subsistence, and mobility. Indicators that were expected to provide a means for analyzing change in these areas during the MCA included: the presence of temporary camps vs. village sites, changes in tool assemblage, changes in artefactual faunal assemblage, and changes in known trade items such as obsidian and marine shells. A

combination of these data informed interpretations related to ways in which people had access to and moved across a landscape.

Does the Sutton Model for site settlement and subsistence patterns in the Western Mojave Desert fit Edwards Air Force Base? Are there features of the model that can be differentially applied to the installation?

A key feature of Sutton's model is the supposition that populations abandoned villages and occupied an increased number of temporary sites, with these sites having reduced populations to more effectively, and efficiently, exploit dwindling resources in transitional zones during the MCA (Sutton 1990, 1991a, 1991b; Gardner 2006, 2009; Cowie 2014). There are no known prehistoric villages (as defined by Sutton; 2017) identified on Edwards Air Force Base lands. Sites with evidence of occupation within the installation range from overnight camps being the simplest, to seasonal camps being the most complex site types identified. Sutton suggests that the temporary camp sites occupied during the MCA may have been dependent upon seasonal resource exploitation (Sutton 1991a, 1991b). Comparisons of data from sites elsewhere in the Antelope Valley may show that Edwards fits into the "transitional zone" portion of Sutton's model. It is possible that what have been interpreted as hunting parties or foraging groups occupying specialized resource procurement sites within the installation (Budinger and Spinney 2004; Earle *et al.* 1997; Hale *et al.* 2010; Hector *et al.* 1988; Wade and Hector 1989) were small populations of people displaced from

their village/s during the MCA. A focused analysis of the artifact assemblages associated with these occupations provides insight here. Assemblages associated with displaced village sites should contain materials similar to those seen in known village sites in the region surrounding Edwards Air Force Base. Though the quantities of material are expected to be reduced between village sites and displacement sites, the ratio of artifact types is expected to be similar. Conversely, specialized resource procurement sites occupied as part of a central place foraging strategy are expected to contain limited variety within their assemblages or artifact ratios indicative of specialized activities (e.g. high frequency of faunal remains).

CHAPTER FIVE

RESEARCH METHODS

Primary project activities consisted of research and data synthesis. Edwards Air Force Base has had approximately forty years of work conducted within the installation. As a result, a number of sites were identified which were suitable for analysis for this study. These sites have already been evaluated, with a variety of available data collected and analyses conducted.

Site Selection and Sample Size

The study area included sites selected from various regions throughout Edwards Air Force Base. For management purposes, the installation has been divided into five Management Regions (Figure 4). These regions include an alluvial plain within a basin floor (Management Region 1; Bissell Basin); the area including and surrounding the Rosamond Dry Lakebed and portions of Buckhorn Dry Lakebed (Management Region 2; Rosamond Lake); the large area comprising the central portion of the base which is made up of multiple landforms and includes the areas containing Rogers Dry Lakebed and portions of Buckhorn Dry Lakebed (Management Area 3; Central Base); the area including and surrounding a prominent ridgeline (Management Area 4; Air Force Research Laboratory); and an alluvial plain and fan area situated between Management

Area 4 and hills located along the installation's perimeter (Management Area 5; PIRA Range).

The selection of sites from all areas of the installation helped to ensure a variety of potential site types and variables contained within Edwards Air Force Base were captured in this study. For example, sites located to the southeast of Buckhorn Lake are situated in a playa/dune environment with mesquite groves and bosque. This area has a known history of seasonal occupation, with dates from approximately 8000 BP to 540 BP (Giambastiani *et al.* 2013). The reason this area of the Antelope Valley drew people for millennia, including during the MCA, was due to resource exploitation associated with wetland features. The proposed study area occurs within the Pleistocene Lake Thompson basin. Remnants of Lake Thompson remained during early occupation periods of the region, but complete desiccation of the lake occurred in relatively short order after approximately 7,700 years ago (Orme 2008).

The wide dates available helped to ensure sites were selected with occupation periods that either pre-dated, included, or post-dated the MCA. This was essential to ensure that change over time was adequately captured. However, it was not necessary to analyze sites far removed from the study period; there is little value in comparing Lake Mojave period sites against MCA counterparts for the purpose of this study.

The selection of sites for this study was directly correlated to their relationship with the MCA. In order to examine potential impacts on the

occupants of the Antelope Valley during the MCA, it was necessary to understand how the archaeological record of MCA-era sites compare with pre- and post-MCA sites. To accomplish this, sites were selected from three cultural periods: Gypsum Period, which dates to approximately 4000-1500 BP; Saratoga Springs Period, which dates to approximately 1500-800 BP; and Post-Saratoga Springs, or Late Period, which dates to approximately 800-300 BP (see Chapter Three for the defining characteristics of each period). To ensure sites were selected from these cultural periods, only sites containing chronological indicators were considered. Materials identified within the archaeological record which serve as chronological indicators can include: obsidian artifacts, charcoal and other floral or faunal remains, shell artifacts, and projectile points.

Over 200 sites were identified within Edwards Air Force Base with specimens that were dated using absolute dating techniques. These included obsidian hydration analyses of flaked tools and debitage, and radiocarbon analyses conducted primarily on charcoal recovered from thermal features. However, only sites that yielded dates tied exclusively to one of the three study cultural periods listed above were considered for this research. This meant that not all sites with obsidian hydration or radiocarbon dates were suitable for this study; pre-Gypsum sites, as well as sites that date within the last 300 years, were not considered. Additionally, sites with dates that fall within more than one cultural period, denoting multiple occupations spanning relatively long periods of time, were not considered. The exceptions to this were instances where discrete

loci dating to a single cultural period could be discerned within a larger site which was subjected to multiple occupational events (see CA-LAN-1189 Midden Areas 1, 2, 3; CA-KER-2016 Locus ARC-12; and CA-KER-5717 Concentrations B and C). The goal was to identify occupational episodes which could be defined by, and limited to, one of the three study cultural periods.

A recognized hazard of rejecting sites that fall within more than one cultural period was the potential for excluding significant MCA occupations. However, site formation processes in the study area generally result in a lack of vertical stratigraphy, creating difficulty in parsing out discrete occupational episodes for this level of analysis. Therefore, sites that could be identified from singular cultural periods were selected for this study to avoid misidentification or bias created by comingled material from different occupation episodes.

Once sites, or loci, were identified as belonging to a single cultural period, with reliable chronometric indicators (see discussion below), the total number of sites included for study in the data set was 15 (Figure 5). Five sites were identified from the pre-MCA Gypsum Period, five sites from the MCA Saratoga Springs Period, and five sites from the post-MCA Post-Saratoga Springs Period. Chapter Five provides descriptions for each of the sites.

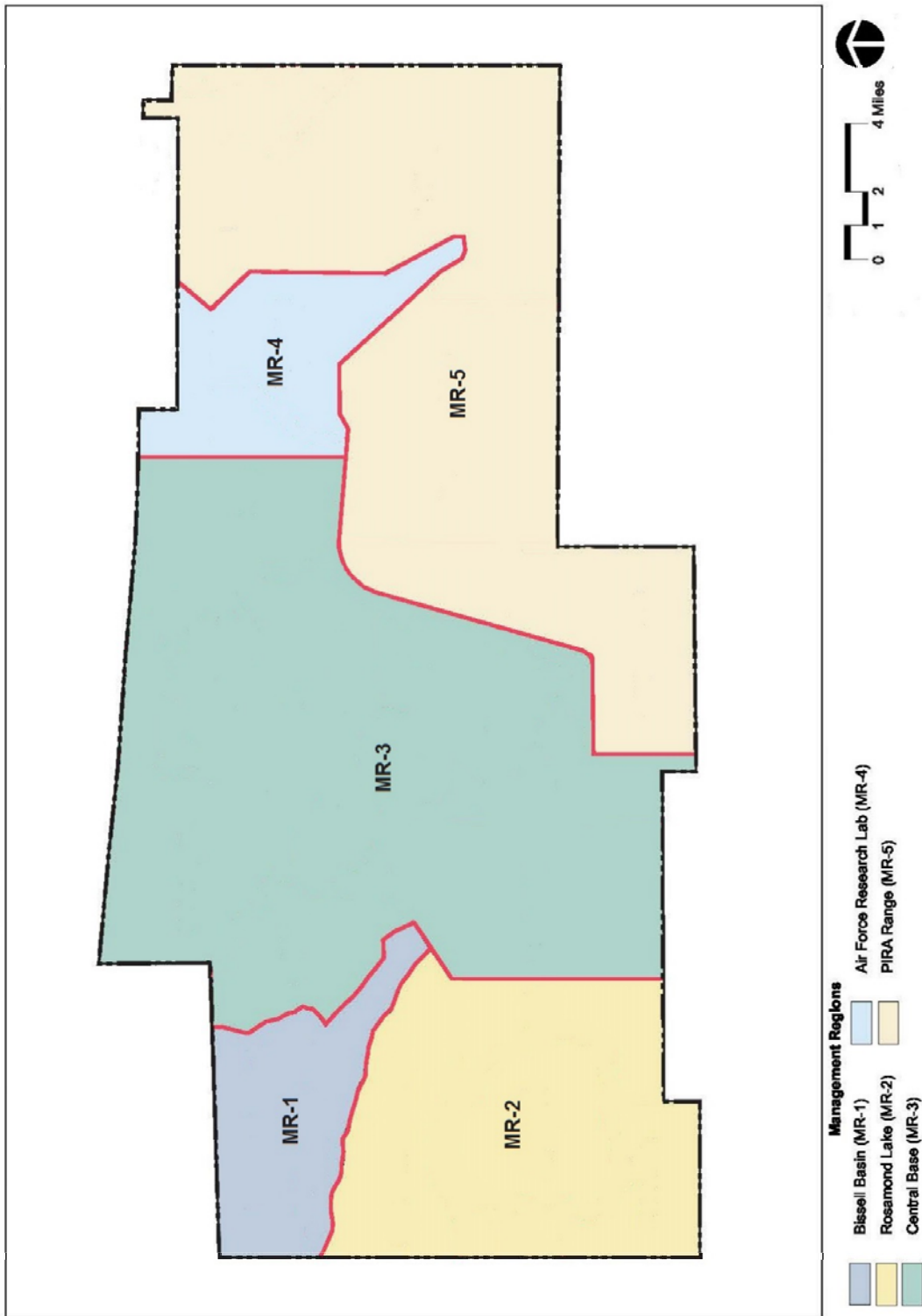


Figure 4. Map of Edwards Air Force Base Cultural Resources Management Regions.

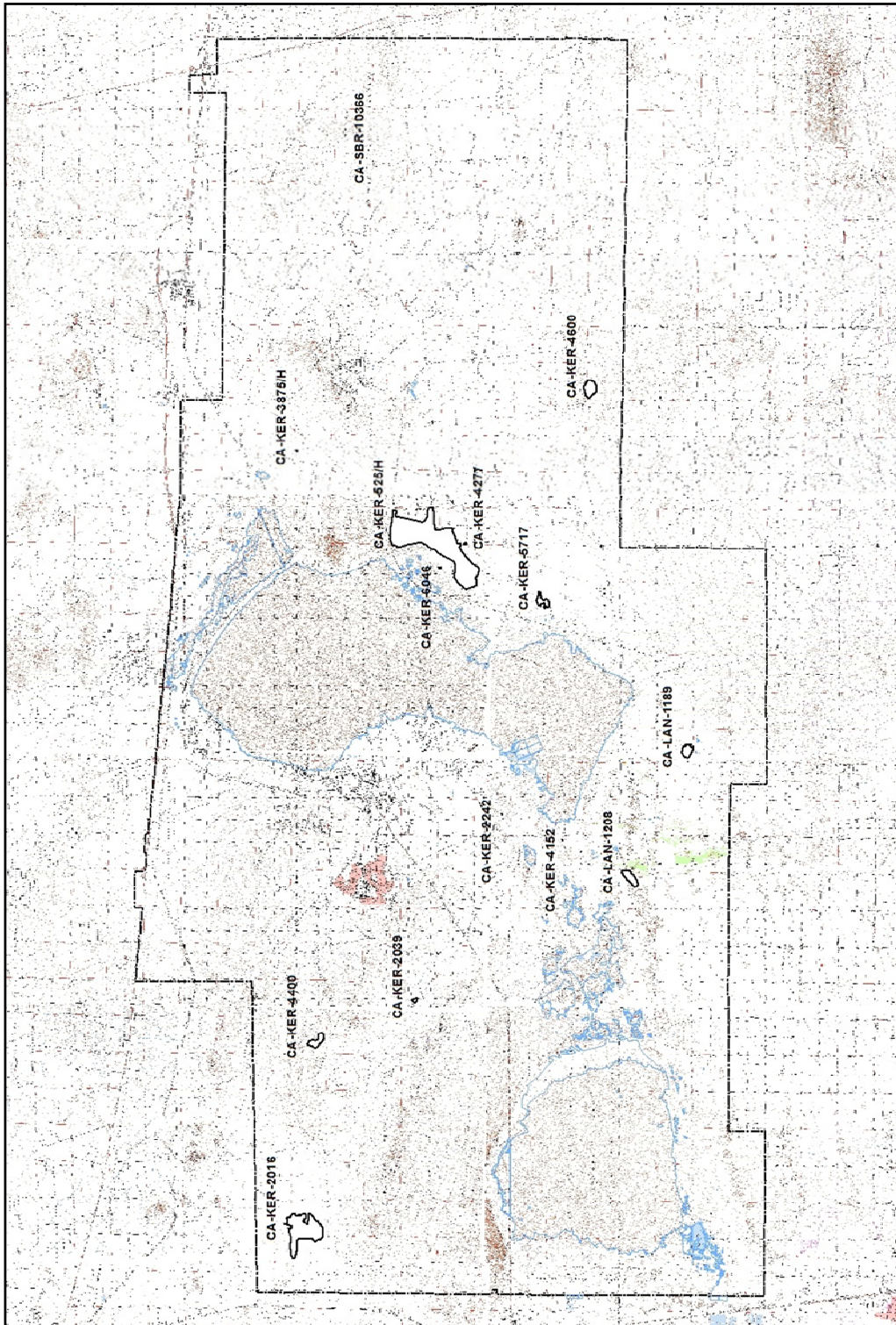


Figure 5. Selected Edwards Air Force Base Study Sites.

Edwards Air Force Base Site Types

In an effort to maintain consistency in describing and classifying sites, Edwards Air Force Base developed criteria for defining various site types identified within the installation which could be applied by both base archaeologists as well as off-base researchers conducting studies within the installation (Crosby 2010).

The two prehistoric site types were selected for this study. They are “base camp” and “temporary camp”. Base camps may represent

“...long-term semipermanent or intensive seasonal activity and occupation. This type is identified archaeologically by the presence of primary and secondary tools...and a variety of other artifacts. [Base camps are] characterized by extensive deposits and quantities of culture material, fire-affected rock, whole and broken flake stone tools, flaking waste, charred bone, milling tools, house structures, hearths, rock rings, and sometimes rock art or burials and cremations Trade items such as shell beads and obsidian are present. A visible well-developed midden usually occurs with this site type.” (Crosby 2010)

Temporary camps generally differ from base camps in assemblage quantity and complexity, and in areal site extent. Temporary camps

“...were occupied for a short length of time...by a few people...

These sites are identified archaeologically by scattered artifacts,

tool manufacturing debris, fire-affected rocks, and possibly features...Midden development is minimal to nonexistent.” (Crosby 2010)

Limitations

As noted above, the total pool of sites within Edwards Air Force Base for which absolute dating analyses was conducted was not appropriate for consideration for this study; the goal of selecting sites representing occupations from a single cultural period precluded such wholesale adoption of sites. Further limitations associated with site selection were not related specifically to study goals. These are presented below.

Obsidian Hydration

Obsidian hydration analysis is an absolute dating method that has been utilized within archaeology since 1960. Along with radiocarbon dating and other chronological advances, the introduction of these scientific analyses has propelled American archaeology by leading to a shift toward the study of context and function with an interest in process, where the focus had previously been on the classification of material remains (Willey and Sabloff 1993:153). However, despite the established use of obsidian hydration as a chronometric tool, caution must be used when determining a site’s age based upon obsidian hydration data alone.

While hydration dates are absolute dating measures, their utility is best realized when paired with radiocarbon dates acquired from associated stratigraphic contexts. However, the occurrence of such pairs is relatively rare in the Mojave Desert (Giambastiani *et al.* 2007). Hydration rates are not uniform; they exhibit regional variation caused by changes in local climate, even on the slightest scale. For this reason, accompanying radiocarbon data points can help calibrate hydration dates for a region. Lacking an abundance of these pairings from Edwards Air Force Base sites, hydration data gleaned from projectile points recovered from the installation was analyzed (Giambastiani *et al.* 2000; Basgall and Overly 2004) to develop a hydration equation for Edwards Air Force Base.

The work done to create a hydration rate specific to the installation greatly increased the confidence of obsidian dates that can be garnered from artefactual remains, however, caution must still be given when relying solely on hydration dates. As mentioned above, hydration rates are highly susceptible to changes in the environment. The unknown history of an artifact makes the uniform formation of a hydration band unknowable. To increase the temporal reliability of sites dated through obsidian hydration, this study attempted to analyze sites which also included additional chronometric measures such as radiocarbon dates, or an agreement with projectile point typologies. In the absence of other temporal indicators, obsidian hydration was considered if multiple hydration samples from a single site were dated to the same period.

Site Formation and Preservation

There are issues to consider regarding site formation. Sites in this region of the Mojave Desert can be problematic due to poor soil formation resulting in issues with site deposition; Campbell (1936) addressed the issue of surface artifacts and the difficulty in interpreting site chronology absent stratigraphy. Horizontal stratigraphy in the project area is common due to poor soil formation and the history of multiple occupations. Wiessner (1982) suggests that difficulty in drawing conclusions from multiple occupations, preservation, or dating should be addressed by having as many independent data sets as possible to examine these issues.

Erosional processes caused by aeolian and pluvial events within the Antelope Valley can be significant forces which negatively impact site preservation. Additionally, human impacts cannot be underestimated. The region has a long history of human occupation, which has continued into modern times. Many prehistoric sites experienced multiple occupations, with occupational levels obscured due to unfavorable conditions for soil formation. More recent site activities such as historic ranching and military activities, and modern looting, have all impacted the archaeology of the region.

Variability in Previous Data Collection Methods.

As noted above, Edwards Air Force Base has an approximate forty-year history of previous archaeological studies conducted within its installation. This is

both beneficial in that it provides a sizable data pool for study, but it also has distinct limitations which come with the diversity of methods employed by various researchers and with the passage of time. Each researcher's approaches were informed by their own study goals, personal methodologies, and knowledge within the field at the time, which was (and continues to be) in constant flux. This lack of constancy in methodology between studies did not allow for a seamless comparison between all sites selected within the installation. Sites chosen from different evaluation projects were analyzed with using different methodologies, with different standards, and with different levels of detail. In general, sites included in earlier studies received a rather Spartan level of analysis.

One method of addressing this situation was to utilize the available data in various records and reports by identifying common shared traits across sites as points of analysis. Though not ideal for fine-grained analysis, this method did offer a decent look at broader site functions by providing information such as the general presence of lithics, fire-affected rock, and faunal remains. However, not all records or reports provide an artifact inventory for their sites. To the greatest extent possible, additional analysis of collected artifact assemblages was conducted to help remedy this situation and to generate comparable data sets for comparison across all sites.

Analyses Conducted

This study relied largely upon analyses conducted during previous studies. However, as noted above, it was necessary to supplement previous analyses with additional new data. The records and reports for the study site varied in regards to the level of detail given for artifact assemblages. Therefore, this supplemental analysis was crucial to determine details such as tool types, projectile point styles, the occurrence of flake types, and the presence of ecofacts

Existing collections for all study sites were accessed at the Edwards Air Force Base archaeological curation facility. All curated materials for each study site were retrieved and examined. The first level of analysis conducted with these artifacts or ecofacts consisted of classification by general type (e.g., debitage, tools, ground stone, faunal remains, etc.). Materials were then further identified by specific artifact or ecofact type, as appropriate. Faunal remains were only identified by counts denoting presence within an assemblage due to inconsistencies in previous recordation methods and the need for specialized analysis. New catalogs were created to reflect the findings of these analyses. These catalogs were then compared against previous site catalogs and the data contained within site records and reports, with the newly created catalogs amended to reflect all known site constituents. Summaries of these efforts can be found in Appendix A.

After all known cultural materials were identified from each site's associated records, reports, and collected artifacts housed at the Edwards Air Force Base archaeological curation facility, cross-comparison analyses of the cultural periods were conducted. The trends observed between sites, and across temporal divides, were analyzed to make determinations regarding technological continuity, potential trade activities, and settlement shifts through time. Chapter six provides the results derived from these analyses.

CHAPTER SIX

RESULTS

The abundance of data generated over the many years of research conducted at Edwards Air Force Base has created numerous data points for analysis within the Antelope Valley. However, there are limitations regarding the comparative utility of these data, as mentioned in Chapter Four. For example, a number of the study sites include faunal remains. This material class was recorded at varying levels of consistency during previous studies. Deviations in addressing faunal assemblages within sites include: classifying all identifiable remains to species type; only classifying remains as 'mammal', 'bird', or 'reptile', and 'large' or 'small'; classifying remains as 'burned'/'charred' or 'unburned'/'not charred'; and making no mention regarding exposure, or lack thereof, to heat. Due to these variations, the current available data negated meaningful comparative analysis of faunal assemblages throughout the present study sites. To utilize faunal materials in this study, fieldwork to address instances in which faunal elements were previously observed *in situ* only, and additional time-consuming, specialized, analyses of collected remains, would have been required. Without those data available for the current study, issues such as subsistence were not wholly explored.

A brief description of the 15 study sites is provided below, followed by a presentation of results gleaned from available data acquired from this study sample.

Gypsum Period (Pre-MCA Dated) Sites

Five pre-MCA dated sites attributed to the Gypsum Period were identified within Edwards Air Force and included in this study. These sites are briefly described below.

CA-KER-525/H

Site CA-KER-525/H is a multi-component site located on an alluvial plain along the eastern shoreline of Rogers Lake. The prehistoric component of the site is comprised of a base camp with multiple loci. Cultural constituents include approximately 1,000 flakes, 31 flaked tools (including 2 projectile points), 5 cores, 7 hammerstones, 23 ground stone, 1 *Haliotis* sp. pendant, 1 unidentified modified shell fragment, 1 lithic pendant, at least 3 hearths, and 1 possible cremation (Crosby 2001; Foradas 1999a; Greene 1998).

CA-KER-4400

Site CA-KER-4400 is described as a large temporary camp with 15+ loci occurring within a series of drainage swales. The site is comprised of approximately 1000 flakes, 5 flake tools (including 3 projectile points), 2 cores, 4 ground stone, and 20+ hearths (Norwood and Johnson 1995).

CA-KER-4600

Site CA-KER-4600 is recorded as a base camp on an alluvial fan and dune environment near the toe of a prominent butte. The site is comprised of approximately 2250 flakes, 29 flaked tools (including 5 projectile points), 9 cores,

15 hammerstones, 8 ground stone, and at least 18 hearths (Crabtree and Crosby 2001; Onzol *et al.* 1995).

CA-LAN-1189 (Midden Area 3)

Site CA-LAN-1189 has been recorded as a large base camp complex situated within a clay pan and dune environment with three discrete midden areas and surrounding artifact deposit (Deis 2001; Norwood and Lillard 1985). Midden Area 3 can be identified as a pre-MCA occupation area based upon all chronological indicators recovered within this locus; three obsidian hydration dates, one radiocarbon date, and two projectile points, are complementary and consistent with the Gypsum Period.

Midden Area 3 constituents consist of approximately 50 flakes, 3 flake tools (including 2 projectile points), 1 slate pendant, 3 ground stone, 1 hearth, and at least 1 cremation (Deis 2001; Norwood and Lillard 1985).

CA-LAN-1208

Site CA-LAN-1208 is a locus of a large multi-component site, CA-LAN-1296, which has been defined as a prehistoric base camp located within mesquite bosque. The locus CA-LAN-1208 is recorded as a campsite within the larger site (Campbell *et al.* 1995). Site constituents consist of approximately 1700 flakes, 37 flaked tools (including 3 projectile points), 5 cores, 3 unidentified shell fragments, 26 ground stone, and fire-affected rock (Campbell *et al.* 1995; Norwood and Phillips 1985).

Saratoga Springs Period (MCA Dated) Sites

Five MCA dated sites attributed to the Saratoga Springs Period were identified within Edwards Air Force and included in this study. These sites are briefly described below.

CA-KER-2016 (Locus ARC-12)

Site CA-KER-2016 is described as a large temporary camp comprised of multiple loci located in a clay pan and dune environment within a basin region. Locus ARC-12 is situated along the side of a prominent dune and can be identified as an MCA-era occupation area of the site based upon chronological indicators recovered within this locus; four obsidian hydration dates, one radiocarbon date, and four projectile points, are complementary and consistent with the Saratoga Springs Period (Giambastiani *et al.* 2000).

A well-developed midden was identified at Locus ARC-12, and associated artefactual remains consist of approximately 700 flakes, 17 flaked tools (including 4 projectile points), 2 cores, 1 core tool, 8 ground stone, and 1 hearth (Norwood 1985a; Onzol 1997).

CA-KER-5717 (Concentrations B and C)

Site CA-KER-5717 is recorded as a large temporary camp situated along the eastern shoreline of Rogers Lake on what is described as a possible “wave-cut terrace” (Fogerty 2004a), with at least five artifact concentrations identified. Concentrations B and C can be identified as MCA-era occupation areas of the site based upon all chronological indicators recovered these areas; four

radiocarbon dates, as well as four projectile points, are complementary and consistent with the Saratoga Springs Period, and can be further limited to the MCA specifically.

Concentrations B and C consist of approximately 175 flakes, 13 flaked tools (including five projectile points), 1 core, 2 hammerstones, 1 unidentified modified shell fragment, and fire-affected rock (Fogerty 2004a; Wolfe 1998).

CA-KER-6046

Site CA-KER-6046 is recorded as a large temporary camp within a clay pan and dune environment along the eastern shoreline of Rogers Lake. Site constituents are comprised of approximately 60 flakes, 4 flaked tools, 1 core, 1 hammerstone, 10 Haliotis fragments, 2 bivalve shell fragments, 2 ground stone, and fire-affected rock (Foradas 1999b; Tabares 2002).

CA-LAN-1189 (Midden Areas 1 and 2)

Site CA-LAN-1189 has been recorded as a large base camp complex situated within a clay pan and dune environment with three discrete midden areas and surrounding artifact deposit (Deis 2001; Norwood and Lillard 1985). Midden Areas 1 and 2 can be identified as MCA-era occupation areas based upon chronological indicators recovered within these loci; four obsidian hydration dates and complementary beads dated using the Bennyhoff and Hughes typology are consistent with the Saratoga Springs Period (Deis 2001), and can be further limited to the MCA specifically.

Midden Areas 1 and 2 constituents consist of approximately 380 flakes, 8 flake tools, 5 slate pendants/ornaments, 1 sandstone pendant, 4 slate beads, 3 steatite beads, 8 *Olivella* beads, numerous *Haliotis* fragments, 1 ground stone, and fire-affected rocks (Deis 2001; Norwood and Lillard 1985).

CA-SBR-10366

Site CA-SBR-10366 is described as a small temporary camp situated on gravel-covered alluvial fan. The site consists of 15 flakes, 1 flaked tool, 3 ground stone, and 1 hearth (Bark *et al.* 2004; McGetrick 2000).

Post-Saratoga Springs/Late Period (Post-MCA Dated) Sites

Five post-MCA dated sites attributed to the Post-Saratoga Springs Period were identified within Edwards Air Force and included in this study. These sites are briefly described below.

CA-KER-2039

Site CA-KER-2039 is a temporary camp situated near the base of a prominent hill on an alluvial fan cut by drainages. Cultural constituents associated with the site are limited to a single flake and three hearth features (Norwood 1985b). However, the flake was recovered in the disturbed contexts of a road cut and therefore lacks proper association. For this reason, the flake cannot be attributed to this site.

CA-KER-2242

Site CA-KER-2242 is a small temporary camp situated within a clay pan and dune environment west of the Rogers Lake shoreline. Site constituents are comprised of 12 flakes, 2 flake tools, 1 hammerstone, 3 *Olivella* beads, 1 ground stone, and fire-affected rock (Norwood 1988; Swope and Kohlhardt 1994).

CA-KER-3875/H

Site CA-KER-3875/H is described as a large temporary camp situated on an alluvial fan within Joshua tree woodland. Site constituents are comprised of approximately 70 flakes, 1 projectile point, 2 cores, 1 hammerstone, and fire-affected rock. The presence of possible midden has also been noted at site CA-KER-3875/H (Boyer 1993, 1995).

CA-KER-4152

Site CA-KER-4152 is a large temporary camp situated in a clay pan and stable dune environment on an alluvial plain. Site constituents are comprised of 50+ flakes, 1 hearth, and additional fire-affected rock (Dowell *et al.* 1994; Puckett and Pritchard Parker 2002; Pritchard Parker and Puckett 2002).

CA-KER-4277

Site CA-KER-4277 is recorded as a large temporary camp situated along the eastern shoreline of Rogers Lake. The site's location has been described as a "broad, flat, gently sloping peneplain...[that] occupies a low ridge beside a shallow swale that may at times collect water" (Fogerty 2004b). Site constituents

consist of 11 flakes, 3 flaked tools, 2 cores, 1 core tool, 5 ground stone, and fire-affected rock (Fogerty 2004b; Wear *et al.* 1994).

Site Variability: Material Assemblage and Areal Extent

The faunal example given above is one instance in which the data available limited the analysis. However, after compiling data for the 15 study sites, it became apparent that areas for cross-comparison were appropriate which relate to general themes of this study. Specifically, trends in material assemblage and areal extent of sites were observed.

Material Assemblage

All known artifacts and ecofacts from the Edwards Air Force Base study sites were identified and analyzed. For the purposes of this study, analyses were limited to assemblages and did not focus on specialized analyses of individual artifacts. Pre-MCA Gypsum Period sites were found to contain the highest quantity of cultural material, on average, of all the sites included in this study (Table 2). MCA Saratoga Springs sites rank second in terms of quantity of materials recovered (Table 3). Whereas post-MCA era Post-Saratoga Springs Period display the least amount of associated materials observed within Edwards Air Force Base sites (Table 4).

Lithic debitage makes up the bulk of the collection from these sites. Thousands of flakes were recovered from all but one of the pre-MCA period sites. Site CA-KER-4600 contains approximately 2,250 flakes, the largest

quantity associated with a pre-MCA site. While Midden Area 3 of site CA-LAN-1189 consists of 50 flakes, the lowest number represented in all pre-MCA occupations. When viewed in terms of assemblage percentage, flakes comprise approximately 98.9% of the CA-KER-4600 site constituents, while the CA-LAN-1189 artifact assemblage contains approximately 87.7% flakes in comparison (see Table 5).

Table 2. Summary of Material Assemblages from Edwards Air Force Base Pre-MCA Dated Gypsum Period Sites.

Recovered Artifacts	CA-KER-525/H	CA-KER-4400	CA-KER-4600	CA-LAN-1189	CA-LAN-1208
Flakes (approximately)	1000	1000	2250	50	1700
Flaked Tool	31	5	29	3	37
Percussion Material	12	2	24	0	5
Shell Bead/Ornament	2	0	0	0	0
Shell (ecofact)	0	0	0	0	3
Lithic Bead	0	0	0	0	0
Lithic Pendant/Ornament	1	0	0	1	0
Ground Stone	23	4	8	3	26
Total	1069	1011	2311	57	1771

Table 3. Summary of Material Assemblages from Edwards Air Force Base MCA Dated Saratoga Springs Period Sites.

Recovered Artifacts	CA-KER-2016	CA-KER-5717	CA-KER-6046	CA-LAN-1189	CA-SBR-10366
Flakes (approximately)	700	175	60	380	15
Flaked Tool	17	13	4	8	1
Percussion Material	2	3	2	0	0
Shell Bead/Ornament	1	1	0	8	0
Shell (ecofact)	0	0	12	2	0
Lithic Bead	0	0	0	7	0
Lithic Pendant/Ornament	2	0	0	6	0
Ground Stone	8	2	2	1	1
Total	730	194	80	412	17

Table 4. Summary of Material Assemblages from Edwards Air Force Base Post-MCA Dated Post-Saratoga Springs Period Sites.

Recovered Artifacts	CA-KER-2039	CA-KER-2242	CA-KER-3875/H	CA-KER-4152	CA-KER-4277
Flakes	0	12	70	54	11
Flaked Tool	0	2	1	0	4
Percussion Material	0	1	3	0	2
Shell Bead/Ornament	0	3	0	0	3
Shell (ecofact)	0	0	0	0	0
Lithic Bead	0	0	0	0	0
Lithic Pendant/Ornament	0	0	0	0	0
Ground Stone	0	4	1	0	5
Total	0	22	75	54	25

Table 5. Quantity and Percentage of Artifacts Present in Pre-MCA, MCA, and Post-MCA Dated Sites by General Artifact Type.

Recovered Artifacts (quantities)	Pre-MCA Sites					MCA Sites					Post-MCA Sites				
	CA-KER-525/H	CA-KER-4400	CA-KER-4600	CA-LAN-1189	CA-LAN-1208	CA-KER-2016	CA-KER-5717	CA-KER-6046	CA-LAN-1189	CA-SBR-10366	CA-KER-2039	CA-KER-2242	CA-KER-3875/H	CA-KER-4152	CA-KER-4277
Flakes	1000	1000	2250	50	1700	700	175	60	380	15	0	12	70	54	11
Flaked Tool	31	5	29	3	37	17	13	4	8	1	0	2	1	0	4
Percussion Material	12	2	24	0	5	2	3	2	0	0	0	1	3	0	2
Other	3	0	0	1	3	3	1	3	23	0	0	3	0	0	3
Ground Stone	23	4	8	3	26	8	2	2	1	1	0	4	1	0	5
Total	1069	1011	2311	57	1771	730	194	71	412	17	0	22	75	54	25

Recovered Artifacts (percentages)	Pre-MCA Sites					MCA Sites					Post-MCA Sites				
Flakes	93.5	98.9	97.4	87.7	96.0	95.9	90.2	84.5	92.2	88.2	0.0	54.5	93.3	100.0	44.0
Flaked Tool	2.9	0.5	1.3	5.3	2.1	2.3	6.7	5.6	1.9	5.9	0.0	9.1	1.3	0.0	16.0
Percussion Material	1.1	0.2	1.0	0.0	0.3	0.3	1.5	2.8	0.0	0.0	0.0	4.5	4.0	0.0	8.0
Other	0.3	0.0	0.0	1.8	0.2	0.4	0.5	4.2	5.6	0.0	0.0	13.6	0.0	0.0	12.0
Ground Stone	2.2	0.4	0.3	5.3	1.5	1.1	0.1	2.8	0.2	5.9	0.0	18.2	1.3	0.0	20.0

Flakes are also the primary constituent of MCA period sites. The quantities are seen to decline significantly from what was exhibited during the pre-MCA period. However, this is not necessarily a useful indicator of change between periods; the pre-MCA Gypsum Period spanned a much longer period of time than the MCA Saratoga Springs Period and therefore provided more

opportunity for artifact assemblages to develop/accumulate (see Chapter Six for further discussion). There is also greater variability in flake counts seen between the MCA-dated sites than was observed between the pre-MCA period sites. CA-KER-2016 contains the largest quantity of flakes for MCA sites at approximately 700, and CA-SBR-10366 contains the least at 15 flakes. However, when expressed in terms in artifact percentages, these flakes represent 95.9% and 88.2%, respectively (see Table 5). By considering the number of flakes relative to the total assemblage makeup, there is little difference in this artifact type quantitatively between pre-MCA and MCA occupations.

The continuity in flake occurrence does not continue into the post-MCA period. The number of flakes drops significantly for sites dating to this period, with CA-KER-3875/H having the most at 70 flakes, and CA-KER-4277 having the least at 11 flakes. When viewed as percentage of assemblages, these flakes represent 93.3% and 44.0% of their total site assemblages (see Table 5). The average percentage of total site constituents for flake assemblages from both pre-MCA and MCA period sites were found to be within the 90th percentile (94.7% and 90.2%, respectfully; see Table 6). While the post-MCA CA-KER-4277 flake assemblage, at 93.3% of its total site assemblage, fits within the ranges exhibited by sites from earlier occupation periods, it is the only site from the post-MCA period that exhibits a flake frequency similar to the earlier periods; the average flake occurrence identified between all post-MCA sites is 58.4%,

though this number has little cross-comparative utility given the great variation between the five post-MCA sites coupled with a relatively small sample size.

The artifact class that occurs after flakes in order of increasing abundance within pre-MCA and MCA period sites are flaked tools (see Table 2 and Table 3). This artifact class includes all tools which are the product of some level of lithic reduction. This includes projectile points, bifaces, and unifaces, but it also includes artifacts such as flake tools, core tools, and choppers. A breakdown of tool types for these cultural periods is included in Appendix A. This table depicts all lithic tools and production material recovered from pre-MCA period sites and therefore includes lithic manufacture debris (i.e., debitage, cores, and hammerstones).

As with flakes, the observed trend in flaked tool occurrence between pre-MCA and MCA period sites does not continue into the post-MCA period (see Table 4). While the earlier period sites saw flaked tools as the second ranked artifact class in terms of percentage of overall assemblages (see Table 5), post-MCA period sites saw, on average, a greater occurrence of ground stone over flaked tools (see also Table 5). Like the flakes, there is a great amount of variation between flaked tool and ground stone assemblages associated with post-MCA period sites; two of the five sites contain neither flaked tools nor ground stone. However, a review of the sites that do contain flaked tools and ground stone showed that ground stone occurred in significantly greater frequency than flaked tools. On average, ground stone occurred in the greatest

percent in post-MCA period sites at 7.9% (with all five sites) or 13.1% (with only the three flake tool and ground stone containing sites) of the overall site assemblages, compared to 1.9% and 2.0% of the overall site assemblages of pre-MCA and MCA period sites, respectively (see Table 6).

Non-tool artefactual materials recovered from the study sites include objects such as shell beads and ornaments, lithic beads and ornaments, and shell ecofacts. For the purpose of analysis, shell ecofacts are counted in conjunction with artifacts of the non-tool class; in the regional contexts in which they were found, these materials are likely shell ornament/pendant fragments.

While non-tool artifacts are found in sites from all three study cultural periods, they occur in the lowest frequency during the pre-MCA period (see Table 2). Pre-MCA sites were found to contain two shell pendants or ornaments, 3 shell ecofacts, and two lithic pendants. The average percentage of the overall assemblage for this artifact class in pre-MCA period sites is 0.5% (see Table 6).

MCA period sites saw a substantial increase in beads, pendants or ornaments, and shell ecofacts (see Table 3 and Table 6). These sites include 10 shells beads or ornaments, 7 lithic beads, 6 lithic pendants/ornaments, and 5 shell ecofacts. The average overall percentage for artifacts of this class in the MCA-dated sites is 2.1% (see Table 6).

Table 6. Percentage of Artifacts Present in Pre-MCA, MCA, and Post-MCA Dated Sites with Average Percentages for Artifact Classes within Cultural Periods.

Pre-MCA (Gypsum) Sites						
Recovered Artifacts (percentages)	CA-KER-525/H	CA-KER-4400	CA-KER-4600	CA-LAN-1189	CA-LAN-1208	Average for Pre-MCA Sites
Flakes	93.5%	98.9%	97.4%	87.7%	96.0%	94.7%
Flaked Tool	2.9%	0.5%	1.3%	5.3%	2.1%	2.4%
Percussion Material	1.1%	0.2%	1.0%	0.0%	0.3%	0.5%
Other	0.3%	0.0%	0.0%	1.8%	0.2%	0.5%
Ground Stone	2.2%	0.4%	0.3%	5.3%	1.5%	1.9%

MCA (Saratoga Springs) Sites						
Recovered Artifacts (percentages)	CA-KER-2016	CA-KER-5717	CA-KER-6046	CA-LAN-1189	CA-SBR-10366	Average for MCA Sites
Flakes	95.9%	90.2%	84.5%	92.2%	88.2%	90.2%
Flaked Tool	2.3%	6.7%	5.6%	1.9%	5.9%	4.5%
Percussion Material	0.3%	1.5%	2.8%	0.0%	0.0%	0.9%
Other	0.4%	0.5%	4.2%	5.6%	0.0%	2.1%
Ground Stone	1.1%	0.1%	2.8%	0.2%	5.9%	2.0%

Post-MCA (Post-Saratoga Springs) Sites						
Recovered Artifacts (percentages)	CA-KER-2039	CA-KER-2242	CA-KER-3875/H	CA-KER-4152	CA-KER-4277	Average for Post-MCA Sites
Flakes	0.0%	54.5%	93.3%	100%	44.0%	58.4%
Flaked Tool	0.0%	9.1%	1.3%	0.0%	16.0%	5.3%
Percussion Material	0.0%	4.5%	4.0%	0.0%	8.0%	3.3%
Other	0.0%	13.6%	0.0%	0.0%	12.0%	5.1%
Ground Stone	0.0%	18.2%	1.3%	0.0%	20.0%	7.9%

Much like what was observed with the previously discussed artifact classes from the post-MCA period sites, the non-tool beads, pendants or ornaments, and shell ecofacts from this period show a lack of continuity from the earlier periods. Artifacts of this class occur in the highest frequency during this period, with an overall assemblage average across the five sites of 5.1% (see Table 6). This seems to fit a trend of increasing beads and pendants/ornaments through time. However, the entirety of this class of artifacts from the post-MCA period consists of six shell beads from two sites. This is a downward trend in artifact diversity and site distribution from earlier periods.

Aerial Extent

An analysis of the spatial patterning of sites show trends related to cultural periods. Comparison of identifiable site areas (Table 7) demonstrates a significant reduction in site size between the pre-MCA and MCA periods. This trend seems to hold in the post-MCA period, with sites having similarly small footprints as what is observed in MCA-dated sites.

Another trend that was observed between cultural periods which should be considered when analyzing aerial extent of sites is the estimated length of time during which each site was occupied (see Table 7). This measurement does not attempt to quantify the number of years people maintained steady occupation within a site, but rather the span of time over which occupation/s occurred. See Chapter Seven for a discussion regarding the potential relationship between site occupation lengths and site size.

Pre-MCA period sites were found to have been potentially occupied for far longer than sites from either the MCA or Post-MCA periods. For comparison, the site with the shortest estimated occupation period from the pre-MCA period (CA-KER-4400) may have experienced occupation over an 800-year period, while the site from the MCA period with the longest estimated occupation period (CA-KER-5717) may have experienced occupation over a 380-year period.

Table 7. Site Areas with Approximated Occupation Information for Edwards Air Force Base Study Sites. (Occupation dates are based on obsidian hydration and radiocarbon dates; 'single' occupation dates are listed when site records indicate evidence for single encampments which are supported by either singular radiocarbon dates or multiple agreeing hydration dates.)

	Site Trinomial	Area (ac)	Approximate Occupation Dates	Estimated Occupation Length (yrs)
Pre-MCA	CA-KER-525/H	370.0	3,389-2,400 BP	989
	CA-KER-4400	55.2	1,500-700 BP	800
	CA-KER-4600	77.5	4,950-1,300 BP	3,650
	CA-LAN-1189	1.5	3,818-1,796 BP	2,022
	CA-LAN-1208	64.4	4,000-1,400 BP	2,600
MCA	CA-KER-2016	0.4	1,089-844 BP	245
	CA-KER-5717	undetermined	1,100-720 BP	380
	CA-KER-6046	1.4	1,089 BP	single
	CA-LAN-1189	0.9	1,089-961 BP	128
	CA-SBR-10366	< 0.1	941(±40) BP	single
Post-MCA	CA-KER-2039	6.8	310(±40) BP	single
	CA-KER-2242	undetermined	361-329 BP	32
	CA-KER-3875/H	1.0	430-220 BP	110
	CA-KER-4152	0.4	442(±60) BP	single
	CA-KER-4277	1.6	490(±40)-400(±40) BP	170-90

Another observed trend which has shown a correlation between cultural periods and aerial extent of sites is related to artifact density (Table 8; Figure 6). An accounting of the recovered artifacts by site demonstrates that pre-MCA period sites, on average, are comprised of quantitatively more artifacts than sites from MCA or post-MCA periods. However, the tally of artifacts alone does not give an accurate account of artifact prevalence within each site. When the number of artifacts recovered per site acre was examined, a different picture emerged.

Table 8. Artifacts per Acre for Edwards Air Force Base Study Sites.

	Site Trinomial	Area (ac)	Total Recovered Artifacts	Artifacts per Acre
Pre-MCA	CA-KER-525/H	370.0	1069	2.89
	CA-KER-4400	55.2	1011	18.32
	CA-KER-4600	77.5	2311	29.82
	CA-LAN-1189	1.5	57	38.00
	CA-LAN-1208	64.4	1771	27.50
MCA	CA-KER-2016	0.4	730	1825.00
	CA-KER-5717	undetermined	194	N/A
	CA-KER-6046	1.4	80	57.14
	CA-LAN-1189	0.9	412	457.78
	CA-SBR-10366	< 0.1	17	850.00
Post-MCA	CA-KER-2039	6.8	0	0.00
	CA-KER-2242	undetermined	22	N/A
	CA-KER-3875/H	1.0	75	75.00
	CA-KER-4152	0.4	54	135.00
	CA-KER-4277	1.6	25	15.63

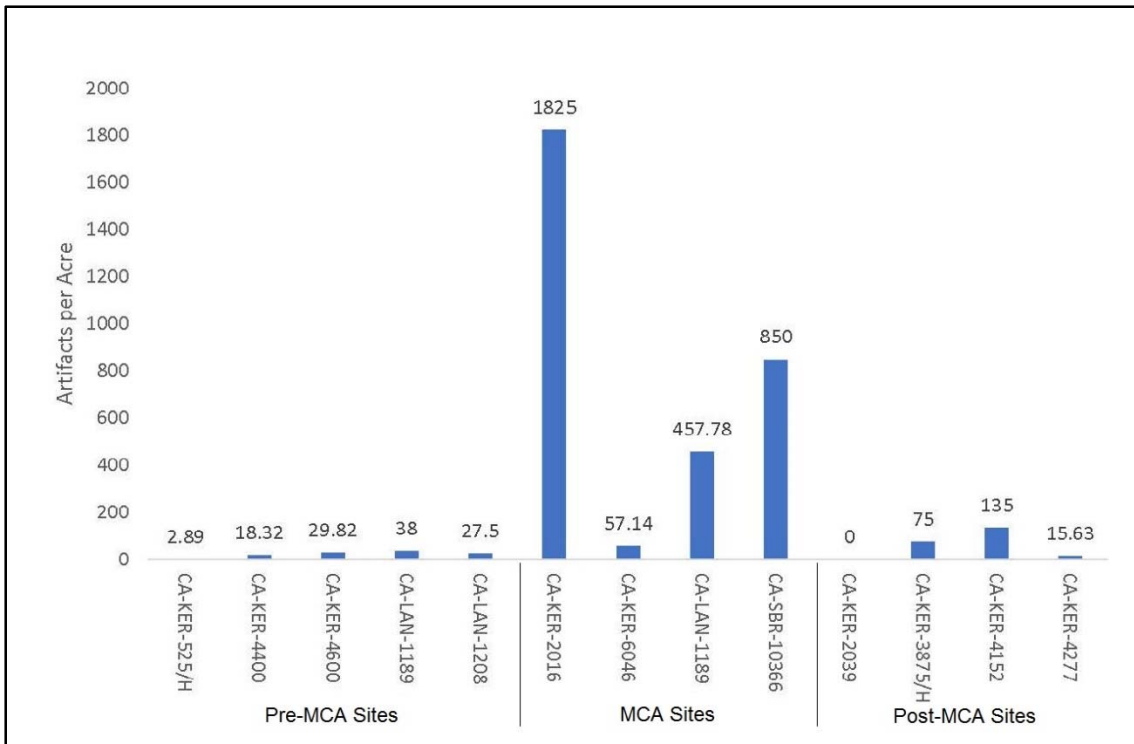


Figure 6. Artifacts per Acre for Edwards Air Force Base Study Sites (depicted by Cultural Period). Sites for which areas could not be determined (CA-KER-5717 and CA-KER-2242), were excluded.

Occupation lengths notwithstanding, while the pre-MCA period sites do contain the most artifacts, they were found to possess them in the lowest density, with the densest site (CA-LAN-1189) displaying only 38 artifacts per acre (see Table 8). A significant increase in site artifact density is seen to have occurred between the pre-MCA and MCA periods, with the later period seeing its densest site (CA-KER-2016) at 1,825 artifacts per acre. While these two examples represent the extremes from their cultural periods, the difference between the average ‘artifacts per acre’ from each period is also substantial, with the pre-

MCA period possessing 23.31 and the MCA period possessing 797.48 artifacts per acre.

Much like what was discussed previously regarding material assemblages, the apparent trend through time from less dense to more dense site assemblages is less clear when sites enter the post-MCA period. These later period sites appear, on average, to be less dense than the succeeding MCA period sites, but possess considerably more artifacts per acre than pre-MCA period sites (see Table 8 and Figure 6).

CHAPTER SEVEN

DISCUSSION AND RECOMMENDATIONS

Conclusions Relevant to Research Questions and Hypotheses

The research questions proposed for this study focused on the identification of MCA effects within Antelope Valley populations through identifiable changes in the archaeological record and on the investigation of possible settlement and subsistence patterns. The research questions were posed to address competing hypotheses regarding seasonal habitation versus population aggregation during the MCA (see Chapter Four).

Material assemblage analysis shows that artifact percentages between pre-MCA period sites and MCA period sites are similar, with the exception of beads and ornaments/pendants which saw a significant increase during the MCA period (Figure 7 and Figure 8; see also Table 5 and Table 6; beads and pendants/ornaments are listed as “Other” on tables). The continuity in artifact assemblages between cultural periods favors a village displacement settlement model over one that suggests the establishment of specialized resource procurement sites during the MCA. Sutton (1990, 1991a, 1991b) proposed the movement out of village sites in the Mojave Desert during the MCA into temporary, likely seasonal, sites to more efficiently exploit dwindling resources during times of climatic stress (Gardner 2006, 2009; Cowie 2014). Under this model, the expected outcome is specialized resource procurement sites with

assemblages reflective of their specialized function. Generally, this entails less assemblage diversity than what is seen in village, or base camp⁶, sites. However, the MCA-dated sites at Edwards Air Force Base were found to have assemblages comparable in variety to the pre-MCA Gypsum Period sites. This suggests a continuation of base camp settlement patterns into the Saratoga Springs Period during the MCA, though there is evidence that the way the land was exploited was indeed altered during this period.

By examining the aerial extent and site densities of pre-MCA, MCA, and post-MCA sites at Edwards Air Force Base it appears that the pre-MCA Gypsum Period within the Antelope Valley was marked by larger sites with either sustained or repeated occupational episodes. The MCA Saratoga Springs Period saw sites with much smaller footprints and dense artifact deposits, suggesting population aggregation over shorter spans of time and possible adherence to a tethered nomadism model (Binford 1980).

It must be noted, however, that variables such as site area and number of artifacts deposited within a site are directly related to the amount of time contained within each cultural period. The Gypsum Period has been defined as occurring between 4,000-1,500 BP, the Saratoga Springs Period occurred between 1,500-800 BP, and the Post-Saratoga Springs Period between 800-300 BP. These unequal chronological divisions result in 2,500-year, 700-year, and 500-year periods, respectively. In light of this, the fact that Gypsum Period sites are largest among the three chronological periods must be tempered by the fact

that sites dating to this period had longer potential occupational periods which may have contributed to expanded site areas. However, when site densities are examined (see Table 8 and Figure 6), the pre-MCA Gypsum Period sites are shown to display the lowest site densities among the sample study. Given that these sites experienced potentially longer episodes of occupation than sites during the Saratoga Springs Period or Post-Saratoga Springs Period, the expected result is that they would possess a greater density of artifacts. This is not the case. The average number of artifacts per acre across the Gypsum Period study sites was 23.31, while the average number of artifacts per acre for the Saratoga Springs Period study sites was 797.48. This significant increase in artifacts during the MCA-dated Saratoga Springs Period was experienced in conjunction with a significant decline in the amount of time during which sites were occupied. The average span of time over which Gypsum Period sites were inhabited was 2,012 years, while Saratoga Springs Period sites had an average occupation period of 251 years. This figure does not take into consideration “single” occupation sites within the Saratoga Springs Period which present themselves as encampments with singularly agreeing chronological indicators. Therefore, the average number of years which sites were occupied during the MCA may in reality be lower than 251. However, it remains clear that a significant decline was experienced in the amount of time that sites were occupied, or reoccupied, and yet MCA-dated Saratoga Springs Period sites are found to have much greater artifact density than pre-MCA dated Gypsum Period sites.

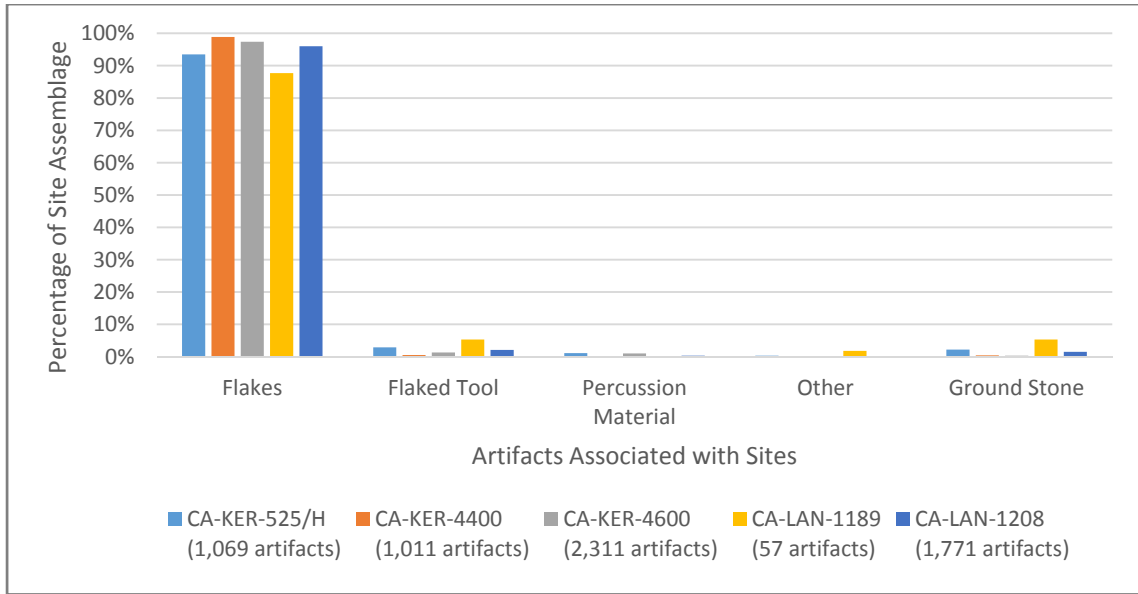


Figure 7. Pre-MCA Study Site Artifact Percentages.

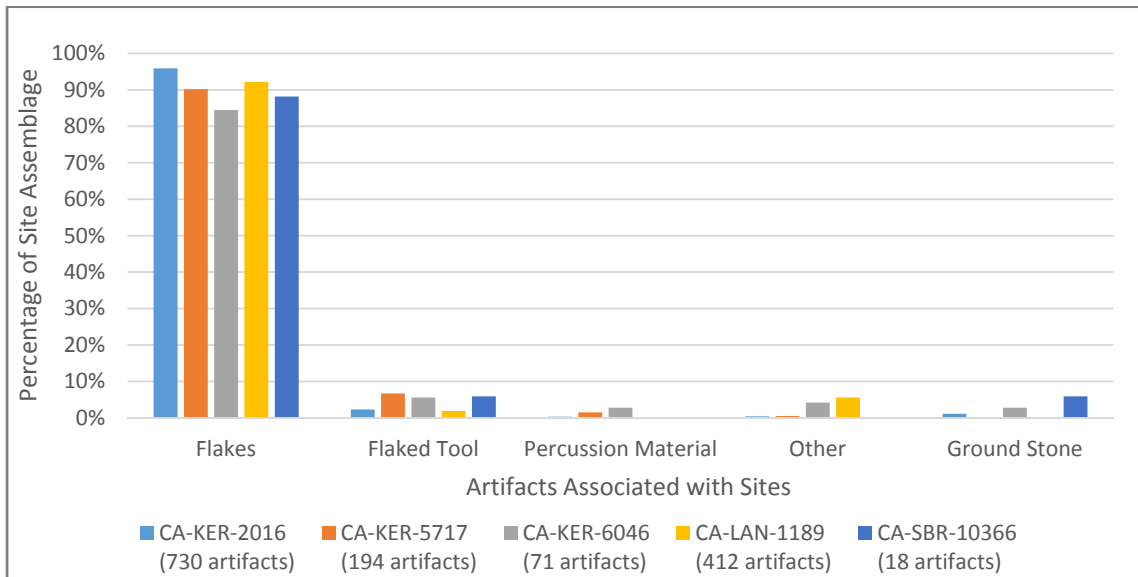


Figure 8. MCA Study Site Artifact Percentages.

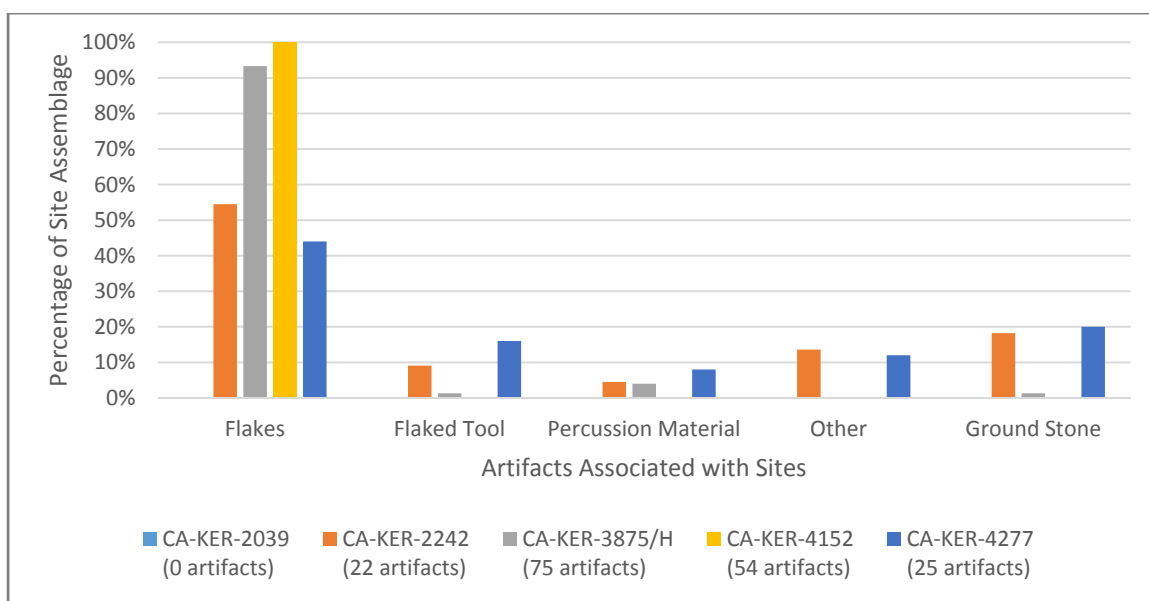


Figure 9. Post-MCA Study Site Artifact Percentages.

The picture is somewhat less clear for the post-MCA sites of the Post-Saratoga Springs Period. Sites which date to this period do not adhere to trends as coherently as sites belonging to the preceding cultural periods (see Table 6, Table 7, Table 8, and Figure 9). However, this does not preclude analysis of issues such as settlement and subsistence; the movement away from earlier trends provides data points for inquiry.

Given the data acquired from the Edwards Air Force Base study sites, the Antelope Valley region of the Mojave Desert appears to have been subjected to forces of population aggregation during the Medieval Climatic Anomaly. Gardner's (2009) previous Mojave research showed signs of population aggregation in areas of the Western Mojave Desert which surround the Antelope

Valley. The current findings suggest that similar patterns of settlement and subsistence activities occurred within the Antelope Valley region of the Western Mojave Desert. In regards to Sutton's model for site settlement and subsistence patterns in the Western Mojave Desert, it appears that this model can be applied depending upon interpretation of Sutton's model. Sutton (1990, 1991a, 1991b) proposed that populations engaged in village abandonment in favor of temporary site occupations by smaller numbers of people during the MCA. The archaeological record suggests that populations did aggregate into smaller areas which they occupied for shorter durations than was experienced previously. However, Sutton (1991a, 1991b) suggested that populations may have occupied temporary camps in the region for seasonal resource procurement. If this is interpreted as specialized resource procurement, there is no evidence of that within the study sample. The Saratoga Springs Period sites analyzed which date to the MCA were shown to possess general artifact assemblages which mirrored those of the pre-MCA dated Gypsum Period and are indicative of more stable, prolonged, occupations (see Figure 7 and Figure 8). This includes artifacts indicative of a variety of activities such as tool production, including ground stone production; hunting; and food preparation.

The current findings at Edwards Air Force Base support Gardner's (2006, 2009) proposed model for population aggregation during the MCA. These study sites suggest a pattern of movement into consolidated areas, likely driven by access to limited resources during times of climatic stress. The assemblages

associated with MCA sites of the Saratoga Springs Period suggest base camp occupations with all the hallmarks of sustained occupation; they contain artifacts indicative of every stage of tool manufacture and maintenance, they have developed middens, and both genders are represented through materials typically interpreted as “male” or “female” associated artifacts (e.g., projectile points and ground stone).

Binford’s (1980) notion of tethered nomadism may apply to the Antelope Valley during the MCA. He posited that people faced with limited critical resources would tether themselves to resource patches during times of environmental stress. The hydrologic nature of the lands in which Edwards Air Force Base is located may have made a patch choice model that utilized a tethered nomadic settlement and subsistence strategy ideal. Recent conditions notwithstanding, Edwards Air Force Base has had a relatively high water table with a small number of springs and areas of marshlands identified. If water remained available at these sources during the MCA, then the aggregation of people around these limited resources during a time of wide-scale climatic stress is logical.

Hale *et al.* (2010) questioned whether the droughts associated with the MCA would affect the Mojave Desert. No known microscale paleoclimatic studies have been conducted for the Antelope Valley region which have isolated the affect, if any, of the MCA on the region; however, known impacts have been identified throughout the Mojave Desert and surrounding regions (see Jones *et*

al. 1999; MacDonald and Case 2005; Li *et al.* 2000). In the absence of paleoclimatic data, it is difficult to determine the true impacts of the MCA on the Antelope Valley. However, based upon proxy archaeological data gleaned from Edwards Air Force Base, it appears as though the MCA did affect the region. Sustained occupation is evidenced throughout the MCA, with sites shown to have experienced a more intense level of occupation than what was experienced previously (when measured in terms of aerial extent and site density). This suggests a tethering to the land likely related to available resources. Climatic conditions may be a cause for this behavior. If however, as Hale *et al.* (2010) suggest, the MCA did not adversely affect the Mojave Desert, this does not preclude an effect on the region. As demonstrated above, the Antelope Valley saw a shift in settlement patterns during the MCA. Evidence for the practice of consolidation around available resources during times of climatic stress should not be limited exclusively to areas that experienced climate change; rather, ancillary regions should also be examined for subsequent effects. MCA-related impacts to surrounding regions may have created a situation in which resource patches within the Antelope Valley were viewed more favorably, and therefore more intensively occupied.

Sites dated to the post-MCA Post-Saratoga Springs Period provide further evidence that the MCA impacted the Antelope Valley region of the Mojave Desert. As mentioned previously, the picture created by post-MCA site data appears somewhat murky, however, it does show a movement away from trends

observed in MCA dated Saratoga Springs sites. One of the Post-Saratoga Springs sites (CA-KER-4277) displays a material assemblage similar in variety to what was seen during the Gypsum and Saratoga Springs Periods (see Table 5, Table 6, and Figure 9), indicating a base camp site type. However, the remaining post-MCA study sites vary significantly in artifact distribution than earlier sites and are more indicative of special use or resource procurement activities. This suggests that a post-MCA change was experienced in settlement and subsistence patterns in the Antelope Valley. It is possible that upon the amelioration of the environment during the Little Ice Age (see Fagan 2000; Barron *et al.* 2015; and Heusser *et al.* 2015a, 2015b) people who once viewed the Antelope Valley as desirable during the MCA no longer saw it as such when presented with additional resources elsewhere. Although the archaeological evidence supports this occurrence, it is important to note that it should not be viewed as evidence in isolation. Other factors such technological innovations and culture contact cannot be excluded when addressing questions related to human activity on a regional scale.

Future Research and Recommendations

While this study has appreciably added to the previous research related to the MCA and its effects on human populations within the Antelope Valley region of the Mojave Desert, there remains much room for additional research. In regards to the Edwards Air Force Base study area specifically, additional work

should be conducted to better address issues of subsistence. Time constraints did not allow for the inclusion of faunal remains in this current research; the assemblages were inconsistent in their field recordation, collection, and laboratory analyses. In order to produce a meaningful comparison of faunal remains across the study sites, new analyses is necessary for nearly all of the site's collections.

Another area for additional analysis is with tools and beads. For the purposes of this study, gross analyses was conducted to classify artifacts into general class. However, special analyses of tools could provide additional insights into site use and resource exploitation. Analysis of shell beads could also provide information regarding trade and potentially provide additional insight into climatic events; the increase in *Olivella* beads seen in Saratoga Springs period sites may be reflective of Chumash resource procurement strategies during times of climatic stress (see Arnold 1992; Jones *et al.* 1999; Jones and Schwitalla 2007; and Jazwa *et al.* 2012).

An examination of lands beyond the installation boundaries of Edwards Air Force Base should also be conducted. This installation was chosen because it provides a large land area in which to study sites belonging to the Antelope Valley. This was important because the Antelope Valley had been the focus of extremely little previous research related to the MCA. However, this region should not be viewed in isolation. A cross-comparison of Edwards Air Force Base sites against other sites elsewhere in the Antelope Valley, as well as Antelope

Valley sites against sites in other regions, could provide interesting insights into larger regional MCA-related trends.

Additionally, paleohydrological studies have the potential to provide interesting data points for the region. An analysis of known archaeological sites in relation to paleohydrologic data could provide insights into regional resource exploitation during times of climatic stress. The lands of Edwards Air Force Base appear to have drawn people for their water. Though this resource has likely been limited in the Antelope Valley for much of the time people occupied the area, a better understanding of hydrologic conditions could help shed light on this issue.

¹ This is not to be confused with Robert Bettinger's use of "Darwinism" in reference to Neo-Darwinian theory and hunter-gatherers, as defined in *Hunter-Gatherers: Archaeological and Evolutionary Theory* (1991b). In Chapter 7, wherein he describes evolutionary human ecology, Bettinger defines Darwinism as "theories that explain macrolevel phenomena as the cumulative consequence of explicitly defined processes (e.g., selection and others) acting on a microlevel, specifically on reproductive individuals." The use of the term in this paper is associated directly with the theory of evolution through natural selection advanced by Charles Darwin.

² Joseph varies her terms for HBE, first referring to Anthropological Evolutionary Ecology (AEE; Joseph 2000), then to Anthropological Evolutionary Behavioral Ecology (AEBE; Joseph 2002). Both terms equate to HBE and for the purposes of this thesis, HBE is used.

³ Neofunctionalism is described by Benjamin Orlove as an intermediary stage of ecological anthropology, with the three stages consisting of: works of Julian Steward and Leslie White, "neofunctionalism" and "neoevolutionism", and "processual ecological anthropology" (Orlove 1980).

⁴ Sutton *et al.* (2007) proposed the use of "complex" (e.g., Gypsum) in the place of "period" to denote specific archaeological manifestations within the broader "period" (e.g., Holocene). Gardner (2009) has adopted this nomenclature in her research. However, to remain consistent with the majority of literature upon which this thesis references, the term "period" is used here to refer to time frames such as Gypsum, Saratoga Springs, and Post-Saratoga Springs.

⁵ Sutton *et al.* (2007) and Gardner (2006, 2009) use "Rose Spring" Period or Complex (see note above for use of "period" versus "complex") to refer to the time period that immediately follows the Gypsum Period. The Saratoga Springs Period has been used by the majority of researchers who have conducted studies at Edwards Air Force Base, and roughly equates temporally to Sutton and Gardner's Rose Springs Complex. For these reasons, the Saratoga Springs Period has been used in this study.

⁶ 'Base camp' is the more common descriptor used at Edwards Air Force Base for sustained occupation sites due to the lack of complexity associated with the installation's sites which preclude 'village' determinations.

APPENDIX A
RECOVERED TOOLS

A-1. Flaked Stone Material from Edwards Air Force Base Gypsum Period Sites.

Recovered Artifacts	CA-KER-525/H	CA-KER-4400	CA-KER-4600	CA-LAN-1189	CA-LAN-1208
Debitage	1000	1000	2250	50	1700
Core	5	2	9	0	5
Hammerstone	7	0	15	0	1
Core Tool	0	0	0	0	0
Biface	16	2	14	1	12
Uniface	0	0	3	0	0
Flake Tool	9	0	5	0	22
Projectile Point	2	3	5	2	3
Preform	0	0	2	0	0
Chopper	4	0	0	0	0
Total	1043	1007	2303	53	1743

A-2. Flaked Stone Material from Edwards Air Force Base Saratoga Springs Period Sites.

Recovered Artifacts	CA-KER-2016	CA-KER-5717	CA-KER-6046	CA-LAN-1189	CA-SBR-10366
Debitage	700	175	60	380	15
Core	2	1	1	0	0
Hammerstone	0	0	1	0	0
Core Tool	1	2	0	0	0
Biface	3	5	4	6	1
Uniface	0	0	0	0	0
Flake Tool	8	0	0	2	0
Projectile Point	4	5	0	0	0
Preform	1	1	0	0	0
Chopper	0	0	0	0	0
Total	719	189	66	388	16

A-3. Flaked Stone Material from Edwards Air Force Base Post-Saratoga Springs Period Sites.

Recovered Artifacts	CA-KER-2039	CA-KER-2242	CA-KER-3875/H	CA-KER-4152	CA-KER-4277
Debitage	0	12	70	54	11
Core	0	0	2	0	2
Hammerstone	0	1	1	0	0
Core Tool	0	0	0	0	1
Biface	0	2	0	0	0
Uniface	0	0	0	0	0
Flake Tool	0	0	0	0	3
Projectile Point	0	0	1	0	0
Preform	0	0	0	0	0
Chopper	0	0	0	0	0
Total	0	15	74	54	17

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