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# Decisions Set in Stone: Spatial Analyses of Ozark Rock Art Sites, Elements, and Motifs with GIS

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Decisions Set in Stone:
Spatial Analyses of Ozark Rock Art Sites, Elements, and Motifs with GIS

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## ABSTRACT

This thesis uses Geographic Information Systems (GIS) to spatially analyze rock art distributions in the Salem Plateau section of the Arkansas Ozarks. Statistical tests, such as chi-square and t-testing, are applied to provide an objective view of rock art patterning in relation to the overall landscape. The data collected from these methods allow one to discern the locational preferences for rock art, which potentially reveal cultural details about the people involved with its creation. Multiple analytical perspectives are applied throughout, initially focusing on comparisons with expected values and random points. Later statistical tests use bluff shelter distributions as reference data for understanding rock art location selection. The final analysis compares motif distributions with each other to see whether certain designs tend to appear in different contexts than others. Results suggest that bluff shelter distributions serve as better comparative data, as they reveal which environmental variables are unique to rock art. These primarily include southern-facing aspects, ease of accessibility from mounds, proximal distance from streams, orientation toward winter solstice phenomena, and occasionally strong viewsheds. An analysis of motifs indicates a duality between geomorphic shapes, both basic and celestial, and more "earthly" designs, such as terrestrial animals. Another observation suggests that certain anthropomorphic rock art were reserved for accessibility, while others were placed in relatively secluded locations. The results presented in this thesis potentially shed light on rock art locational preferences, as well as the meanings or activities behind their designs.

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# CHAPTER 1: INTRODUCTION

Throughout the Mississippian Period (approx. 900 – 1600$_{CE}$), the native inhabitants of the Ozarks maintained a complex understanding of the world around them. These perceptions manifest themselves in the archaeological record through iconographic depictions of otherworldly figures, cosmic shapes, and naturalistic designs. One medium through which they expressed these views was rock art, which are still visible on stone formations today. Both pictographs (painted images) and petroglyphs (pecked or incised images) appear throughout the Ozarks in several different forms and appearing in a variety of environmental contexts. It is therefore possible to study these images by looking at their distributions across the landscape. This potentially reveals patterns on a macro-level and indicates what decisions or preferences were considered when selecting locations to create rock art. This thesis uses GIS (Geographic Information Systems) to understand these locational preferences by quantitatively assessing Ozark rock art sites and elements in light of their environments.

As with any site distribution, archaeologists are left to ask why features appear in certain places as opposed to others. Rock art adds another layer of complexity to this line of thought as multiple images possibly imply different reasons or preferences in the context of the landscape. This thesis aims to address this topic through a macro-level approach that quantitatively analyzes rock art distributions in the Salem Plateau subarea of the Arkansas Ozarks (Figure 1.1). This type of study is possible through GIS which allow for efficient calculations in spatial research. As such, there are two main questions that guide this thesis:

1. What were the environmental preferences for rock art location selection among the Pre-Columbian Native Americans who lived in the Ozarks?

2. What geographical landscape perspectives can we apply to the study of rock art, namely those in the Southeastern United States?

The first question is concerned with understanding why a particular location might be appealing to a Mississippian person residing in the study area. These reasons typically vary from pragmatic to spiritual. The second question is concerned with methodology. Multiple techniques exist for spatial analysis, so it is important to use the correct perspective so that results lead to accurate suggestions. In the case of rock art, one might opt for a comparison with random samples, existing site locations, or even focus on the motifs of the art themselves. By improving the spatial analytic techniques and quantitative approaches, we can come to a better understanding of people's decision-making processes.

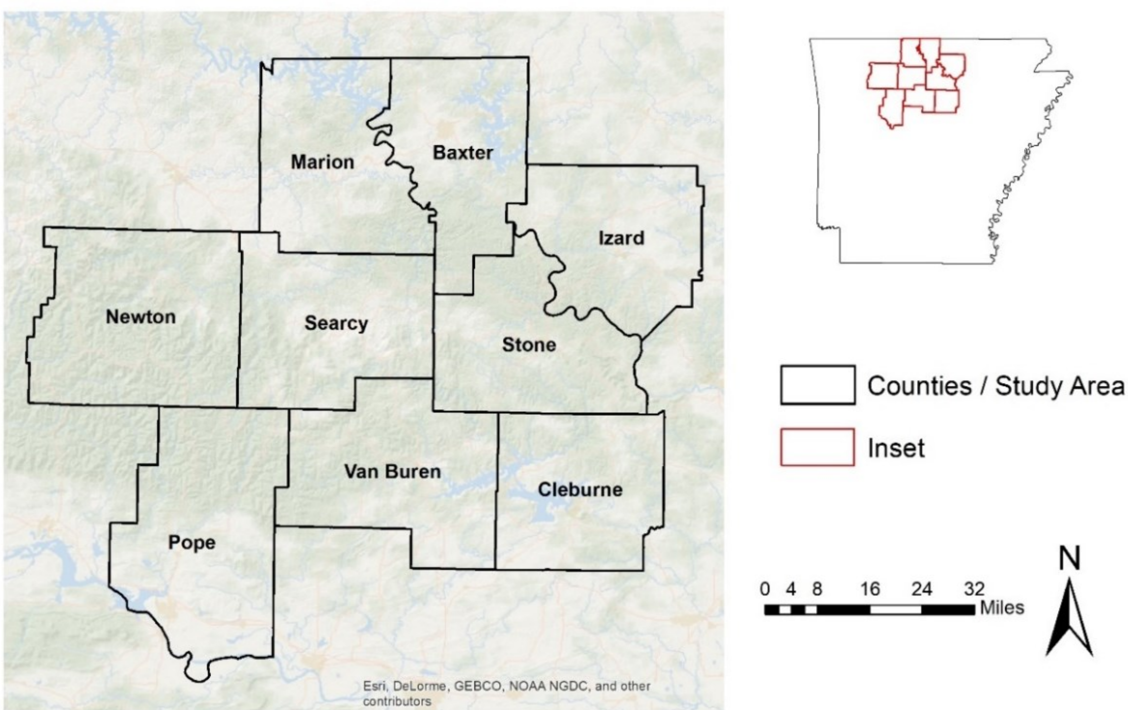



***Figure 1.1:*** *The study area in the Arkansas Ozarks. (Portions of this figure include intellectual property of Esri and its licensors and are used herein under license. Copyright © 2018 Esri and its licensors. All rights reserved.)*

The data used in this thesis is the result of past research carried out by the Arkansas Archeological Survey (ARAS). Sabo and Hilliard (2005) discuss much of the history behind rock art studies in Arkansas. Attempts were made to understand these images throughout the late 1800s and early 1900s, though most of the useful archival information comes from the mid to late 1900s. Two prominent figures in ARAS rock art research history are Gayle Fritz and Robert Ray, who began revisiting sites in 1978 to provide documentation of what existed in them. Based on their findings, they identified regional stylistic patterns and grouped the rock art into subareas (Fritz and Ray 1982). These suggestions provided ground for the ARAS to begin the Arkansas Rock Art Project in 2000, which recorded site dimensions, orientations, GPS coordinates, and took Mylar sketches of the elements. This ultimately led to a publication in their popular research series (see Sabo and Sabo 2005a). With a database of rock art spatial distributions, ARAS personnel could now analyze these locations from a landscape perspective. Sabo et al. (2012) looked at rock art distributions generally across the entirety of the Arkansas Ozarks, using predictive modeling techniques to identify distributional patterns across the landscape. Later, a study was performed on the rock art at Petit Jean and Crow Mountains, which revealed organized placement of rock art motifs in relation to the Arkansas River. These findings later led to a publication in the Cambridge Archaeological Journal (see Sabo et al. 2015). This study is essentially a continuation of these efforts to understand Arkansas Ozark rock art spatial distributions, especially as they relate to the landscape as a whole.

Before addressing the hard data and numbers, it is first important to discuss the methods and theory used in this thesis. The rest of this chapter explains the theoretical and methodological underpinnings behind spatial analysis as it applies to rock art. It does so by reviewing pertinent archaeological literature where spatial analysis was applied as a means to understand past thoughts and behaviors. Special emphasis is placed on research covering themes of rock art and prehistoric beliefs. The main purpose of this chapter is to lay out the theoretical framework for Ozark rock art studies with GIS, while simultaneously justifying the methodology. It begins with a general discussion of spatial analysis and its usefulness in understanding decision-making in the landscape. Next, a discussion is provided that covers the utility of GIS and landscape perspectives to rock art studies, as well as how environmental context plays an important role. The final section focuses on the Ozarks and explains the practicality of these techniques to this geographic region. By spatially analyzing rock art in the context of the environment and landscape, one can expect to gather valuable information regarding the beliefs and perceptions of the people who originally created them.

## SPATIAL PATTERNS AS INDICATORS OF THOUGHT

GIS notably offer powerful tools which allow scholars to understand patterns existing in the archaeological record. With ever expanding developments in these types of techniques, archaeologists are now better equipped than ever to decipher spatial distributions as they relate to human decision frameworks. Contextual approaches that examine cultural phenomena from a landscape or environmental perspective can often assist with this endeavor. Recently, spatial analytic perspectives have been applied to rock art studies in an attempt to better understand the choices that went into producing them.

Some scholars have debated the methodology of GIS as it applies to archaeology, noting that they lack an established theory. Aldenderfer (1996:17) argues that "there is no necessary isomorphism between a particular data type or category and the use of GIS to solve or explore the problem." The assumption is basically that, while GIS can discover patterns, they alone cannot explain human behavior. Spatial analyses of cultural phenomena, such as site distributions, merely capture the results of peoples' actions, without truly understanding their perceptions. This viewpoint, however, does not necessarily capture the role of GIS in these types of studies. Wheatley (1993) claims that it is problematic to view spatial technologies as simply neutral tools. Instead, they are a part of the scientific model that help us to answer questions about the past. Rather than focusing strictly on extant distributions, spatial techniques have the potential to highlight the decision-making processes and preferences of the people who previously inhabited a region.

The results are especially significant when they can be embedded within a cultural framework. Predictive modeling, for example, is useful for "projecting known patterns or relationships into unknown times or places" (Warren and Asch 2000:6). Through analysis of the spatial distributions of past cultures, it is possible to discern what their preferences were in the context of the landscape, be it for settlements, burials, or rock art. This is done by highlighting the environmental settings where large quantities of sites tend to appear. From this available data, one can indirectly test hypotheses about the decisions and perceptions held by people in the past. These inferences, however, should not neglect the cultural behaviors of the group under study. To fully grasp site patterns, one must be knowledgeable about a group's beliefs, desires, and needs, though this objective is usually difficult to attain in archaeology.

A study by Brandt et al. (1992) used site-location modeling in the Regge Valley region of the Netherlands to understand site distributions ranging from the Late Paleolithic to the Middle Ages. According to their theoretical discussion, "It is a fundamental premise of modern archaeology that human behavior is patterned; therefore, locational behavior – that is, where sites or settlements are placed across the landscape – should exhibit non-random tendencies" (Brandt et al. 1992:269). What this implies is that people generally exhibit preferences for certain environmental criteria or features in their respective landscapes. In many cases, this is reflected in the placement of their culturally constructed houses, roads, markets, or religious centers. If archaeologists are able to identify these spatial patterns, then they can infer what environmental criteria were important for a group of people, whether for utilitarian or non-utilitarian purposes.

Brandt et al. (1992) elected to analyze site distributions alongside several environmental variables. Some of these included soil texture, geomorphology, distance to water, and unit surface area. By comparing the site locations with a series of random background points, they were able to identify possible locational preferences for close proximities to water and ecological borders, while also discovering a preference for high cover sand deposits. Testing observed site locations against a random sample offers powerful quantitative implications. If site distributions differ significantly from a random sample, then one can infer that the people who originally formed the sites were not simply selecting their locations randomly (Kvamme 1990). These variations become visible when t-testing is applied, which effectively tell whether a distribution differs from another. If the resulting p-value is low, then the observed sites likely do not follow a random pattern. Quantitative techniques such as this establish a certain logic behind environmental preference; people are carefully evaluating the landscape and making informed decisions regarding site selection. Unfortunately, GIS are heavily reliant on existing environmental criteria selected by the analyst. Some considerations do not manifest in the material world and are instead contained within the mind. A group may opt to avoid certain areas due to non-physical, religiously motivated reasons. In these instances, it is important to combine quantitative results with our knowledge of cultural viewpoints.

Of course, other quantitative methods are applicable to archaeological spatial analysis. One may also elect to use chi-square testing to compare an observed distribution with an expected distribution. By classifying environmental criteria into multiple hierarchical categories, archaeologists can determine what proportion of sites ought to exist in each category if the distribution is even across the landscape (Baxter 2003). If a large quantity exists in areas where one would only expect to find a few, then it is possible that those who selected the locations had a preference for that environmental criteria. This can vary from high elevation, to low water runoff, to soil type. Similar to the t-tests, the results of a chi-square test produce p-values that indicate the significance of a distribution, or how much it varies from expectation.

Spatial analytic perspectives, with the help of GIS, offer powerful inferences behind human thought. Notable patterns in the landscape are revealing of the desires certain cultures maintained with site placement. This is possible because of environmental context. The environment has a strong influence on culture as both a physical and cultural construct. Physically, it provides specific resources that can either promote or constrain a group's activities. Access to water, for example, often influences where a community decides to form settlements. Culturally, it shapes and is shaped by a group's views. Groups engaged in animistic forms of religion hold certain natural objects to be sacred, undoubtedly influencing how they perceive the environment. Examining archaeological features with close attention to their natural surroundings is thus an important consideration for those engaged in GIS and spatial analysis. With this in mind, careful application of these methods is useful for answering questions about the past, namely the "interrelationship between culture and environment" (Butzer 1982). Contextual approaches that examine site distributions alongside environmental criteria can ultimately help archaeologists to decipher the perceptions held by those who lived in the landscape many years ago.

## ROCK ART AND THE POWER OF CONTEXT

The section discussed above shows how spatial analyses with GIS are useful for inferring past decision making. Yet, Brandt et al. (1992) were primarily concerned with settlement strategies. One might reasonably argue that the conclusions formed from these studies focus primarily on utilitarian preferences. The people possibly selected sites for practical reasons, not for deep metaphysical reasons. While this viewpoint is debatable, there are perhaps other archaeological site types that reveal complex human perception. This is where rock art comes in. Rock art is a particularly special piece of cultural data that tells us much about a person or group's thoughts or beliefs. Perhaps most importantly, it provides in-situ evidence of ritual activity that links ideology and place (Diaz-Granados et al. 2018). In his discussion of Hohokam rock art, Wright (2015:203) posits their importance as "sacral symbols infused with mythic ambience, religious meaning, and spiritual potency." Simply put, rock art carries with it a meaning that persists through time. This allows archaeologists to assess the iconography and infer their meaning. The suggestions developed typically come from ethnohistoric evidence that often pull from the subjects of artistic chronology or indigenous belief systems.

Another key factor is that rock art is a fixed entity in its respective environment; it does not move. Unlike other forms of material culture, it will not simply fall out of one's pocket and embed itself in a place where it is not intended to be. Rock art exists in the same spot where it was originally developed. This immovability not only contributes to its survival, but also provides a direct record of the places where these elements were originally produced and consumed (Chippindale and Nash 2004). Given this element of locational permanence, it is possible to form suggestions about their meaning by examining them in the context of their environment. If, for example, rock art sites consistently appear on high mountain ridges, then one can begin to assess why this pattern exists. A macro-level landscape perspective is therefore appropriate for rock art studies, as their proximity to certain environmental features, their placement at specific elevations, or their cardinal orientations might hint as to why some locations are preferable to others. Equally important are their relationships with cultural features, such as proximity to ceremonial centers, hunting grounds, or territorial boundaries. Thus, spatial analyses of rock art, with regard to environmental context, offer valuable information about the ideas and symbolisms they potentially convey. "For it is this form of ancient human activity that is most directly linked to early perceptions of landscape – the very location and organizational structure of rock art speaks of human relationships to places and spaces" (Taçon 1999:34).

Given these premises, that rock art carries symbolic meaning and that it is fixed in its landscape, archaeologists are able to apply multiple methods to study them. Chippindale and Nash (2004:1-36) discuss two different perspectives that relate to these features of rock art: informed and formal. Informed perspectives draw from ethnography and insights gained from groups involved with making the rock art. These methods focus on "insider stories" to interpret the images in light of the worldviews of the respective culture. In anthropological terms, this grants an *emic* perspective. While it is noteworthy that a specific motif occurs frequently in a study area, it is vital that archaeologists ask why it appears often and what it stands for. Chippendale and Nash (2004:19), for example, were able to interpret rock art motifs in the Northern Australian landscape based on Aboriginal creation narratives. The informed perspective offers strong insight on the possible meanings behind certain symbols, as well as their significance within the culture. However, it is also limited to the presence of ethnohistoric data. Another potential drawback here involves time. One should be wary of projecting the beliefs of contemporary groups onto their ancestors, for culture often changes as time progresses. In cases where no documents, people, or knowledge of the past culture exist to explain meaning, archaeologists must try other techniques.

This is where formal perspectives contribute. They tend to be more empirical in nature, relying on quantitative or locational data in order to interpret archaeological phenomena. A formal method does not rely on insider knowledge, but instead looks at "features that can be observed in the rock art itself, or in its physical and landscape context" (Chippendale and Nash 2004:20). Examples of this include spatial analysis and quantitative anthropology. Formal methods therefore permit an *etic* perspective, or an outsider's viewpoint. Much like the GIS techniques discussed earlier, one can examine patterns of rock art placement across the landscape and identify areas where they consistently appear. If rock art elements constantly show up on sandstone rock faces when other types of surfaces are available, then one might infer a preference for this type of geology. Yet, a lack of ethnohistoric data presents a challenge as one is left to question why a preference exists at all. Did the people have some cultural connection with sandstone, or was it simply an easier substance to place rock art on? The lines between utilitarian and non-utilitarian placement become blurred in these circumstances, and the archaeologist is left to make suggestions. Thus, optimal rock art studies combine these two methods to provide powerful contextual inferences about it.

Recent applications of GIS to rock art distributions tend to apply these perspectives. A study by Fairén-Jiménez (2007) identified trends and recurrences in the location of British Neolithic rock art sites in relation to distinctive landscape features of Northumberland, England.

This was done primarily through the techniques outlined above. By forming systematic and objective descriptions of the landscape in which rock art sites exist, while also exploring the associations of rock art sites with other components of the landscape, one can expect to isolate the potential reasons for past placement or utilization of rock art. Such descriptions are especially useful when one considers "the significance of certain places, topographic features, or natural resources in rituals associated with the production of rock art" (Fairén-Jiménez 2007:283).

Fairén-Jiménez took several variables into account, namely elevation, slope, distances to rivers and ridgelines, aspect, and topographic prominence. The results showed that rock art sites tended to appear in areas elevated above their surroundings and at specific distances from rivers and ridgelines (Fairén-Jiménez 2007:290). Through application of chi-square testing, she was able to confirm these patterns based on statistics. While these data alone are valuable for the purposes of spatial analysis, they also allow for explanations as to why they occur in these areas at all. GIS modeling of these patterns effectively demonstrates the cognitive processes involved in their placement. The reasons behind these patterns can vary between social, political, or psychological (Maschner 1996). Human minds are complex and our decisions do not always manifest clearly in the archaeological record. With that being said, the context in which we find these features is potentially telling of these thought processes.

Context therefore allows for interpretation. Spatial relationships between rock art locations and environmental variables raise multiple explanations. In some cases, quantifiable measures infer pragmatic decision-making; people make choices based on economic or functional purposes. These reasons, however, are not always strictly utilitarian. Investigations of other factors, such as viewsheds or aesthetic qualities, possibly reveal other interpretations for a site's purpose or value. Llobera (2001) discusses perception and its involvement with landscape studies, as well as the limitations behind it. While it is true that cognitive concepts such as monumentality, movement, and perception are important in human-environmental interaction, it is also notoriously difficult for archaeologists to formulate interpretations from them. Still, it is worthwhile for archaeologists to try to understand these concepts. Returning to Fairén-Jiménez (2007:291-292), based on the topographic position of rock art sites in relation to the surrounding terrain, she noticed that sites were located as to maximize visibility of natural routes in the landscape. This is an instance where spatial techniques helped to understand the perceptions held by those in the past regarding the landscape. So while perception certainly sits on the more difficult side of archaeological analysis, it is not impossible to ascertain it.

A more recent study by Nimura (2015) used a similar approach for Nordic Bronze Age rock art. Her analysis, however, considered the designs and their relationship with the environment. Of note are the frequent ship motifs that dot the Scandinavian landscape. Nimura notes that these ship designs tend to appear in areas that lie in close proximity to bodies of water. With an observable connection between the rock art and an environmental feature, one can begin to interpret the meaning. Some of these interpretations range from practicality to cosmology (Nimura 2015:25-36). Ethnographic evidence, for example, reveals the importance of watercraft in everyday activities such as trade and fishing. These suggestions lead to multiple explanations regarding the purpose of the rock art sites. Perhaps they served as meeting grounds for local seafarers, or maybe they mark trade routes. What is important is that archaeologists are capable of deducing the meaning of these symbols, as well as what they might have been used for. Answers developed from ethnography and ethnohistory are quite advantageous when it comes to any type of art. They provide a means to "move beyond shamanic essentialism and Cartesian dualism” by “including ecological and environmental perceptions without the modernist trap of environmental determinism” (Robinson 2013:374).

Other suggestions for the meaning of boat motifs are less utilitarian. The cosmological interpretations reflect Scandinavian worldviews, connecting the rock art with Bronze Age religion and mythology. It is possible that the boats represent mortuary rituals, given both the environmental and archaeological contexts, as well as ethnographic accounts that connect ships with religion. Ship-shapes appear on artifacts often associated with burials, such as bronze razors and burial urns (Nimura 2015:32). This, combined with the fact that several rock art sites contain burials, makes a strong connection between the motifs and prehistoric belief. The association of rock art with belief is not limited to Scandinavia, but is in fact a common trend among prehistoric groups worldwide.

Evidently, the combination of informed and formal methods to rock art studies offers much potential for interpretation. The context in which rock art appears in the landscape provides strong evidence for suggestion regarding their meaning. If rock art is distributed in a specific pattern, with careful attention to these environmental factors, then archaeologists can possibly understand the behaviors or thoughts that lead up to their placement. A combination of quantitative methods with ethnographic considerations offers particularly useful data, which ultimately hints at why a pattern exists in the first place, how people interacted with ecological zones, or possibly even how certain motifs fit into a group’s cosmological views (Lewis-Williams 2002:15-51). When a cultural symbol is fixed in the landscape, a macro-level spatial analysis is therefore appropriate. Once data are collected and empirical patterns are firmly established, one can apply analogies or other informed methods to elaborate the interpretations (Knight 2013).

APPLICATIONS TO OZARK ROCK ART

Now that the utility of spatial analysis and landscape perspectives is understood, the applications to rock art in the Ozarks can now be explored. The previous section in this chapter discussed the notion that rock art is commonly related to the worldviews of those who originally created it. Sabo and Hilliard (2005) already have a comprehensive discussion on the history of Ozark rock art research, so this section focuses on how spatial techniques are particularly useful in this study area. Given the strong connections between Late Mississippian cosmologies and the natural world, contextual approaches hold much potential to discern the thoughts that went into rock art placement in the Ozarks. Spatial analyses that highlight relationships between locational preferences and natural features thus have potential to connect rock art with decision frameworks and perception. In fact, many southeastern archaeologists have already noticed the influences of nature on their beliefs, as well as how this manifests in their artwork.

Lankford (2007a) lays out these connections present in the Southeastern Ceremonial Complex (SECC), an ideological system that encompasses many prehistoric cultures in the Eastern Woodlands. One of the more notable aspects of Mississippian cosmology is the belief that the world is layered into three separate tiers: the Beneath World, the Middle World, and the Above World. The Beneath World "is composed primarily of water," the Middle World is "the earth-disk on which live humans, plants, and other creatures," and the Above World "is the world of air" (Lankford 2007a:15). This belief system had a strong influence on Mississippian iconography as many artifacts depict symbols that associate with the three worlds.

In many cases, these symbols relate to natural phenomena found in nature. Given the watery nature of the Beneath World, amphibian and reptilian imagery were often used as symbols associated with this realm. The importance of these creatures lie in their ability to move between water and land, therefore transcending the Beneath-Middle World boundary (Dowd 2011). Similarly, avian creatures such as the prolific birdman figure that occupied the sky were commonly attributed to the Above World (King 2007). When animal motifs are present in Mississippian art, Southeastern archaeologists are often capable of determining how that particular artifact fits into their culture. Still, motifs derived from the environment are not necessarily limited to animals. Caves, for example, possibly represented a boundary between worlds (Diaz-Grandados et al. 2015). One also cannot neglect the impact of astronomical phenomena, which had profound influence on prehistoric religious views. Osage Indians traced the movement of the sun and moon across the sky and incorporated them as potent symbols, both in their belief systems and art (Duncan 2011). As such, motifs portraying astral features, such as sunbursts, appear frequently in Southeastern rock art sites.

The point here is that much information exists regarding the cosmological views of Late Mississippian inhabitants of the Ozarks. Many of these beliefs relate directly with natural features present in the landscape. Therefore, a contextual approach through spatial analysis might hint at the possible considerations these people made regarding the placement of symbols. With an understanding of Mississippian beliefs, archaeologists are capable of interpreting their symbolic artwork. This promotes the informed perspective, as ethnographic data is used to relate rock art motifs with environmental criteria. Furthermore, assessing these motifs as a component of the overall landscape, through spatial analytic techniques, allows one to apply the formal perspective. The distribution of rock art sites might exhibit patterns that reveal connections between the environment and locational preference. GIS and statistical techniques thus offer an objective viewpoint of these patterns, which can be tested alongside the ethnohistoric interpretations. There are, of course, multiple ways through which archaeologists can grasp these patterns. The methodology applied to rock art studies potentially answers different questions regarding their overall distribution.

One such technique for this type of study is a general analysis of rock art sites present in the landscape. This would be similar to an earlier study performed by Sabo et al. (2012), who used a macro-level approach to understand the distribution of Ozark bluff shelters. The varied terrain of the Ozarks offers much potential to explore site associations with environmental variables and other site types. The study area sees frequent dips in elevation between mountains and valleys, meandering streams that spread throughout, and shifts in geology between locations. As such, a plethora of variables exist for this region that can be applied to a spatial analysis. Sabo et al., for example, examined several data types. Some of these include elevation, aspect, vegetation, soils, and watershed. Chi-square tests were then applied to "indicate potentially significant associations (positive or negative) between sites and specific properties of their locations" (Sabo et al. 2012:243). The tests revealed large quantities of rock art bluff shelters facing southern and western aspects at values higher than expected. These objective data fit well with the religious views of people who inhabited the area, as the western and southern sky are believed to be places where spirits gathered following death.

While an analysis of rock art site distributions offers powerful inferences regarding the decisions behind their placement, it is not the only measure through which these preferences can be assessed. One is left to wonder whether or not a site containing only one or two elements represents locational preference as effectively as a site containing twenty. In other words, if the people who made the rock art truly desired a location based on preferred environmental criteria, then they might have created more elements at that particular spot. If this is in fact the case, then an analysis of element placement might be superior to site placement. The methodology for this type of pattern would be similar, however sites would be weighted by the quantity of elements present within them. Altering the numerical values for individual rock art sites possibly offers a different perspective on this subject, one that helps to identify "the way people categorized their landscape" or how people "were able to perceive and choose areas" that corresponded to their desires (Popa and Knitter 2016).

Still, one might question whether these analytic techniques discern the preferences for rock art location selection, or simply general settlement location selection. To determine whether environmental preferences are unique to rock art sites, their distributions can be compared to that of bluff shelters in the Ozarks which do not contain rock art. This evaluation works because much of the rock art in the study area is contained within bluff shelters. In fact, of the 29 known rock art sites used in this study, 27 exist inside these geologic features. Just as it is vital to examine where rock art *does* appear, it is just as important to analyze where it *does not* appear (Hilliard et al. 2005). Bluff shelters therefore serve as a good control group for discerning rock art locational preferences and spatial patterns. They represent an environmental feature frequently utilized for rock art creation, but are also useful for other purposes (shelter, burials, etc.). Hence, there might be environmental conditions specific to rock art that are not reflected in bluff shelter site distributions.

Earlier in this chapter, it was explained that rock art holds significant symbolic meaning and is often associated with religious activity. Southeastern rock art is no exception, often exhibiting spatial patterns that reflect attempts to organize relationships between "the phenomenal realm of human existence and an unseen spiritual realm" (Sabo 2008:279). This makes rock art a unique type of archaeological site which possibly exhibits a different distribution than bluff shelters. The potential variation between sacred and mundane places has been explored in other studies. Müller (1988), for example, compared the distribution of cairns with that of houses in West Shetland and found a distinction in locational preference. Cairns tend to exist in areas less suitable for agriculture and also at higher elevations than houses. This possibly indicates a purposeful separation of these two features. Observations such as this are also applicable to rock art sites in the Ozarks. Sabo et al. (2012:243) have already indicated that there are some variations. Bluff shelters containing rock art tend to appear in areas farther away from water, whereas bluff shelters without rock art are generally closer. By noting the objective differences between these two types of distributions, one can determine the whether the desires for rock art location varied from practical settlement choices. If variations exist, as they seem to already, then this reveals a different perspective on the perceptions associated with the rock art as they pertain to the landscape.

Finally, there is the issue of the motifs themselves. The Ozarks are home to various rock art designs, representing different ideas. Sabo (2008:284) outlines three broad motif categories: geometric, abstract, and naturalistic. Geometric designs are the largest category by sheer number, comprising basic shapes such as circles, squares, and triangles. Abstract designs are typically characterized by shapes that do not fit any known design. In many cases, they are unidentified. The third category, naturalistic motifs, includes symbols that represent things found in nature. Examples include plants, animals, humans, and astral figures. Because there is a wide variety of motifs present across the landscape, one is left to wonder whether the people who formed the rock art had locational preferences for specific designs. If this is the case, then it is appropriate to break down the site distributions to their motif types to see if variations exist.

To put it another way, consider a person who desired to make zoomorphic motifs depicting amphibious or reptilian animals. Given our understanding of the associations between these creatures and water, it is possible that this individual considered areas within close proximity of streams to be more appropriate for that type of imagery. Similarly, it is useful to test other motif types for possible connections with environmental features. Perhaps anthropomorphs appear at certain elevations, or maybe geometric motifs tend to face specific aspects. Such observations not only indicate the thought processes behind their placement, but potentially reveal the symbolic meanings and uses of the rock art itself. GIS make these hypotheses easily testable with multiple tools that calculate distances, slopes, aspects, and other valuable data. When objective measures are collected on these distributions, then ethnohistoric information can be used to suggest interpretations.

Past studies of Ozark rock art used similar techniques on motif distributions. A study by Sabo et al. (2015), for example, identified a dichotomous pattern of rock art along the Arkansas River that represented a cosmological interpretation of the landscape. Rock art south of the Arkansas River at Petit Jean Mountain depicted naturalistic images appearing "to represent objects readily observable in the in the phenomenal reality of the Native Americans' world" (Sabo et al. 2015:263). None of these motifs symbolized anything supernatural. The rock art found north of the Arkansas River at Crow Mountain offers a stark contrast. There, motifs commonly depicted extraordinary concepts, such as a headless anthropomorph and an insect that traverses the Below, Middle, and Above Worlds. Thus, a separation existed that Sabo et al. interpreted as symbolically related to village patterns of Siouan-speaking tribes. The Sky People clans were responsible for ritual activities and communication with the spirit world; they resided on the north side of the village. Meanwhile, the Earth People clans were responsible for material welfare; they lived on the south side of the village. This study not only offers a good connection between spatial analysis and ethnohistory, but also shows how a community imposed its own cultural categories on the landscape rather than being constrained by environmental variables.

The various angles taken on Ozark rock art distributions through GIS potentially answer many questions. Namely, the perspectives outlined above help archaeologists understand the overall thoughts and perceptions held by those who originally produced the rock art, especially as they relate to location selection. Environmental preferences are highlighted which indicate landscape preference, comparisons between rock art sites and bluff shelters distinguish habitational choices from spiritual motivations, and analysis of motif distributions possibly discerns the meaning of these symbols in relation to nature. All of this is possible through spatial analysis and the ability to see the landscape as a bigger picture of culture.

# CHAPTER 2: ROCK ART SPATIAL PATTERNS IN THE ARKANSAS OZARKS

The first necessary step is to develop an understanding of rock art location in the context of the Ozark landscape. This chapter is specifically concerned with *where* rock art tends to appear. By establishing what patterns exist between rock art locations, we can develop an understanding as to what locations are most likely to contain them. In order to effectively investigate these patterns, however, there are two contextual approaches to consider. The first approach examines the placement of rock art sites, while the second examines the placement of individual rock art elements (see Figure 2.1 for site and element distributions). For the purposes of this thesis, a "site" refers to the entire archaeological site including all individual rock art elements within it, while an "element" refers to "any discrete representation (rendered as pictograph, petroglyph, or painted petroglyph) that we observe at a site" (Sabo and Sabo 2005b: 14).

A common approach for many spatial analyses is to simply use the site locations as an input. Each rock art site is considered as a single placement, independent of the type or quantity of elements present at the site (see Fairén-Jiménez 2007). This is a typical method used to assess site distributions, but it perhaps fails to capture the significance of sites with large quantities of elements. Because of this, it might be more appropriate to "weigh" each site by the number of elements present or even break the elements down to their motif types (see Nimura 2015). In other words, the geospatial analysis considers the placement of individual rock art elements across the landscape, as opposed to sites. One could reasonably argue that this approach is desirable for understanding locational preferences for rock art, as it possibly captures locational preferences more effectively.

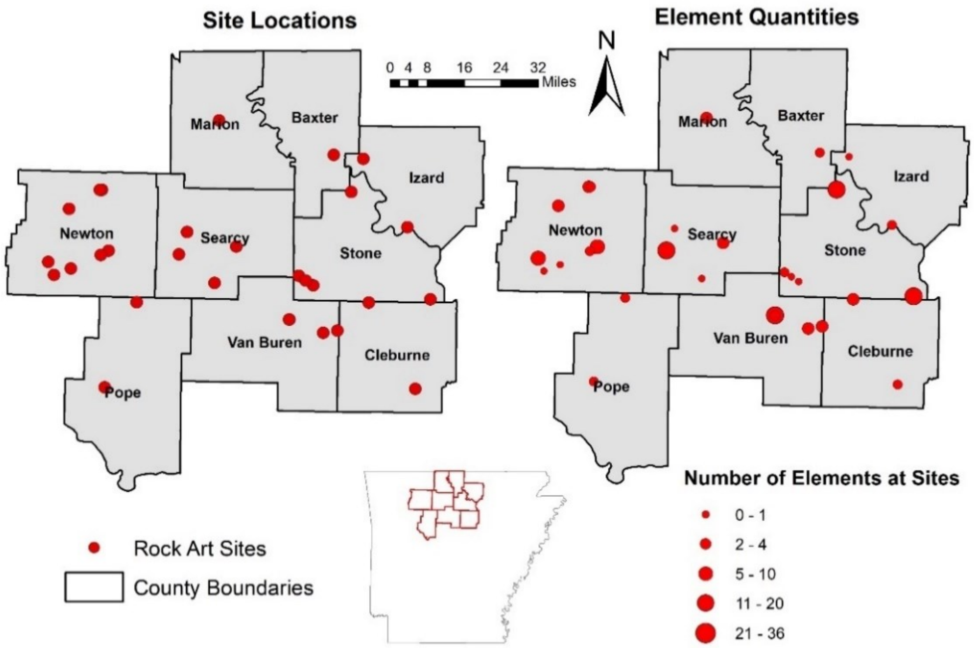
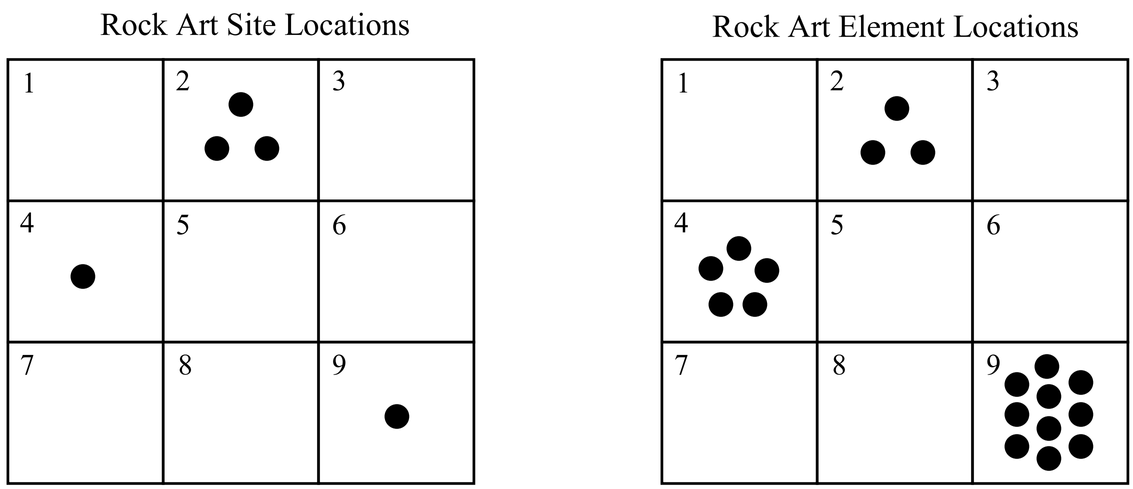



***Figure 2.1****: The distribution of rock art sites and elements in the study area. (Portions of this figure include intellectual property of Esri and its licensors and are used herein under license. Copyright © 2018 Esri and its licensors. All rights reserved.)*

Figure 2.2 shows an example as to why this distinction might be necessary. The grids represent raster environmental data in GIS, while the dots represent site locations on the left grid and element quantity on the right grid. On the left grid, there are three dots on square 2 while only one on 4 and 9. One might therefore conclude that square 2 contains variables that draw people to the location to create rock art. In the right grid, each site is weighted by the total number of elements present at the locations. While square 2 has the most sites, each site only has one element. Meanwhile the site at square 4 has five elements while the site at square 9 has ten. This possibly indicates that squares 4 and 9 have more desirable environmental criteria than square 2, and therefore deserve a higher degree of consideration while analyzing locational preferences. The difference here is subtle, but it could have noticeable impacts on our understandings of past behaviors.




Grid 2: 3 rock art sites, each contains 1 single element
Grid 4: 1 rock art site, contains 5 elements
Grid 9: 1 rock art site, contains 10 elements

***Figure 2.2****: Two grids representing the difference between the site and element approaches*

Because of this, it is important to explore both site and element distributions across the Ozark landscape. There are, however, some issues that need to be addressed with the element analysis. The tests used in this study assume independence with the placement of elements across the study area. In many cases, it is difficult for contemporary researchers to distinguish one rock art element from another. Though we might consider two designs as separate elements, the people who made the art might have considered the two shapes as a part of the same design. Conversely, perhaps a design we today identify as one element actually consists of multiple elements that just so happen to be superimposed on each other or close enough to mimic a singular shape. Another issue is time, as rock art elements might have been placed at separate times in the same location. A person in the past could have placed one element at specific point in time, but later, another person might have used the same location to create multiple elements. If instances like this did indeed happen, then one is left to wonder whether rock art elements truly represent independent trials in statistical testing. All of these issues make the numerical inferences derived from elements a bit dubious. Because it is difficult to fully understand these factors, the tests used below will assume that elements were individually placed. This potentially results in overly significant results, as elements are heavily clustered to singular locations. The attempt here, however, is to emphasize locations with large quantities of elements as more significant than those with lower quantities. Though violations of independence may exist, it is worth trying this perspective to see if it yields useful results.

The initial analysis provided in this chapter uses traditional quantitative methods to discern rock art locational preferences in the study area, which includes the following counties: Baxter, Cleburne, Izard, Marion, Newton, Pope, Searcy, Stone, and Van Buren. Geologically, this area consists of highly dissected and eroded bedrock, which "lies at an elevation of 1100 to 1300 feet above mean sea level, with valley floors 100 to 500 feet below the upland surface" (Vogelle 1990:3). Bedrock in the study area varies significantly. The north generally contains Powell Dolomite and Cotter and Jefferson Dolomites, the middle mostly contains Pitkin Limestone and Fayetteville Shale, and the south is mostly composed of Bloyd Shale and Atoka Formation (Haley et al. 1993). For the most part, escarpments are sandstone and limestone, though most of the rock art rests on sandstone. This could imply a preference for specific geological surfaces, though it might simply mean that sandstone environments are better protected from erosional processes than limestone. Hence, some of the patterns discussed below might be a result of taphonomic effects, where rock art samples that do not fit these trends were eroded away long ago.

This study area was selected because it is large enough to provide an adequate sample size of rock art, but also small enough to remain manageable and keep processing time low.

Archaeological point data were collected from the Arkansas Archeological Survey's Automated Management of Archeological Site Data in Arkansas (AMASDA) database. AMASDA allows researchers to study archaeological site locations and view their respective forms, thus providing both spatial and qualitative information. After eliminating historic rock art sites, the total number of sites in the study area is 29, with 243 total elements between them (see Table 2.1). It is worth noting that Crow Mountain in southern Pope County contains 24 rock art sites which are excluded from this study. This is because they likely represent a unique cultural landscape formation that is separate from rock art north of the area (see Sabo et al. 2015). Additionally, their tight clustering would heavily skew the resulting data. The Arkansas Ozarks consists of a few cultural areas relative to geography that potentially vary in style. Hence, the rock art distributions used in this study focus primarily on those residing in the Salem Plateau region. Ideally, this partition the rock art distributions into a similar stylistic cluster as suggested by Knight (2013). After this initial filtering, rock art site vector points were analyzed alongside various raster data that represent environmental variables. For the purposes of this study, the following criteria are considered:

**General Landscape Variables:**

- Elevation – the height of a given location above sea level
- Slope – the gradient or ground steepness
- Aspect – the direction of maximum slope in a downhill direction, or a site's orientation in relation to cardinal directions

**Distance Variables:**

- Cost Distance from Streams – amount of effort required to reach the nearest stream
- Euclidean Distance from Streams – straight-line distance to the nearest stream

- Cost Distance from Mounds – amount of effort required to reach the nearest mound
- Euclidean Distance from Mounds – straight-line distance to the nearest mound

**Visual Variables:**

- Viewshed – how much terrain is visible from a given location
- Directional Prominence – the elevation of a given location compared to the mean elevation of the areas in the direction of its aspect
- Illumination from a Winter Solstice Sunrise – the amount of light a location can expect to receive from a sunrise during a winter solstice
- Illumination from a Winter Solstice Sunset – the amount of light a location can expect to receive from a sunset during a winter solstice

A digital elevation model (DEM) with a 25m resolution was obtained from the USGS, which was then placed into Esri's ArcMap 10 software and used to create the other rasters listed above. Each raster was then divided into five equal-area sections (See Appendix 1 for raw raster and reclassified maps, Figures 1a – 1k). The decision to classify the data this way is due to the limited sample size of rock art sites. In order for the chi-square tests to be truly effective, expected values should be at a value of five or greater. Therefore, with each data type divided into five sections of equal size, the expected number of sites found in each area will be 5.8 while then expected number of elements will be 48.6. Obviously there cannot be 0.8 of a site or 0.6 of an element, but the number is meant to represent 20% of the data for all five categories. The rock art vector points were then cross-tabulated with environmental raster data to see what quantities of sites appeared in certain areas; this represents the observed values. With five equal-area categories, one can visualize the data in fifths. For example, the first category of elevation (Table 2a) represents the lowest 20% of land available in the study area. Conversely, the fifth category represent the highest 20% available. All variables follow this pattern. The exception to this is aspect, which is classified by cardinal directions.

With both the rock art vector points and environmental rasters in place, values were cross-tabulated to establish the conditions at which all sites and elements rest in the landscape. Statistical tests, such as those recommended by Kvamme (1990; 1992), were then applied to assess patterns among rock art. Chi-square tests were used to determine if rock art distributions differ from expectation. Additionally, t-tests were applied to compare stats with random samples, which helps us to understand if a pattern is random or not. These random samples were confined to the county boundaries, as the AMASDA database offers information on a county-by-county basis. One criticism of using a region this big to generate random points is that it will inevitably include areas unfavorable for rock art, such as flat river valleys. This is certainly valid, but the results produced in this chapter are intended to bolster those in the next, thus serving as a good methodological comparison. The random sample sizes typically match those of rock art samples to effectively simulate a different distribution of equal quantity. If a distribution diverges from expected values, or if it varies from a randomly generated set of points, then the results possibly indicate purposeful selection of environmental criteria. For variables where either chi-square or t-testing was not appropriate, other statistical tests were substituted in their place. These include the Rayleigh Z, Watson's $U^2$, and Mann-Whitney U tests. Thus, all variables use two statistical tests, which allows for one to back up another. The following sections discuss the results of these tests, while offering inferences as to why some of these patters exist. The results of these tests are found in Appendix 2.

**Table 2.1:** List of rock art sites in the study area, with their number of elements

| Site Number | Site Name | Total Elements | Remarks |
|---|---|---|---|
| 3BA0030 | Old Joe | 2 | |
| 3CE0060 | Rockhouse Hollow | 3 | |
| 3CE0073 | Dollar Bluff | 6 | |
| 3IZ0143 | (No Site Name) | 2 | |
| 3IZ0149 | Goat Hollow Cave | ? | Graffitied over, exact number unknown |
| 3MR0094 | Sunburst Shelter | 7 | |
| 3NW0037 | Painted Bluff Site | 2 | |
| 3NW0076 | East Rock Shelter | 1 | |
| 3NW0079 | Owens Mountain | 20 | |
| 3NW0276 | Hiner Shelter | 10 | |
| 3NW0459 | East Cole Creek Bluff | 20 | |
| 3NW0626 | (No Site Name) | 1 | |
| 3NW0681 | Lambdin Hollow Shelter | 3 | |
| 3NW1054 | Goat Cave | 7 | |
| 3PP0614 | Pedestal Rock | 2 | |
| 3PP1380 | Myer Petroglyph | 4 | |
| 3SE0105 | Jacobs Rock | 34 | |
| 3SE0321 | Hubbard Petroglyphs | 1 | |
| 3SE0406 | Conner Pictographs | 5 | |
| 3SE0605 | (No Site Name) | ? | Missing site information/documents |
| 3ST0018 | Paxton Shelter | 2 | |
| 3ST0054 | Pictograph Cave | 28 | |
| 3ST0070 | Gustafson Cave | 36 | |
| 3ST0076 | Fox | 1 | |
| 3ST0400 | Lewis | 1 | |
| 3VB0006 | Edgemont | 7 | |
| 3VB0019 | Lynn Creek | 5 | |
| 3VB0316 | Sprott 1 | 31 | |
| 3VB0317 | Sprott 2 | 2 | |

## GENERAL LANDSCAPE VARIABLES

The first set of variables considered are ones that typically accommodate landscape studies and spatial analysis: elevation, slope, and aspect. Tables 2.1a through 2.11b reveal the results of the chi-square and t-tests. Because elements are generally clustered into single locations (their sites), their p-values tend to indicate a high level of significance. Almost all categories revealed a significance of less than 0.0001 for the chi-square tests, while the t-tests resulted in a similar phenomenon. This is a frequent occurrence throughout all statistical tests and possibly implies that these results should be taken cautiously; however, a comparison between the observed values and the expected values reveals useful information. If, for example, a large quantity of elements is present at numbers significantly higher than the expected count for any given category, then one can infer that the data truly are significant. These tables also elucidate why the distinction between a site-oriented approach and an element-oriented approach might be necessary. In some of the tables, a large portion of sites are present in one category, while the total number of elements is split between multiple categories. Because these sites contain only a few elements, they possibly are not as indicative of preference as one might initially judge.

Elevation is commonly utilized in landscape research, partially due to the fact that DEMs are used to form other raster variables, but also because height often holds cultural significance to certain groups of people. Rock art spatial distributions occasionally show these elevation-related preferences. Simek et al. (2013), for example, noted a dichotomy between rock art placements in northern Alabama, where elements high up on Painted Bluff comprised of red pigments while those in the subterranean depths were typically darker in tone. Potential explanations behind elevation patterns range from desired visibility of panels to the symbolisms involved with artistic designs high up in the air. It is therefore useful to explore this variable with Arkansas rock art and see if any connections exist.

Looking at the chi-square results on Table 2.1a, one will notice that the p-value for sites is 0.0586, which is almost statistically significant at a 95% confidence interval. While this does not exactly meet the typical standards, it is fairly close and merits consideration. There is a chance that higher elevations were preferred for site selection, as 41.38% exist in the highest category (see Figure 2a). With that being said, a significant number of the elements are split between the middle and highest elevations (32.92% and 39.51% respectively), though still numerically significant with a p-value lower than 0.0001. If the element-oriented approach is to be taken seriously, then the results here might indicate that the people placing rock art were not as concerned with using the highest elevations available. This is perhaps due to the varied elevation of the Ozarks in general, which sees large differences between high mountain tops and low river valleys. These p-values are similar to those of the t-tests (Table 2.1b) which result in strikingly close figures. Sites hold a p-value of 0.0558, while elements once again result in a p-value lower than 0.0001. Based solely on a comparison with expected values and random samples, one might assume favorability for sites and elements at higher elevations. This conclusion, however, is questionable in light of data presented in the next chapter, where bluff shelter distributions are introduced. Most rock art appears on sandstone outcrops, which tend to be more common at middle to high elevations. Hence, the elevation trends present here might be a result of geological constraints, not necessarily environmental preference.

This leads into a discussion of slope in the region. Given the diverse elevations present in the study area, frequent steep slopes are expected. In relation to rock art, there seems to be a clear connection between high slopes and their placement. A significant portion of both sites (62.07%) and elements (63.79%) are found on the steepest slopes present in the study area (Figure 2b). “Steep” slopes, the second steepest category, also hold a large portion of these features, with 24.14% of sites and 32.51% of elements found there. All p-values from both tests confirm this pattern, with values lower than 0.0001 (Tables 2.2a and 2.2b). This, however, is not indicative of anything truly unexpected. A significant portion of rock art appears in bluff shelters throughout the Ozarks. Naturally, this implies that rock art is placed on areas with steep inclines, such as the sides of bluffs or mountains. There are a few exceptions to this, namely 3PP1380 and 3ST0400, both of which contain open-air pictographs on exposed rocks. Still, the prevalence of rock art in the bluff shelters of steep areas does imply a strong preference for these areas over flat, open-air locations. One suggestion is that some bluff shelters served as settings for the performances of ritual activities, which express the cosmological beliefs of local Mississippian communities (Diaz-Granados and Duncan 2000:214-240). Hence, caves and bluff shelters had a special allure that drew people into them for the purposes of creating rock art.

Aspect, or a site's orientation, is another regularly used variable. Given the prominence of cardinal directions in American Indian worldviews, it is an especially important variable to consider for rock art. For the chi-square tables, it is worth pointing out that the expected values differ between categories. Unlike the other raster types, aspect is not split into 5 equal-area sections, but instead divided into categories based on the cardinal directions. Also noteworthy are the expected site values. All of these numbers are lower than five, which does not make for a robust chi-square test. This ultimately means the resulting p-value is questionable. Luckily, another statistical test is provided here to offer stronger results: the Rayleigh z test. Because angular data lack a true "zero," their means are calculated differently. This means that t-tests are invalid. The Rayleigh z test is more appropriate for handling directional data and tells us whether there is a sample mean direction.

With this out of the way, we see that aspect offers particularly interesting results. It appears there are some considerations being made by pre-contact Ozark Indians regarding the direction their rock art faces. Sites generally face in a southern direction, with an emphasis on southeastern aspects. Table 2.3a shows the possible significance of aspect, as sites provide a p-value of 0.0017 and elements a p-value of less than 0.0001. About 37.93% of sites and 54.32% of all elements face toward the southeast (Figure 2c). If we choose to lump percentages, then 82.76% of sites and 84.77% of elements face the southern directions (southeast, south, or southwest). Rayleigh z tests on Table 2.3b offer additional insight. Both sites and elements are very statistically significant, both of which receive p-values lower than 0.0001, implying that both do in fact have a mean direction. Sites are overall more likely to face closer toward the south, with a mean of 165.29 degrees. Meanwhile, elements hold a stronger orientation toward the southeast, maintaining a mean of 147.795 degrees. The R-values measure angular dispersion, where numbers closer to zero imply uniformity while those closer to one denote concentration in one direction. Interestingly enough, sites have a higher R-value than elements (0.606 and 0.426 respectively). This implies that sites are more homogenous in their orientations, though this might be a result of their lower sample size. Still, the data here shows a lack of sites and elements in locations with non-southern aspects. Very few exist in north, northeast, and west-facing areas, while none appear on flat or northwest aspects. It therefore seems as if the rock art creators are avoiding areas that do not face either, southeast, south, southwest, or possibly even east.

This is consistent with other rock art studies carried out in the southeastern United States. Simek et al. (2013:431) argued that rock art "reflected modifications of the natural landscape according to cosmological models that underlay late prehistoric Mississippian period religion." In their study of rock art in the uplands of Middle Tennessee, they found a strong tendency for both open air and cave rock art to face the south. Given the similarities between this pattern in prehistoric Mississippian culture, it is entirely possible that there was a preference for southern-facing aspects which reflect a metaphysical interpretation of the landscape. One potential explanation involves religion. Some pre-contact southeastern Indians viewed the southern sky as a place where souls go to rest (Kay and Sabo 2006:32). This is materialized in the form of the Milky Way, or the dense band of stars that dominates the southern night sky (see Figure 2.3). Typically referred to as the "Path of Souls," this bright collection of light was highly significant in Mississippian cosmologies and represented the road on which souls traveled upon death (Lankford 2007b:204). Evidence for this belief comes from ethnographic accounts, which describe these mythic stories. Fletcher and La Flesche (1992 [1911]), for example, noted Omaha and Osage perspectives that regarded the Milky Way as a path made by spirits who pass into the realm of the dead.

So far, it seems possible that rock art is connected with high elevations, steep slopes, and south-facing aspects. All of the variables discussed in this section, however, are based largely on topographical factors. In other words, some of the trends highlighted above might be the result of the Ozark's geology as opposed to environmental desires. Expected data and randomly generated points may be misleading by portraying the results as more significant than they truly are. This holds especially true for sites that are constrained by geological factors, such as the bluff shelters that typically hold rock art. Hence, the comparisons provided in the next chapter likely provide better statistics, as they include bluff shelter distributions and emphasize which locational preferences are unique to rock art.


***Figure 2.3:*** *Part of the Milky Way's "disk" visible in the southern night sky on December 21, 1450$_{CE}$ (modelled in Stellarium)*

DISTANCE VARIABLES

The next set of variables used in this study are concerned with distance. Proximity to certain features, whether they be environmental or cultural, can hint at the natural constraints or social desires involved with location selection. Perhaps a group wishes for specific sites to exist near important resources, or maybe they want them hidden far away from burial grounds. These patterns are easily extrapolated with GIS, which have tools for calculating various forms of distance. Here, two types of distance are explored for two different features: cost distance and Euclidean distance from both streams and mounds. A least-cost path analysis denotes how much effort is required to reach specific points across varied terrain. In GIS, the tool establishes how a traveler gets from point A to point B in a manner that keeps the accumulated cost as low as possible (Surface-Evans and White 2012). Due to the mountainous nature of the Ozarks, this technique for measuring distance is useful because it determines how accessible a feature is in the context of its landscape. The Ozark terrain also justifies a Euclidean distance analysis. There might be a short distance between a rock art site and a stream, but a large cliff separating the two points would make travel between them impractical. Thus, there is a distinction between accessibility of a resource (cost-distance) and a desire for proximity (Euclidean distance).

Availability of water often influenced pre-contact Indian settlement distributions. Such desires could therefore apply to rock art placement. As evident by Tables 2.4a and 2.4b, there might be a desire to keep sites and elements away from major streams. The chi-square test for cost distance from streams produces a p-value of 0.1532 for sites, while the t-test reveals a p-value of 0.3026. Though these figures do not reveal statistical significance at 95% confidence, the total number of sites consistently increases with the amount of effort required to reach streams (see Figure 2d). Also noteworthy are the means of rock art site and random sample distributions. The average cost distance of site locations is about 2651 units higher than the random sample, which suggests actual sites are slightly more difficult to reach from streams than randomly selected locations. Element distributions offer far more conclusive results, as both tests indicate high statistical significance. Interestingly enough, 65.84% of all elements exist in places requiring the highest amount of effort to reach from streams. The mean cost distance of all elements is over 8300 units higher than the random set of points, signifying that elements tend to appear in hard-to-reach places from streams.

Tests analyzing rock art's Euclidean distances from streams provide a case where the chi-square and t-tests do not necessarily agree. The chi-square results on Table 2.5a show a p-value of 0.0508 for sites, which is a relatively significant number. A t-test with random samples, however, results in a p-value of 0.6768, a considerably less significant figure (Table 2.5b). Some interesting figures here are the percentages of sites present in the "far" category (34.48%) vs. that of the "farthest" category (3.45%) (see Figure 2e). The former is a fairly large quantity, while the latter is rather low. Elements follow a similar pattern, as most appear in the "far" category and dwindle off in the "farthest" category. The data seems to indicate preferences for areas far away from stream, but one would then expect to see more sites and elements in the "farthest" category. The element t-test also results in an insignificant p-value (0.1581). Whereas the mean rock art distance is smaller than the random sample's, the elements produce a larger mean than their respective random sample. Because rock art sites produce a smaller mean, and given the lack of sites present in the "farthest" category, it could be that rock art was not produced at extreme distances from streams. This is unfortunately hard to test, but other factors, such as bluff shelter characteristics and viewshed properties, might contribute to our understanding as to why this pattern exists. Nonetheless, the chi-square test seems to indicate a preference for areas distant, but not too distant, from streams. In light of the previous cost distance tests, the data suggest that rock art is both difficult to reach and overall spatially withdrawn from streams.

These results are similar to an earlier spatial analysis by Sabo et al. (2014:244) who observed that "rock-art sites generally occur farther away from water" and that "many of these sites are located in out-of-the-way places that are more sheltered from view and harder to reach than other sites." One common hypothesis behind this pattern involves vision quests or other private rituals. Keyser (1977:52) notes the influence of vision quests on northwestern plains Indians, who held the event as "a personal experience with specific details kept secret." When partaking in these experiences, individuals selected isolated locations and created rock art there. Hilliard et al. (2005:53) suggest that similar mentalities can be found in Ozark rock art placement, emphasizing how remote locations are fitting for sacred or private rituals. If this is the case, then one can expect to see a difference between rock art location selection and other site types. Hence, an effective discussion of isolation is probably, again, best saved for the next chapter, when bluff shelter distributions are brought in for comparative purposes.

The cost distance and Euclidean distances to mounds follows similar logic. Rather than proximity to a natural resource, however, these analyses evaluate distances to social resources. Mounds served as important locations for Mississippian people. Many archaeologists suggest that mounds served as important centers for social activity and played a role in sociopolitical organization (Blitz and Livingood 2004; Knight et al. 2010). Others emphasize their significance as ceremonial centers for ritual activity (Pauketat 2004; Kelly et al. 2007). Because mounds served an important social function in Mississippian culture and certainly carried some level of ritual meaning, it is important to assess connections between rock art and these features. If one is to assume that rock art serves as some form of religious or ritual expression, then easy access or close proximity to local mounds might play into the selection of site or element locations. If the desire for privacy or isolation still persists, then perhaps rock art tends to exist far away from them instead.

Neither of these expectations, however, are necessarily reflected in the statistical results. Tables 2.6a and 2.6b imply little connection between cost distance from mounds and rock art locations. Chi-square results include p-values of 0.2569 for sites and 0.0407 for elements. While the latter figure is normally statistically significant at a 95% confidence interval, it is the only element chi-square test in Appendix 2 that fails to produce a p-value lower than 0.0001, which casts doubt on its reliability. Nevertheless, it does pass the alpha level for significance, and therefore should not be discounted. The main observation from Figure 2f is the "mid" category, which sees lower percentages than the other categories. This gives the appearance that rock art creators either wanted their art easily accessible or difficult to reach from mounds. A closer look at the motifs present in these areas might reveal some connection between certain designs and proximities to mounds. For the time being, t-testing also indicates little to no connection, as both sites and elements produce p-values that are not very significant (0.7909 and 0.3166 respectively).

With Euclidean distance from mounds, there still seems to be little connection with rock art site locations. Neither the chi-square p-value (0.1532) nor the t-test p-value (0.511) are statistically significant (see Tables 2.7a and 2.7b). Yet, the tests for elements do reveal significance, with possible preferences for either far or the closest distances available. This is evident by Figure 2g, which shows 37.45% of elements exist in the "closest" category, while 31.69% are in the "far" category. These numbers are bolstered by the fact that the other categories have much lower percentages of elements present. Chi-square testing produces a p-value less than 0.0001, and the t-test results in a p-value of 0.0005.

Both of these analyses merit an examination of rock art designs. Some motifs possibly exist with distance to mounds in mind, which might elaborate why there is a split between closeness and farness in some categories. For example, a motif-type might be important for purposes that merit ease of access to mounds, while others require solitude and are therefore kept away. While this suggestion is speculative at the moment, it will make better sense in Chapter 4, where motif distributions are analyzed.

## VISUAL VARIABLES

Aside from typical landscape topographies and proximal variables, it is important to consider perceptual factors, that is, how a cultural group viewed the landscape. Certain features in the environment offer striking visuals that feasibly influenced indigenous art and worldviews. The final set of variables address this theme by analyzing four additional influences: viewshed, topographic prominence, and illumination received from sunrises and sunsets during winter solstice periods. With GIS, it is possible to quantify these variables and assess their influence on rock art distributions. Doing so allows archaeologists to understand human engagement with the landscape (Cosgrove 1984). Still, computational modelling techniques "are potentially overly-deterministic abstractions that derive more from processing power than human experience" (Golden and Davenport 2013). It is difficult to fully grasp the subjective nature of visuals through quantitative means. The point of these analyses is not necessarily to claim that there is a concrete method through which we can gauge a culture's perception of the landscape. Rather, it is to offer an unbiased look at the conditions at which rock art exists in relation to these variables. If certain patterns manifest from the results, then there is a starting point for interpretation.

Viewshed refers to the amount of land visible from a given location or set of locations. In most GIS software, it calculates which raster cells can be seen from specific points, taking into account landform obstruction, earth curvature, and viewer height. The Arkansas Ozarks are home to some truly remarkable views that could leave an impression on anyone, no matter the time period or culture. Such views can be simulated with ArcMap's *Viewshed* tool, which highlights areas that are visible from a set location. One downside to this tool is its lack of specificity; it does not allow the user to see viewsheds from individual points when used on a collective set of points. So instead of using the *Viewshed* tool to discern visible areas, the *Observer Points* tool was instead selected because it reveals how many pixels are visible from individual locations. After setting the observer offset to 1.75m to represent average human height, the tool was run to calculate a viewshed raster for rock art.

One will note that there are two sets of t-test tables for rock art sites and elements. This is due to the existence of outliers. Two sites (3SE0406 and 3VB0006) hold extravagantly large viewsheds, both of which totaled over 200,000 total pixels. This likely skews the data toward stronger viewsheds, as most of the other sites ranged anywhere from a few hundred pixels to tens of thousands (see Table 2.8a). Thus, t-tests were carried out both on the total population, as well as without the two aforementioned sites. These tests compare rock art means with a set of 29 randomly generated points for the site comparison and 80 points for the element comparison. (*Observer Points* only works on 16 points at a time, so the test was run 5 different times). Also noteworthy for this variable is the lack of chi-square testing. Unlike the other variables used in this thesis, viewshed cannot be broken down into five equal area sections. This is because viewsheds are calculated from vector point locations as opposed to values present in the raster. To make up for the lack of chi-square testing, the Mann-Whitney U test is applied, which is useful for nonparametric data and averts the outlier issue.

The results of these tests are found on Table 2.8b. There are a few interesting statistical factors with these data. Firstly, the p-value for rock art sites (0.3707) does not indicate statistical significance. This may seem odd, given the mean viewshed for rock art sites (29377.276) is considerably larger than that of the random sample (19232.138). The standard deviation is likely to blame, as the data is skewed by sites with extremely large pixel counts, namely 3SE0406 and 3VB0006. After eliminating both of these sites, the new mean is 15041.63 and the new p-value is 0.4531. It seems that, overall, rock art sites do not show a consistent tendency for impressive viewsheds. Rock art elements also lack statistical results to indicate a preference for strong views. T-tests for this approach produced p-values of 0.3298 when all elements are included, and 0.1568 when those from the outliers were excluded. Remarkably, the p-value became more significant after eliminating 3SE0406 and 3VB0006. After a closer look, however, this shift is because the mean fell from 26324.667 to 16306.88, meaning the element distribution started to become significantly lower than the random sample.

Mann-Whitney U testing (Table 2.8c) indicates that rock art viewsheds do not significantly differ from the random sample. The result these tests include p-values of 0.6171 for sites and 0.7795 for elements. This potentially implies a lack of concern for stunning views while placing rock art. Of course, calculating viewsheds from random points is a risky tactic. If a point happens to fall on an area surrounded by flat terrain, then the total visible pixels will likely be high. Another issue, again, is the use of bluff shelters for rock art creation. If the Ozark inhabitants held preferences for bluff shelters as areas for rock art creation, then a series of random points likely is not the best distribution for comparative purposes. Thus, results provided in the next chapter potentially offer better inferences.

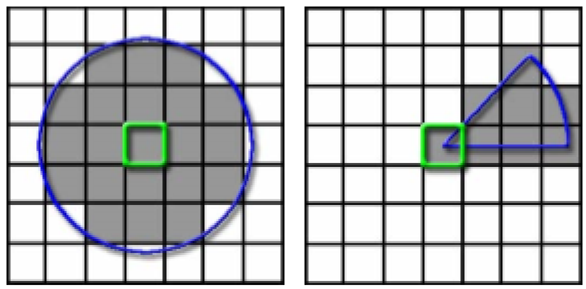


***Figure 2.4:*** *A circular neighborhood is used for prominence (left), while a wedge is used for directional prominence (right) (from Jenness 2007:17)*

Another variable that considers a location's view is topographic prominence, which is examined in many landscape studies. Llobera (2001:1007) described prominence as a "function of height differential between an individual and his/her surroundings, as apprehended from the individual's point of view." This typically establishes the visibility, or noticeability, of a location relative to its surroundings. Prominence is a useful variable, though it is arguable as to whether it works well with Ozark rock art. Because rock art is typically found inside bluff shelters or on steep slopes, their prominence is restricted to the locations in which they face. Therefore, a different variable is proposed for this study: directional prominence. Directional prominence refers to the difference between the elevation at which a site exists and the mean elevation of the area directly in front of it. While Llobera's prominence takes all the surroundings into account, directional prominence only concerns areas that lie in the direction a site faces. Figure 2.4 shows the difference; typical prominence is calculated by a circle neighborhood, while directional prominence is calculated from a wedge shape relative to a location's aspect. Here, the directional prominence was calculated with a tool downloaded from Jenness Enterprises. It subtracts the mean elevation of the cells 300m outward from a site's aspect (a wedge shape) from the actual elevation of the site itself.

In Figure 2h, there appears to be a recognizable site preference for areas elevated above their surroundings, notably at the highest category. About 42.28% of sites appear in areas with the highest directional prominence. Elements follow a similar pattern, as 43.62% fall into this category, though there is a noteworthy percentage of 30.04% present in the lowest category. If there is preference for certain levels of prominence for specific motifs, it might explain this split. Both chi-square tests result in very low p-values of 0.0006 for sites and <0.0001 for elements (Table 2.9a). This perhaps implies a desire for visibility of the areas in front of rock art. Conversely, this might mean that the people who made the rock art wanted them placed in conspicuous positions relative to the landscape. If there was indeed a preference for secluded places, as evident from the distance to streams variables, one is left to question whether desires for seclusion did indeed exist. A site could exist in a topographically prominent position while maintaining seclusion, though it can reasonably be argued that these two criteria contradict each other. Interestingly enough, the t-tests depict different results (Table 2.9b). The rock art site trend is not statistically significant with a p-value of 0.7284, while the element trend still is, though to a lesser significance of 0.0308. It certainly is possible that preferences were held for sites with high or low directional prominence, given the diversion from expected values and random points. However, it is important to consider geology for this category. High topographic or directional prominence could simply be a common pattern among Ozark bluff shelters. If this is the case, then it casts doubt on locational preference for this variable. This topic is explored more thoroughly in the next chapter when bluff shelter distributions are used as reference points.

The final set of visual variables are less concerned with the earth, but instead look upward toward the sky. Astral phenomena, such as the sun and stars, played an important role in Mississippian cosmology and often found their way into southeastern material culture. Like the earlier analysis of aspect, certain orientations afford different views of surroundings. For this analysis, connections with both sunrises and sunsets during the winter solstice are explored. This is done by assessing how much light a location can expect to receive during these periods. While this is not exactly an obvious choice for an environmental variable in most landscape analyses, it seemed appropriate for this study. During Robert Ray and Gayle Fritz's documentation of rock art sites during the late 1970s and early 1980s, they frequently made notes regarding the observability of a winter solstice sunset from that vantage point. Ray even cited Sofaer et al. (1979), who referenced other accounts of prehistoric Indian rock art construction in relation to astronomical phenomena. Pauketat (2013:62) notes the "ease with which the sun's daily and annual motion establishes cardinality," and that "it is no surprise that people the world over often cite solar happenings in their social constructions and daily practices." Many Mississippian structures, such as those at Cahokia, are aligned on axes with attention to the rising and setting sun during these solstice periods (Pauketat 2013:88-132). Given the role of the sun's movement in American Indian cosmologies, especially those of southeastern Mississippians, it seemed suitable to test connections between rock art placement and the winter solstice.

Using ArcMap's *Hillshade* tool, one can simulate sunlight from various azimuths and altitudes. In order to simulate a rising winter solstice sun, the azimuth was set at 130 degrees (representing the southwestern sky) and the altitude at 30 degrees (representing a morning sunrise). Additionally, a winter solstice sunset was recreated by setting the azimuth at 230 degrees (the southwestern sky) and the altitude again set at 30 degrees (setting sun). These figures are derived from an ephemeris simulation run in Stellarium, a software used for modeling astronomical views at different temporal periods. Figure 2.5 depicts this simulation and illustrates the southeastern sunrise and southwestern sunset during the winter solstice.


***Figure 2.5:*** *Models of a sunrise (left) in the southeastern sky and a sunset (right) in the southwestern sky on December 21,* $1450_{CE}$ *(modelled in Stellarium)*

The results displayed on Figure 2i indicate that there may be a connection between site selection and illumination from a winter solstice sunrise or sunset. Beginning with the sunrise variable, 58.62% of sites exist where illumination is highest. This follows an even trend from the previous categories. Meanwhile, a remarkable 85.19% of all elements appear in these same areas. All statistical tests, for both rock art sites and elements, result in p-values lower than 0.0001; this is extremely statistically significant (see Tables 2.10a and 2.10b). Sunsets offer similar patterns, though to a lesser degree. As with sunrises, there is a considerable percentage of sites present at the highest category (44.83%). However, elements are split between the lowest and highest categories (30.04% and 43.62% respectively), which might infer that some sites contain specific motifs that are suitable for locations with high sunset illumination and others for lower amounts (see Figure 2j). Chi-square tests indicate statistical significance, with p-values of 0.0035 for sites and <0.0001 for elements (Table 2.11a). The t-tests, however, suggest otherwise.

Sites maintain a p-value of 0.4354 and elements sit at 0.1036, implying that they do not differ as much from random points as they do from expected values (Table 2.11b).

Still, it is interesting that relatively large number of sites exist in positions that receive light from these events. Orientation toward either a winter solstice sunrise or sunset possibly explains why sites and elements do not generally face directly toward the south, but rather face either southeast or southwest. To fully grasp why this pattern might exist, it is useful to examine the season in which these solstices occur: winter. According to Kay and Sabo (2006), winter held a symbolic connotation with death in Mississippian belief, and especially for the Caddo. The path of the sun during this season potentially represents a cycle of death and rebirth. Though slightly outside the study area, there are ethnohistoric accounts gathered from missionaries who conversed with the Caddo of eastern Texas during the late seventeenth and early eighteenth centuries. One substantial narrative describes the path of souls upon death. Once a person dies, his/her soul leaves the body and travels toward the west. "From there they go to wait in a house located towards the south, called the House of Death" (Felis de Espinosa [1718], translated by Hatcher 1927:162). Kay and Sabo (2006:32) suggest that souls therefore rest specifically in the southwestern sky and that Harlan-style charnel houses, which face toward the southwest, serve as locations for rituals involving themes of death.

This might explain why the southwest and winter solstice sunsets are noteworthy, but the significance of southeastern sunrises is still unexplained. After all, southeastern orientations and winter solstice sunrises hold much higher significance in the tests above. Another account from Swanton (1942:210) also concerns reincarnation, but tells of a corpse that escapes and travels east. This description evaluates a story from Dorsey (1997 [1905]), which emphasizes the east as the direction of life. If the southwestern sky holds symbolic associations with death, then the southeastern sky possibly represents life. The Milky Way in the southern sky would then serve as a metaphysical boundary between these two areas. Though it is somewhat presumptuous to assume a connection between seventeenth century Caddo worldviews and those of pre-contact people in the Arkansas Ozarks, it is interesting that this astronomical spectacle likely held significant meaning to an indigenous group in the southeastern United States.

## TOWARDS A BETTER ANALYSIS

Statistical testing against expected values and random samples leaves us with multiple variables to consider for rock art locational preferences. For rock art sites, preferences exist for the following criteria: highest elevations, steepest slopes, southern-facing aspects, far Euclidean distances from streams, highest directional prominences, highest amounts of illumination from winter solstice sunrises, and either lowest or highest amounts of illumination from winter solstice sunsets. Rock art elements, on the other hand, show signs of preference for additional variables: mid or highest elevations, steepest slopes, south or southeastern-facing aspects, highest cost distances from streams, far Euclidean distances from streams, closest or far Euclidean distances from mounds, highest directional prominences, highest amounts of illumination from winter solstice sunrises, and lowest or highest amounts of illumination from winter solstice sunsets. If elements are stronger indicators of location selection, then we are left to consider variables that do not hold significance with site locations.

One shortcoming of this study is the limited sample size of rock art sites, which are sparsely distributed across the Ozarks. Wescott and Kuiper (2000) discuss the problem of "available data" in archaeological GIS analyses. Quantitative studies are limited to variables collected from previous surveys and the quality of the data on the site forms. There may be several sites existing in areas that do not follow patterns observed by this study. If this is the case, then the suggestions here are biased toward features that have already been discovered, which ultimately skews the data. That, unfortunately, is one of the downsides of spatial analyses with GIS; one must work with what is available. Because observed data is relatively limited, more so with rock art sites than elements, conveniently placed random points potentially tip the data either towards significance or insignificance. Considering that 243 elements exist in the study area and that they are confined to only 29 raster cells, this skewing becomes especially problematic. The results for elements generally resulted in p-values lower than 0.0001 because they were tested against a separate distribution of 243 random points. Naturally, statistical tests will indicate a significant level of difference between these two distributions. There is also the issue of geology; most rock art appears in bluff shelters which are environmentally constrained in the landscape. This is problematic, as the locations most favorable to rock art are limited to areas where expected and random data will not likely reach consistently. Hence, a stronger analysis of Ozark rock art patterns should include these types of features, which is explored in the next chapter.

# CHAPTER 3: ROCK ART VS. BLUFF SHELTER LOCATION SELECTION

With a general understanding of Ozark rock art in the context of its landscape, we can now apply a new perspective. In this chapter, the distribution of rock art sites is compared with that of documented bluff shelters. This comparison seeks to establish whether the people residing in the study area maintained special environmental preferences for rock art site selection that differed from those of a similar site type. Of the 29 rock art sites used for this thesis, 27 exist inside bluff shelters. The exceptions are 3PP1380 and 3ST0400, both of which contain petroglyphs on exposed boulders out in the open. Due to this consistency, it seems appropriate to carry out the same statistical tests used in the previous chapter. However, rather than simply using expected or random background data as a metric for comparison, bluff shelter distributions are used for a more refined analysis. The rationale behind this decision stems from the multi-purpose nature of bluff shelters; they were used for multiple reasons, including shelter, burial, rituals, and of course rock art creation (Sabo and Early 1990). If locational patterns differ between rock art and bluff shelters, then we will know which environmental variables were specifically considered for rock art creation rather than other activities. Additionally, one cannot simply "build" a bluff shelter anywhere on the terrain. If there was indeed a fondness for rock art creation in bluff shelters, then the artists were often limited to areas that already existed in nature. This means that the results of the previous chapter may not reflect environmental preferences that are specific to rock art, but instead mimic those of bluff shelter location choices in general.

Initially, there are a few complications involved with this method. The first involves the bluff shelter data. While the AMASDA database offers a large number of bluff shelter points for GIS, the metadata is not always clear about the use or occupational period of the sites. In many cases, the information only refers to lithic scatters and scant burials. Additionally, there is variation between Paleoindian, Archaic, Woodland, and Mississippian inhabitation, but in most cases the metadata states only that a site is prehistoric. These factors unfortunately make it difficult to distinguish varying types of bluff shelters based on their purposes, or to factor in sites that represent the same time period as the rock art sites (Mississippian). Still, the bluff shelter distribution remains as an appropriate marker for geological features that would have been appropriate for rock art. In other words, the bluff shelter points denote places where an individual *could* have created rock art, but either elected not to or simply was not aware of that location's existence. Thus, we have a series of points through which we can compare locations that were deliberately selected vs. locations that were not. By using the data collected from bluff shelter locations, one can substitute the expected values and random samples from the previous chapter. The quantity of bluff shelters in each equal-area category now represents the expected value, while the means and standard deviations from bluff shelter distributions fit into the t-tests. This ideally leads to more specific conclusions as to what environmental criteria were desirable for the people who produced rock art.

One will note that there are significantly more bluff shelter sites in the study area than there are rock art sites. Figure 3.1 displays the distribution of the 944 bluff shelter sites registered on the AMASDA database in the relevant counties. The most significant concentrations reside in the mountainous areas of the west and north-central sections. This is not surprising; bluff shelters tend to form where there are bluffs. There is some overlap between bluff shelter and rock art locations, but a noteworthy quantity of rock art exist in the southeastern section of the study area. It is curious that relatively few non-rock art containing bluff shelters reside in this area. Hence, a comparison between these two distributions will hopefully explain why some of these spatial differences exist.

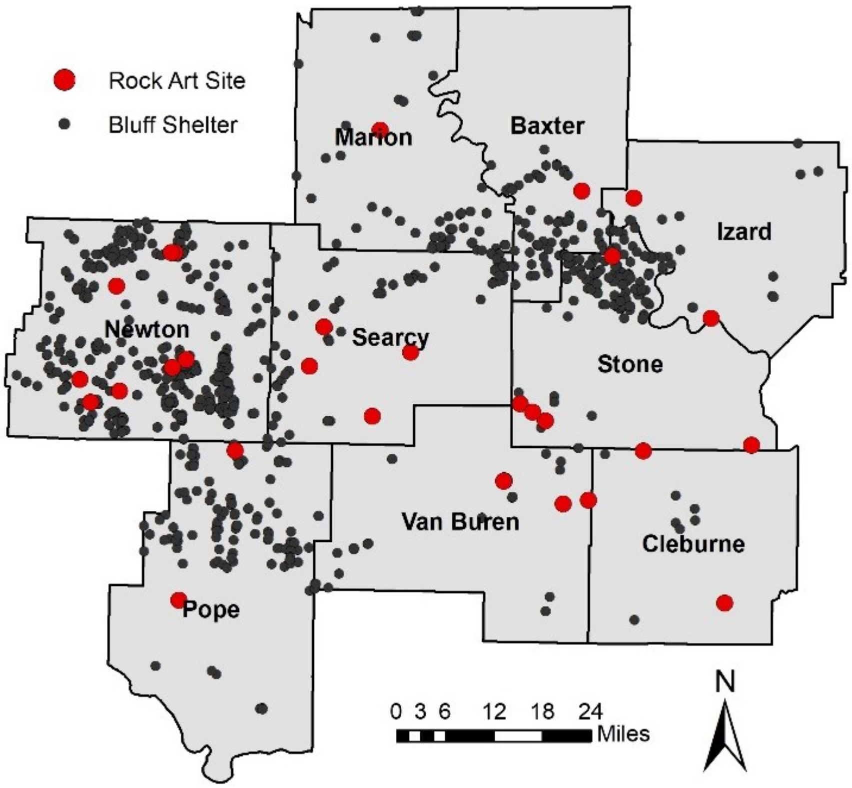



***Figure 3.1***: *Rock art site and bluff shelter distributions in the study area (Portions of this figure include intellectual property of Esri and its licensors and are used herein under license. Copyright © 2018 Esri and its licensors. All rights reserved.)*

For the rock art distributions, there are a few considerations that need to be addressed. As stated earlier, two of the rock art sites (3PP1380 and 3ST0400) do not reside in bluff shelters, but instead exist on exposed rocks out in the open. Because of this, one could reasonably argue that they should be excluded from the rock art data. After all, the purpose or locational preference for open air rock art elements might differ from those found in bluff shelters. If this is true, then including these two sites potentially skews the data in a different direction. On the other hand, if we are attempting to be strict in our analysis of all rock art sites or elements against bluff shelters, then it is appropriate to include them. From this perspective, all rock art is necessary to establish whether or not locational preferences differ. For the sake of consistency, these two sites are included in the following tests because this study in concerned with understating the patterns extant in all rock art. The following sections reanalyze the data from Chapter 2 in light of non-rock art containing bluff shelters. As with the previous chapter, results are portrayed in a series of chi-square tables, bar graphs, and t-test tables which are available in Appendix 3.

## REANALYSIS OF GENERAL LANDSCAPE VARIABLES

When examining the rock art statistics side-by-side with bluff shelters, some interesting trends reveal themselves. Table 3.1a, for example, shows the quantities of rock art sites, motifs, and bluff shelters at varying levels of elevation. The results from the previous chapter indicated a possible preference for rock art placement at the highest elevations present in the study area. Considering the bluff shelter patterns, this observation might be inaccurate. Figure 3a shows that bluff shelter sites follow a similar configuration to rock art sites, with minute differences between them. 41.38% of rock art sites appear in the highest category, which is a fairly significant amount given the 20% expectation across all categories. That being said, 40.68% of the recorded bluff shelter sites also reside in the highest elevations. Whereas elevation might have been a considerable environmental factor when using expected values as a reference, these new results cast doubt on elevation being a concern among those who created rock art. This conclusion is reflected in the statistical tests; the chi-square test results in a p-value of 0.9928 and the t-test gives a p-value of 0.6958 (Table 3.1b). Neither of these numbers are statistically significant by any conventional criteria.

Elements exhibit the same phenomenon as in the previous chapter, where tests often result in p-values lower than 0.0001. With two different tests, however, there is room to consider both figures. If both the chi-square and t-test result in highly significant p-values, then there may be a connection between rock art elements and the respective environmental variable. If one of the tests disagrees with the other, then it possibly casts doubt on any connection. In the case of elevation, we see just that. The chi-square tests gives a p-value lower than 0.0001, while the t-test results in 0.0714. Though the previous chapter was rather lenient with p-values outside the 95% confidence interval, the fact that the t-test did not result in a p-value lower than 0.0001 is noteworthy. There is a slightly larger percentage of elements in the "mid" category, which likely explains why the chi-square tests returned significant results. It could be that a connection exists between certain motifs and differing levels of elevation. For the macro-level approach used in this chapter, however, any link between rock art and elevation is speculative at best.

The results described above show why it is useful to use other site-types as a reference when spatially analyzing certain distributions. If bluff shelters are ignored, one might think that high elevations were purposefully selected for rock art placement. It is possible that people simply selected bluff shelters at higher elevations and that rock art site selection followed suit. The more likely scenario is that bluff shelters are simply more common at higher elevations. It may seem a bit obvious, but in order for a bluff shelter to exist, you need a bluff. Ozark bluffs are the result of erosional processes that began several million years ago. Some of these processes include geologic uplift which physically pushed the land upward, as well as fluvial degradation from meandering streams which cut into the limestone and sandstone layers of earth (Vogele 1990:3-4). This effectively created an area of land that was significantly higher than the typical southeastern river valleys. Hence, high elevation rock art trends are likely a result of geomorphological constraints and therefore not reflective of the environmental desires of those who created them.

Tables 3.2a and 3.2b indicate a similar pattern between rock art and bluff shelters in relation to slope. This trend, again, is probably due to the geological nature of bluff shelters and not necessarily environmental preference. It does, however, still serve as a good example as to how statistical significance can vary with differing reference data. The chi-square and t-test now show that slope is not statistically significant for rock art sites, with p-values at 0.6083 and 0.6488. While elements reveal significance with a chi-square p-value lower than 0.0001, the t-test suggests otherwise with a p-value of 0.2474. See Figure 3b for a visual on the similar patterns between site types in relation to slope.

The aspect analysis offers particularly interesting results. One may note that bluff shelters also show signs of directional preference. Like rock art, it appears as if there is a slight trend toward southern-facing aspects; 52.23% of all bluff shelters face either southeast, south, or southwest (see Figure 3c). There are likely some pragmatic explanations behind this, relating to their protectiveness against the elements. Once temperatures dropped during the late fall and winter seasons, bluff shelters with southern exposures "were probably selected in order to take advantage of afternoon sunlight and the greater radiant heating of the walls of the shelters" (Henry 1983:145). This refers to the winter solstice, where the sun sets farther to the south than usual and ultimately provides additional light and heat during the winter seasons. A winter solstice may have maintained some ideological impetus on the Mississippian Indians, but it also promotes utilitarian forms of location selection. Another environmental concern involves the wind. Wedel (1979:88) suggested that the east and south orientations of Middle Missouri and Plains earthlodge entrances served as shielding from strong northwest winds. Hence, some sites necessitate a discussion, not necessarily on what they are oriented toward, but what they are oriented against.

Since both bluff shelters and rock art tend to face a southern direction, one might assume that, like elevation and slope, the aspect of rock art was not a significant consideration among their creators and that existing patterns reflect desires for environmental protection discussed above. This viewpoint, however, misses a few key observations present in the data. Firstly, Figure 3c shows that the bluff shelter pattern is more closely aligned with the expected values than the rock art pattern. Bluff shelters do not experience any sudden jumps in percentage through any of the cardinal categories. Meanwhile, the rock art patterns seem far more concentrated in the southern categories. Secondly, there are significantly fewer rock art sites in non-southern aspects than bluff shelters. In fact, only 5 out of 29 rock art sites (17.24%) appear in areas that do not face southeast, south, or southwest. Compare this percentage with bluff shelters, where 451 out of 944 sites (47.78%) are outside the southern orientation zone. One of the key concerns of archaeological spatial analysis involves looking at where sites *do not* appear. In this case, it seems as if the Ozark inhabitants were far less likely to put rock art on northern aspects, leaving the southern-facing trend more pronounced in rock art than bluff shelters.

The statistical tests express this subtlety. Chi-square testing for rock art sites (Table 3.3a) provides a p-value of 0.0409, indicating a noteworthy level of difference between locations, namely in the "southeast" and "southwest" categories. Elements also show signs of directional preference, as their p-value is lower than 0.0001, with a relatively large percentage in the "southeast" category (54.32%). In place of the t-test, Watson's $U^2$ test is used to compare rock art and bluff shelter orientations (see Table 3.3b). This is a ranked statistical test, which determines whether the azimuths of two separate groups significantly differ. In this case, we see that both sites and elements result in statistical significance. Sites hold a p-value under 0.05, while elements are again lower than 0.0001. Based on the average means, it appears that both sites and elements maintain orientations slightly more southeast than the average south-facing bluff shelter. Also of note are the R-values. Both rock art sites and elements tend to hold stronger concentrations toward their means than bluff shelters, which only maintain an R-value of 0.261. Even though the average bluff shelter faces almost directly south, the tendency for this to happen is not all that strong. Given the slightly different mean aspects of rock art, as well as their stronger cardinal concentrations, it is possible that southeastern aspects, not necessarily southern aspects, were the preferred azimuth for rock art.

Due to these results, it may be inaccurate to conclude that rock art locations are a result of survivalist tendencies, such as warmth during the colder seasons or protection from harsh winds. The southern trends are simply far too strong to ignore the possibility of religiously-minded location selection. Even so, just because an archaeological distribution follows a seemingly utilitarian pattern, that does not mean it lacks any religious connections. Purposefully avoiding northwest winds "may go hand in hand with a perceived supernatural opposition to the cold and dark of the north and west" (Pauketat 2013:93). Understanding whether rock art sites promote habitability is important. If locations were chosen for pragmatic reasons which promote consistent use or long stays, then the rock art might have been made as part of routine activities as opposed to secluded rituals (Hilliard et al. 2005:51). If rituals were short and the resulting rock art was intended to remain hidden, then survivalist accommodations might not be necessary for the selected bluff shelter. Here, we see that rock art orientations probably would be beneficial to habitation. That being said, later sections in this chapter discuss how rock art tends to be isolated from major streams, implying that seclusion was indeed preferred. What this means is that rock art orientation could have cosmological implications, as secretive locations were appropriate for private vision quests. This notion is discussed later, given that much of this discussion involves winter solstice and astronomical themes.

## REANALYSIS OF DISTANCE VARIABLES

The results from the previous chapter hinted at a possible connection between rock art sites and elements in relation to their distances from streams and mounds. There appeared to be preferences for areas distant from streams and varying distances from mounds. By adding bluff shelter distributions into the analysis, it is now possible to reexamine these variables and see if rock art is closer or farther away. By doing this, we can be sure as to whether or not these variables of accessibility or proximity are unique to rock art.

Starting with cost distance from streams, we see that rock art sites follow a similar pattern as bluff shelters. Neither the chi-square test (Table 3.4a) nor the t-test (Table 3.4b) result in statistically significant p-values (0.7401 and 0.7729 respectively). Figure 3d depicts how similar these patterns are; both have relatively few percentages in the lower categories and experience a sharp increase at the "highest" category. Rock art sites, however, are more consistent in that they never decrease in quantity as cost distance from streams increases. This is slightly different than bluff shelters, which experience a small drop between the "lowest" and "low" categories. Rock art elements see minor increases in quantity as cost distance increases, with a considerable jump at the "highest" category. The percentage of elements (65.84%) is significantly higher than the percentage of bluff shelters (33.58%), suggesting that a majority of elements were placed in locations difficult to reach from streams. Supporting this are the chi-square and t-test, both of which result in p-values lower than 0.0001. Couple this with the fact that smaller percentages of rock art appear in the "lowest" and "low" categories, and the likelihood that rock art creators desired isolation becomes much stronger.

A look at the Euclidean distances from streams offers more substantial observations. In the previous chapter, we were left to wonder why the number of sites and elements drops off in the "farthest" category after a strong presence in the "far" category. In light of the bluff shelter distribution, it seems that bluff shelters are possibly less common in the areas farthest away from streams. This would make sense, given the role of streams and rivers in forming many of these shelters. Guy (1996:26), for example, notes a tendency for open-air rock shelters around Mammoth Cave National Park to "generally appear on small natural levees or on the large alluvial/colluvial fans associated with major tributaries." This reveals a concern for hydrological factors which allow for easier access to certain areas through the use of tributaries. Bluff shelter patterns in the Ozarks seem to follow suit, as the total percent of recorded sites diminishes with each successive category (Figure 3e). Because of this, the fact that 37.93% of rock art sites and 66.25% of rock art elements exist in the "far" and "farthest" categories is definitely remarkable.

Chi-square testing (Table 3.5a) suggests that the distribution of rock art sites does in fact differ from non-rock art containing bluff shelters, producing a p-value of 0.0226. The test shows the most significant category to be the "far" distance, which contains the largest portions of both sites and elements. While the t-test (Table 3.5b) results in a less significant p-value of 0.1583, it does reveal that the average rock art site is about 477m farther away from streams than the average bluff shelter. Both tests reveal statistical significance for elements ($p < 0.0001$), again, with the "far" category being the most prominent. Perhaps most noteworthy is just how distant most elements are from streams when compared to bluff shelters, the average element being about 1519m farther away from the nearest stream.

The cost distance from mounds variable offers new and interesting insight with respect to bluff shelter locations. Most of the recorded bluff shelter sites appear in areas with the “highest” cost to reach from the nearest mound, whereas few exist in the lower categories (Figure 3f). The previous chapter indicated that rock art sites and elements followed a relatively expected distribution, though only a few appear in the “mid” category. Now, it seems like some rock art sites and elements might exhibit desirability for easy access from mounds. This is evident by the “lowest” and “low” categories, both of which see larger percentages of sites and elements than bluff shelters. Chi-square and t-testing supports this observation, as all p-values indicate statistical significance. Specifically, the chi-square tests (Table 3.6a) produce p-values of 0.0002 for rock art sites and <0.0001 for elements. Meanwhile, the t-tests (Table 3.6b) result in p-values of 0.0041 for rock art sites and, once again, <0.0001 for elements. The means for both of these features are significantly lower than mounds, averaging cost distances much lower than bluff shelters with no rock art.

Hilliard et al. (2005:56) discuss the need to analyze rock art locations with respect to their nearness to residential and ceremonial sites. Doing so allows one to gain a better understanding of a group’s cultural landscape. As with cost distances to streams, rock art that is difficult to reach from public spaces possibly serves as ritual grounds for activities that merit seclusion. Using a least-cost path analysis carried out by Jami Lockhart, they suggest that rock art in Rockhouse Cave at Petit Jean Mountain might have served as a location for ritual activity, owing to its isolation from nearby habitational sites. Due to the variation of designs present at rock art sites, an examination of motifs might indicate why certain sites exist within close proximity to mounds, while others are farther away. This idea is explored in the next chapter.

Tests analyzing Euclidean distances from mounds provide less significant results. As evident by Figure 3g, there is a larger percentage of both rock art sites and elements in the "closest" category, but a much smaller percentage in the "close" category. The chi-square tests (Table 3.7a) indicate that these two categories exhibit the most dissimilarities. Results include a p-value of 0.1293 for sites and <0.0001 for elements, which initially suggests that sites are not significant while elements are. In light of the t-test (Table 3.7b), it seems that neither of these features are significant as sites produce a p-value of 0.6328 and elements a p-value of 0.1458. Even though the chi-square test proposes a significant connection for elements, this possibility will be rejected due to the t-test indicating otherwise.

Given the results discussed above, rock art seems to exhibit some degree of locational preference in regards to distance from certain areas, especially when compared to bluff shelter distributions with no rock art. A large portion of rock art elements require much effort to reach from streams in the study area, while both sites and elements commonly appear in areas proximally distant from said streams. The amount of effort required to reach rock art might be relevant if elements are in fact better indicators of environmental preference. That being said, there is a much clearer connection between rock art sites, elements, and Euclidean distance from streams. This could mean that the people creating rock art viewed privacy in the form of actual distances from streams, more so than cost distance. Rock art elements still, however, maintain a strong connection with cost distances from streams.

Regarding privacy, it is also interesting that many rock art sites exhibit spatial distance from tight bluff shelter clusters. Figure 3.2 displays rock art sites present at the "mid," "far," and "farthest" Euclidean distances from streams. Many of these sites exist in the southeastern and central sections of the study area, where relatively few bluff shelters coincide. It could be that distance from utilized bluff shelters also played a role in rock art location selection. A proper analysis of this, however, would require a cluster analysis to determine whether or not these patterns indeed exist. Based on the map, this type of analysis shows promise. As for mounds, there might be a link between cost distance and rock art. Statistical tests show highly significant results for both sites and elements, hinting that some rock art is designed to be easily accessible from local mounds or social centers. If this is in fact the case, then a closer look at the motifs present at sites with low cost distances might reveal interesting results.

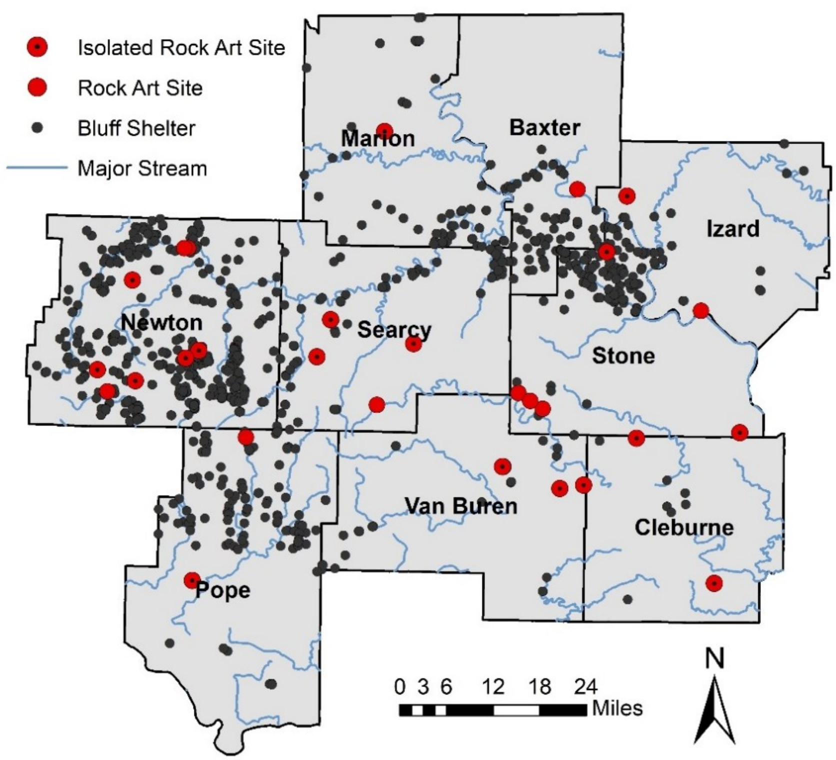



***Figure 3.2:*** *Rock art sites at the "mid," "far," or "farthest" Euclidean distances from major streams in the study area (Portions of this figure include intellectual property of Esri and its licensors and are used herein under license. Copyright © 2018 Esri and its licensors. All rights reserved.)*

## REANALYSIS OF VISUAL VARIABLES

Finally, we return to the set of visual variables. A reanalysis of these criteria is vital because, again, bluff shelters are geologically constrained in the landscape. Randomly generated points, which are capable of existing in any location, occasionally fall in areas drastically unlike environments that accommodate bluff shelters. Locations surrounded by large tracts of land will inevitably promote a much higher viewshed than typical bluff shelters, which often lie in areas with steep slopes that may block one's view. Conversely, these flat areas lack topographic prominence. When random points fall onto these areas, rock art patterns would likely differ and indicate preference for this type of environmental setting. Bluff shelter distributions should therefore offer better inferences when used as reference data.

Viewshed notably offers new perspectives when considering preference. Table 3.8a shows the same data as available on Table 2.8a; it is provided in Appendix 3 for the sake of convenience. Table 3.8b divulges the new t-test results for viewshed. If all rock art sites and elements are averaged, including the outliers (3SE0406 and 3VB0006), then the p-values show promising connections. Sites produce a p-value of 0.0953, which is far more significant than the previous test comparing them with random locations. A similar phenomenon occurs with the element t-test, which now reveals a p-value lower than 0.0001. Both of these results suggest a possible connection between rock art and impressive views. However, as discussed earlier, these data might be skewed by outliers. After removing the aforementioned sites, p-values now equal 0.3426 and 0.0935 for sites and elements respectively. Mann-Whitney U tests (Figure 3.8c) also portray this connection, as the p-values are 0.0078 for sites and less than 0.0001 for elements. Even though these figures are still more significant than the tests provided in the previous chapter, it is still somewhat questionable as to whether viewshed was a big concern.

It could be that some rock art locations were selected for the pleasantness of their views, but this trend does not seem to be consistent. After all, some sites maintain viewshed values in the low hundreds (see Table 3.8a). 3CE0073 only sees 370 pixels in the raster data, 3IZ0143 sees 400, and 3VB0019 sees 740. Compare these with some of the larger values, such as 3MR0094 with 48346 pixels and 3NW0076 with 30507, and one will see the sheer variability in rock art viewsheds. Furthermore, large quantities of elements do not always appear in sites with the largest viewsheds. 3NW0079, for example, contains 20 elements, but only sees 8425 pixels. Likewise, 3ST0070 holds 36 elements, but can only see 4016 pixels in the raster data. Both of these numbers are noticeably lower than the means displayed in the t-test tables, meaning their viewsheds are lower than average. While viewsheds in the thousands likely pose strong views, relatively speaking, one is left to question why sites with large numbers of elements would hold viewsheds lower than some sites with extremely high viewsheds. Because of this, it is probably safe to conclude that viewshed was occasionally considered, but was not a primary concern, at least in this specific study area.

Continuing on the subject of visibility, we return to the directional prominence variable to see if topographically perceptible locations are unique to rock art, or simply a common factor of bluff shelters. An earlier study by Hilliard (1993) assessed commonalities between a larger sample of rock art sites with bluff shelters and caves containing no rock art, emphasizing landscape prominence. His statistical tests suggested that rock art sites are more likely to appear on prominent locations than habitational bluff shelters and caves, meaning they tend to be higher than the surrounding terrain. Rock art existing on prominent landforms could be a result of one's desire to have the art seen by other people. Hilliard's analysis encompassed a larger area and included many more rock art sites than this thesis, but it used the typical circular neighborhood to calculate prominence. As discussed earlier, the nature of bluff shelter orientation promotes analyses that account for cardinal direction.

When compared to bluff shelters, neither rock art sites nor elements show signs of different locational preferences concerning directional prominence. Figure 3h depicts the similar distributions between all three site-types; they appear in moderate numbers in the "lowest" category, see reductions in quantity through the "low" and "mid" categories, then sharply increase through the "high" and "highest" categories. Chi-square testing (Table 3.9a) results in an insignificant p-value for rock art sites (0.1918) and a highly significant p-value for elements (<0.0001). The t-test (Table 3.9b) confirms that the site pattern is not significantly different than the bluff shelter pattern, with a p-value of 0.4999. However, it does contradict the chi-square result for elements, producing a p-value of 0.5316 which is by no means significant. Given this discrepancy, it is probably safe to assume that elements do not differ from bluff shelters with respect to this variable. Whereas the previous chapter indicated that rock art likely had some relationship with directionally prominent locations, it seems more likely that, geologically speaking, bluff shelters just so happen to exist in these areas already. Therefore, the tendency for high directional prominences is not unique to rock art.

Concerning the sun-related variables, some interesting pieces of information materialize. Statistical tests on rock art and bluff shelter distributions, with respect to the amount of light they receive from winter solstice phenomena, indicate a possible connection with sunrises, but less so with sunsets. Winter solstice sunrises fully encapsulate more rock art sites and elements than bluff shelters in the "highest" category, with differences of 16.04% for sites and 42.61% for elements (see Figure 3i). While bluff shelters tend to exist in areas that receive the largest amounts of light, there is also a considerable percentage that receives the least amount of light.

Chi-square testing (Table 3.10a) does not provide a statistically significant p-value for sites (0.1436); however, the t-test (Table 3.10b) results in a very significant p-value (0.0015). This implies that rock art sites generally average more sunlight from a winter solstice sunrise than bluff shelters. Tests carried out on elements suggest a strong connection, as many exist in these heavily illuminated areas. Both chi-square and t-testing yields p-values lower than 0.0001. Rock art distributions therefore differ from bluff shelters based on the winter solstice sunrise variable in that they tend to receive considerably more light.

The strong patterns relating to winter solstice sunrises are quite remarkable. Sabo and Hilliard (2005:25) note that sun worship was a common practice among many Southeastern groups. Ethnohistoric documentation provides evidence for this claim. Felis de Espinosa ([1718], translated by Hatcher 1927:173) recorded a Hasinai harvest ceremony and wrote, "…after the song, they all await the rising of the sun. Certain young men and boys are sent out into the nearby woods as if calling or speaking to the sun for the purpose of hastening its coming." He then explains how the Hasinai seemed as if they were giving thanks to the sun for past crop yields and asking it for aid in future projects. This particular account not only reveals the importance of the sun in Southeastern Indian belief, but also provides an instance where young men traveled into the wilderness to engage in rituals. Building upon information provided earlier regarding vision quests and distances from streams, it is possible that many rock art sites served as spaces for sunrise-related activities that merited seclusion.

Compared to bluff shelters, rock art follows an overall similar trend relative to winter solstice sunsets (Figure 3j). Some rock art and bluff shelters receive little to no light from this phenomenon, while large percentages of each receive large amounts of illumination. For rock art sites, the chi-square tests reveals a p-value of 0.2863 (Table 3.11a), while the t-test produces a less significant p-value of 0.6125. Though the statistical tests provided in the previous chapter showed signs of preferences for either the "lowest" or "highest" categories, these new results suggest that these patterns are not unique to rock art. Elements, however, receive highly significant p-values from both tests (<0.0001). There is a relatively even split in percentages between the "lowest" category (36.63%) and the "highest" category (30.45%), while the middle categories hold fewer elements. This could mean that certain designs were appropriate for locations receiving little sunlight, while others were preferred for larger amounts. Thus, a look at rock art motif patterns, relative to this variable, might indicate whether or not this trend exists.

Thus, it appears that rock art has a stronger connection with winter solstice sunrises than they do with sunsets. There are a few possible reasons as to why this pattern exists. The first relates to Mississippian cosmological views. Given the prominent role of the rising sun as a symbol for life, it could have maintained additional significance during the winter seasons, which were seen as times of death (see Kay and Sabo 2006). This viewpoint, if credible, might manifest in the physical remains of certain rituals. If rock art was indeed aligned with winter solstice sunrises, then the implication is that they were created during the winter. While this is admittedly speculative, there are powerful symbolic connotations. Rock art would face the rising sun, a symbol of life or renewal, during winter seasons which were commonly associated with death. Thus, a figurative duality exists between the formation of rock art and the periods in which it was created. An alternative explanation involves directionality. Possibly, connections with winter solstice sunrises are simply by-products of southeastern orientations. Did rock art creators desire locations that receive light from winter solstice sunrises and therefore face southeast, or did they desire locations that face southeast and therefore receive light from these sunrises? It is a post-hoc conundrum that merits a discussion of rock art motifs in order to fully understand this configuration, which the next chapter will hopefully divulge.

## DECISION FRAMEWORKS

This chapter showed the appropriateness of bluff shelter distributions as a means for comparison with rock art. These results appear to be far better indicators of location selection, if bluff shelters were indeed the preferred environment for rock art creation. The bluff shelter distribution proved to be particularly useful in narrowing down the amount of variables to consider for locational preferences. Whereas statistical testing with expected values and random samples suggested that most of the variables are significant, bluff shelter data highlighted the most promising variables. For rock art sites, these include the following: southern-facing aspects, far Euclidean distances from streams, low cost distances from mounds, high illumination from winter solstice sunrises, and possibly strong viewsheds. For elements, these include: southern-facing aspects, high cost distances from streams, far Euclidean distances from streams, low cost distances from mounds, high illumination from winter solstice sunrises and less concern for sunsets, and possibly strong viewsheds. These new results eliminated superfluous variables that are not representative of rock art, but instead simply where bluff shelters tend to occur. Elevation and slope, for example, are not particularly noteworthy; bluff shelters are simply more common at higher elevations and steep slopes.

Now that we finally have a reasonable understanding of rock art locational preferences, we can assess which variables were the most important. Criteria with the most significant data likely held high importance among rock art creators. Thus, we can place these highly significant variables into decision frameworks, which display a hierarchy of preferences. In other words, the frameworks show the decision-making processes involved with rock art location selection.

Figure 3.3 posits a possible decision process involved with rock art site location selection. The order of preference is determined by averaging the p-values from both statistical tests used for each variable (APV = average p-value). Viewshed contains two numbers: the first includes the t-test that used all rock art values, while the second includes the t-test that excluded the outliers. The initial decision might involve how accessible a site is from local mounds. Though the general site pattern was not statistically different than expected values or random points, bluff shelters containing rock art are far more likely to appear in closer proximity to mounds than their non-rock art containing counterparts. Thus, for the sake of quantitative consistency, it is the first consideration. The next decisions involve orientation, namely southern aspects and alignment with winter solstice sunrises. After this, considerations are made regarding seclusion from major streams. The last important decision involves aesthetics, or whether or not the location has a strong view of surrounding areas. Because viewshed had mixed statistical results with concerns about outliers, it is probably safest to treat it as a "luxury" that, while certainly important in some circumstances, was not a strict requirement for site locations.

In this site decision framework, there is a split in the accessibility considerations. Concerns about orientation and astral phenomena potentially came after desires for accessibility from mounds, but before privacy from streams. There is, however, the matter of elements, which saw slightly different distributions in relation to different variables. Figure 3.4 illustrates a possible decision framework for rock art element location selection. Because this framework only includes variables that maintained p-values lower than 0.0001 for both statistical tests, each variable is weighed by significant percentages of elements that differed from bluff shelters in any of the categories presented on the graphs in Appendix 3. In "Illumination from Winter Solstice Sunrise," for example, the highest percentage (HP) was 85.19% in the "highest" category. Some values, such as Aspect, were calculated by adding two significant percentages. Both the "southeast" and "south" categories seemed significant, so they were combined to more effectively represent the possible decision-making process. Viewshed is the exception, which is weighted by p-values because no percentages exist. It is included in this framework because both p-values from the chi-square and Mann-Whitney U test produce values lower than 0.0001 when outliers are omitted.

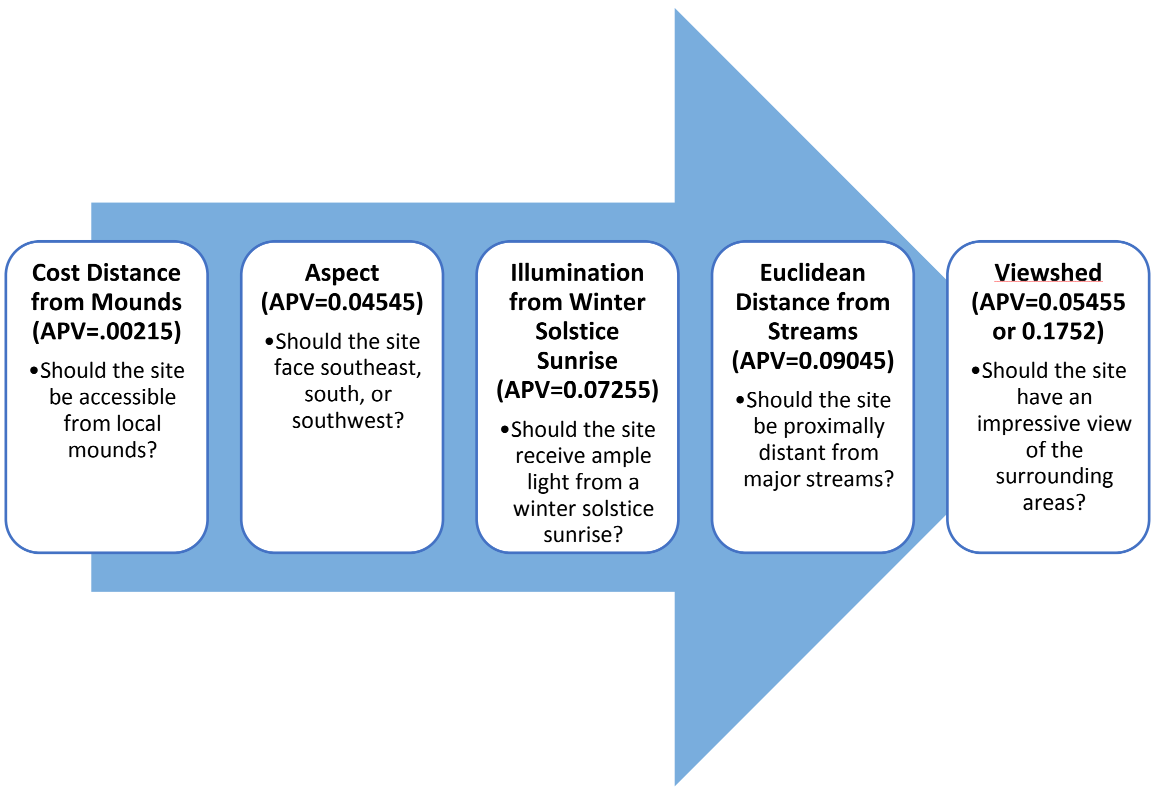



***Figure 3.3:*** *The decision framework associated with rock art site location selection*

The preliminary considerations made under this framework involve orientation, especially as they relate to winter solstice sunrises. This could go hand-in-hand with element aspects, which typically faced southeast, but also frequently faced south. These two variables seem to take priority over accessibility and isolation. The following decisions involve cost and Euclidean distances from streams. It seems there was a slight preference for difficult-to-reach locations from major streams, more so than desires for Euclidean distance from the same streams. These were likely the most important decisions for elements: where should my rock art face, then where should I put it? After these choices were made, a person or group might have considered whether or not the elements should be easily accessible from local mounds, or whether they should be shielded from winter solstice sunsets. In the case of winter solstice sunsets, elements probably were not purposefully hidden from the solar event. Rather, the pattern probably resulted from the stronger preference for sunrises, hence rock art elements likely receive less light from winter solstice sunsets. Finally, desires for impressive views could have followed afterword. Viewshed does not have any percentage values, so the data comes from statistical p-values.

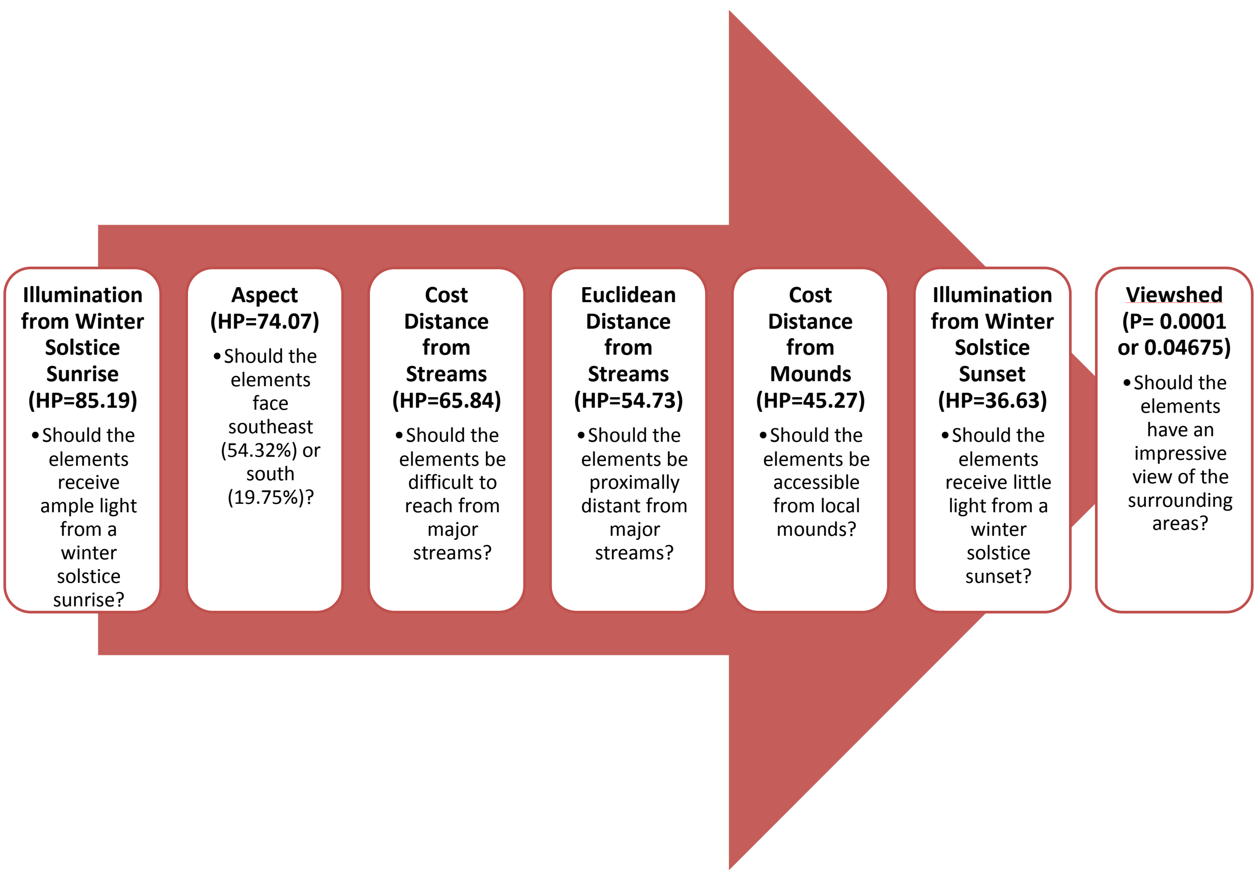



***Figure 3.4:*** *The decision framework associated with rock art element location selection*

Obviously, the slight differences between rock art site and element distributions make it somewhat difficult to discuss locational priorities. Using rock art sites as indicators for preference allows one to assess the differences between p-values more effectively, thus providing inferences based directly from the statistical tests. These same tests, when applied to rock art element, revealed data that was too statistically significant to determine which variables were more important based solely on p-values. Yet, this shortcoming might actually have benefits. If both the chi-square and t-tests agree on values lower than 0.0001, then there is better certainty regarding preference for that variable. It also forces one to look at the observed values and percentages present at each category to formulate a decision-making process. The site-related decision framework places a distance variable first, then orientation variables, and then another distance variable. The element-related decision framework, on the other hand, provides a more streamlined process: orientation variables come first, then distance variables.

One caveat here is that a contemporary researcher's view on coherent decision priorities likely differs from that of a different cultural group in a different time period. In other words, what we today might view as a logical, streamlined decision process might not be the same as Mississippian Indians several hundred years ago. Another issue, again, involves sampling. With the scant quantity of rock art sites, it is difficult to know whether the frameworks described above are accurate, or simply a product of a low sample size. Either way, the use of elements will prove particularly useful in the next chapter, when differing artistic styles and motifs are considered in the context of the Ozark landscape.

# CHAPTER 4: MOTIFS IN THEIR LANDSCAPE

The previous two chapters focused on large macro-level analyses, which emphasized site and element placement in the Ozarks. While this is useful for understanding general locational preferences, they neglect to discuss the types of rock art found in these locations. Indeed, certain motifs might have connections with the environmental variables used in this thesis. It is therefore important to look at these designs and inspect their contexts within the landscape. Doing so possibly indicates the favored environments for these motifs, their ideological purposes, or even the types of activities involved in their production.

The Arkansas Ozarks are home to a wide array of rock art designs, varying from natural objects to the more abstract shapes. Sabo (2005) outlines a series of identifiable rock art motifs: human figures, animals, composite creatures, plants, celestial phenomena, crafted objects, geometric figures, and abstract figures. This chapter uses a categorical scheme adapted from Sabo's list, focusing on general themes or patterns (see Figure 4.1). There are multiple motifs one can utilize for spatial analysis. The categories selected here basically condense some of these possible categories for the purpose of maintaining adequate sample sizes. For example, one could try to analyze the locations of turtles, snakes, and centipedes independently. However, doing so would only leave one turtle, three snakes, and two centipedes for use in the analysis, which are far too small for adequate testing. But when combined into a Beneath World category, the population becomes much better while still maintaining the overall symbolism conveyed by these motifs.

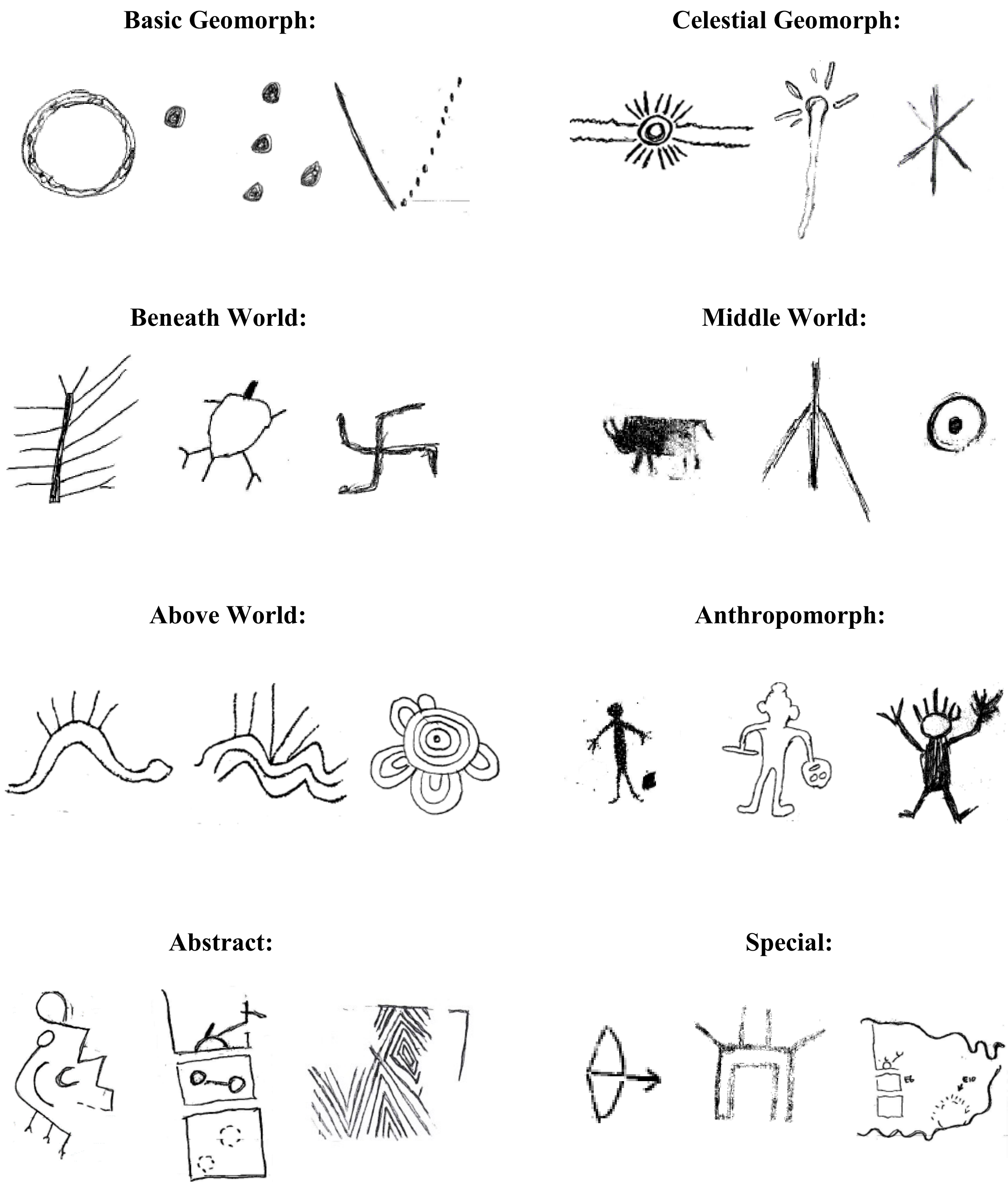



***Figure 4.1:*** *Rock art motif typologies with examples (sketches adapted from the Arkansas Archeological Survey rock art site forms)*

The first two categories focus on geometric shapes: basic geomorphs and celestial geomorphs. Basic geomorphs are simple shapes that represent the largest quantity of elements in the Ozarks. This includes circles, parallelograms, and lines. Celestial geomorphs include astronomical shapes and heavenly bodies, such as sunbursts, stars, and "rayed" figures. The reason behind separating these two types of geomorphs lies in their meanings. Basic shapes are notoriously difficult to decipher. In many cases, rock art experts are not clear as to what these shapes represent or what they mean symbolically. Celestial shapes, on the other hand, are far more discrete in their form. While a sunburst likely denotes a sun or astral sensation, a typical circle is far more ambiguous. Furthermore, there is already much information regarding the connections between astral figures and Mississippian cosmologies, namely suns and stars (Lankford 2007a; Lankford 2007c).

On the topic of cosmology, the next three categories are concerned with the Mississippian three-tiered worldview: Beneath World, Middle World, and Above World motifs. As discussed in the introduction to this thesis, pre-contact Mississippian Indians in the Southeast professed to a complex system of ideological exchanges known today as the Southeastern Ceremonial Complex (SECC) (Lankford 2007a). Much of the ideology involved with the SECC was integral to daily Mississippian life, dictating spatial organization and providing inspiration for various art forms. The Beneath World category consists of a few different types of images. Amphibious and reptilian animals, which typically inhabit watery environments, are associated with this realm (Dowd 2011). In the study area, this primarily includes snakes and a turtle motif. Aside from these, two centipede elements from 3ST0070 are also considered a Beneath World motif, as they too inhabit "underground" habitats. Beneath World imagery is not limited to animals. Spinning crosses, or "swastikas," served as symbolic locatives for the Beneath World (Reilly 2007). As a result, they too are counted in this category.

Like the Beneath World category, Middle World motifs involve a combination of zoomorphs and symbolic locatives. Animals include a few bison motifs found at 3ST0070, but primarily involve turkey track petroglyphs. Though their footprints are not an animal themselves, they represent a *pars pro toto*, or "part for the whole," whose shape invokes the imagery of the entire animal (Dobrez and Dobrez 2013:81). Another shape in this category is the "dot-in-circle" motif. Much like the spinning cross, this design acts as a symbolic locative for the Middle World. Reilly (2007:41-42) interprets this shape as ritualistic in nature, condensing a three-dimensional activity into two-dimensional space. The middle dot stands for a central pole, while the surrounding circle represents the activities or dances performed around the center. This geometric figure has connections with this cosmological plane. Osage people of the late nineteenth and early twentieth centuries used this motif "as a symbol for the Isolated or Sacred Earth Clans" (Diaz-Granados 2011:84).

Generally, Above World motifs consist of images associated with the air and often include winged beings who inhabit this realm. Few of these motifs are currently known in the study area. One site (3ST0054) contains three winged serpents, which creates an interesting dilemma. Snakes typically belong in the Beneath World category; however, these particular animals are displayed in flight. These motifs effectively combine two cosmological themes: the Beneath World and the Above World. "In American Indian belief, the powers associated with the three realms were antithetical and dangerous to combine, but could bring benefits to earthly communities when correctly brought together in the context of appropriate ritual" (Sabo 2005:107). Because the winged serpent motif represents these present in both worldly realms, these three elements are categorized as both Above and Beneath World designs, though Reilly (2004) considers this motif as part of the Above World. There is one other rock art element that might fit into this category. At 3VB0316, there is a curious shape which looks like an amalgamation of concentric circles (Figure 4.2). When combined, they appear as a "petaloid" figure, which Reilly (2007) suggests is another symbolic locative for the Above World. Though it could very well be another geomorph, or even an alteration of a concentric circle motif, it is worth examining in this category to see if it possesses Above World characteristics within the landscape context.

***Figure 4.2:*** *A possible "petaloid" motif found at 3VB0316 (from ARAS site form)*

Next are anthropomorphs, which depict human-related motifs. Occasionally, these figures are illustrated with objects in hand or ornaments adorning their bodies. In some cases, anthropomorphs are portrayed in action, engaged in ritual or hunting activities. With the right context, it might be possible to identify the social status associated with certain individual figures (see Sabo 2005: 95-101). Unfortunately, most Ozark anthropomorphs lack this additional information. Much of the figures are simple "stick drawings" that do not reveal much in the way of activity or status. There are, however, a few exceptions. Some anthropomorphs, such as those at 3VB0006 and 3VB0316, hold objects in their hands. Another at 3PP0614 portrays an individual with a possible headdress. These detailed figures are useful because they can be compared with anthropomorphs lacking said details, which potentially reveals whether their locational preferences differ. Aside for human body shapes, there are a few handprints that fall into the anthropomorph category. Much like the turkey track serves as a *pars pro toto* for a turkey, a hand print effectively represents the human body.

Abstract motifs are difficult to describe. Sabo (2005:115) defines them as “images that cannot be grouped among the simple geometric shapes, but are still unidentifiable as to subject.” In most cases, they appear as a single element composed of multiple artistic details, such as crossing lines, irregular shapes, or multiple figures that combine to make one unidentifiable element. One site that contains multiple examples is 3SE0105, which contains a series of squares inlaid with circles and lines, as well as zig-zag shapes with bulbous ends (Figure 4.3). For this study, the abstract category basically includes any motif that is too complex to fit into the Geomorph category, but also too ambiguous to fit into any of the others.

The final category, special, comprises any motif that does not fit into any of the above groups. They typically involve hand-crafted objects or other subjects that do not hold a consistent theme in relation to other motif-types. 3NW0459, for example, contains three individual bow-and-arrow elements. 3ST0054 has two curious shapes, which might represent masks worn by important individuals. The only other site included in this category is 3SE0105, which contains a painted border encompassing other elements. Due to the variability of these rock art motifs, it is difficult to draw any concrete conclusions from their patterning in the landscape. Nonetheless, they are included in this analysis to see if any data can be retrieved from their locations.

***Figure 4.3:*** *Series of abstract motifs found at 3SE0105 (from ARAS site form)*

Judging the above categories, one could make reasonable arguments against the placement of certain motifs in any of these groups. Interpretation of ancient art comes with a few caveats. Namely, what we, in our cultural context, consider to be a "snake" might not be the intended message of those who created the design hundreds of years ago (see Muller 2007:24-27). This makes it difficult to read symbols as they may stand for a variety of ideas and, in some cases, exhibit purposeful ambiguity. Hence, one motif could belong in a different category, no categories, or even multiple categories. Another issue is more specific to this categorical scheme. Other rock art researchers might claim that some of the above categories are far too generous with the motifs included within them. Rayed figures might not actually represent astral phenomena, but instead be a series of simple lines. If this is the case, then they more appropriately fit into the basic geomorph category rather than the celestial geomorph group. As we learn more about Mississippian iconography, the categories used in this thesis can be reexamined to determine whether they were in fact too lenient.

An unfortunate drawback for this analysis of motifs is the limited sample size for some types. There are, for example, only ten Beneath World and four Above World elements currently known in the study area. Neither of these totals allow for particularly robust statistical data and there is potential for skewed results. If five Beneath World elements exist in one environmental category, the results will likely show significance as 50% of the total population falls into one shared location. With only five out of ten elements, however, one is left to question whether the results are indicative of locational preference or simply coincidental. Hence, statistical significance may be a by-product of sampling issues.

Because of this sampling issue, statistical tests alone likely cannot explain all rock art motif patterns. That being said, the wide array of artistic designs allows for a different type of comparison. One can look at motif distributions in the context of other motif-types, which potentially allows for interpretation regarding which areas were preferable for certain designs. If, for example, a significant proportion of basic geomorphs exhibit a notably different pattern than other motifs in respect to an environmental variable, then we can infer that said variable was uniquely selected for basic geomorphs. This type of contextual approach was adopted by Simek et al. (2013:438), who compared the locational tendencies of motifs in the Cumberland Plateau landscape. While anthropomorphs and geomorphs appeared in both open air and dark zone contexts, serpents, birds, and transformative creatures were almost exclusively found deep in caves. Simek et al. therefore suggested that these zoomporphs conveyed themes of the underworld.

The following sections use a similar approach to Simek et al. (2013). Rather than attempt to squeeze out statistical significance from small numbers using chi-square and t-tests, comparisons are made with respect to other motif types. Appendix 4 consists primarily of two sets of data. The tables show the total number of elements for each motif that reside in the landscape, using the five equal-area classifications from the previous chapters. The graphs translate these numbers into percentages, thus allowing visual representations of these distributions. The one exception is viewshed which, as discussed earlier, is not capable of being split into multiple classifications.

## MOTIFS RELATIVE TO GENERAL LANDSCAPE VARIABLES

While considering the variety of motifs present in the Ozarks, we finally have a probable explanation behind the "mid" to "highest" elevation split discussed in the previous chapters. According to Table 4.1, it looks like there is a dichotomy between the placement of geomorphs (both Basic and Celestial) and that of more "worldly" motifs (such as zoomorphs and anthropomorphs). About 46.24% of basic geomorphs and 47.37% of celestial geomorphs appear at the highest elevations available in the study area. Meanwhile, 80% of Beneath World, 38.46% of Middle World, 75% of Above World, and 48.84% of anthropomorphic motifs exist in the "mid" category (see Figure 4a). Because the "lowest" and "low" elevation categories are generally unfavorable for bluff shelter development, and therefore less likely to accommodate rock art, it might be more appropriate to view the "mid" category as a lower elevation classification. This would mean that motifs representing natural living creatures, such as animals and humans, were preferred for lower elevation environments, while those signifying shapes and astronomical figures were usually reserved for higher elevations.

This distinction between the more worldly figures and geometric shapes is curious. Other studies in the Arkansas Ozarks have noted similar phenomena. Sabo et al. (2015), for example, interpreted the Arkansas River as a boundary between motif patterns, where rock art south of the river typically consisted of images relating to seen and unseen dimensions of human existence, while rock art north of the river consisted of spirit and cosmological themes. These designs effectively form a cosmogram, where symbolism is embedded in the placement of cultural sites in the landscape. Given the trends discussed above, it could be that a similar pattern exists with respect to elevation. If this is the case, then the directional cosmogram is mimicked in three-dimensional space. Rock art depicting earthly themes were therefore produced at lower terrain, while those depicting astral or geometric shapes were created higher up.

There is, however, the issue of Middle World motifs, of which 34.62% exist at in the "highest" category. This is a relatively high percentage that possibly casts doubt on this suggestion. Still, of the nine elements that make up this percentage, six are zoomorphs and three are dot-in-circle motifs. One of the zoomorphs at this elevation comes from 3NW0459. It is a turkey track which, in relation to the surrounding "stick-like" elements, could be a geomorph mistaken for a zoomorph. In any case, the Middle World motifs present in all categories lower than the "highest" are far more consistent with animal imagery, only two of which are symbolic locatives. What this all means is that the Middle World motifs with lower elevation tend to be zoomorphic in nature, and therefore represent themes one can see on the physical landscape. One other point of contention includes the winged serpent elements from 3ST0054 (see Figure 4.4). These shapes likely symbolize otherworldly entities, which one would think fit more appropriately with the higher-elevation motifs. The presence of winged serpents at lower elevations, however, is actually consistent in southeastern rock art distributions. Simek et al. (2013) discusses the tendency for snakes and transformative figures to appear in dark-zone cave contexts with lower elevations than open-air rock art. Another study by Simek and Cressler (2008) notes that transformative figures are more common in deeper areas within caves in relation to other motifs. Thus, the subterranean nature present in lower elevations possibly held an allure to serpent-like, Beneath World motifs. This conclusion might be speculative, as there are only three of these elements in the study area and they exist in the same site.

***Figure 4.4:*** *A winged serpent motif found at 3ST0054 (from the ARAS rock art website)*

Basic and celestial geomorphs, on the other hand, more consistently reside at the highest elevations available. If we use Sabo et al. (2015) as a comparison, then these rock art elements might represent themes less associated with observable earthly phenomena. Basic geomorphs are notoriously difficult to decipher, as their shapes could hold multiple interpretations. However, because they share a similar pattern with celestial geomorphs, their meanings might hold common ideas. As these astronomical shapes act as symbols for figures in the sky, be they stars, rays of light, or the sun itself, it is possible that the people making rock art wanted these shapes closer to the phenomena they represent. According to Brown (2011: 42), the Above World was occupied by important stars, the sun, and the moon. Though celestial geomorphs are placed into a category distinct from Upper World designs, the tendency for them to exist closer to the sky fits well within Mississippian cosmological frameworks.

Slope does not offer too much in the way of discussion. Most motifs follow the same pattern, where the largest quantities exist in the "highest" category (Table 4.2). Perhaps the most noteworthy statistic here is the percentage of celestial geomorphs in the "high" category. About 68.52% of these elements are present at these locations, which have somewhat flatter slopes than the other motifs (Figure 4b). Abstracts also exhibit a similar trend; 66.67% reside in the "high" group, though there are only nine Abstracts total so the results might be skewed by a small sample size. It could be that some basic and celestial geomorphs were preferred for environments with relatively lower inclines. A brief review of the site forms, however, does not offer much information regarding why this might be. Both of these motifs see mixed distributions for different designs, whether they be circles, sticks, sunbursts, or rayed figures. Hence, the pattern here might simply be coincidental.

In relation to aspect, most motifs face southeast (Table 4.3). Anthropomorphs are most consistent with this orientation, as 81.4% of these elements face southeast (Figure 4c). It is difficult to ascertain why such a large percentage exists with southeastern aspects. Most of the anthropomorphs facing this direction do not exhibit special ornamentation or are engaged in observable activities. The same goes for anthropomorphs facing south and southwest, save for one at 3VB0316 depicting a human holding another person's decapitated head (Figure 4.5). This strong tendency for anthropomorphs to face southeast might be related to the winter solstice sunrise, invoking themes of life and reincarnation. This possibility is discussed later on in this chapter. Abstract motifs also fall slightly outside of the southeastern orientation trend, as 55.56% face east. As stated earlier, abstracts are somewhat difficult to understand. However, the lack of a strong southern trend might imply that their distribution is related to some phenomena other than winter solstices or the southern Milky Way star cluster.

***Figure 4.5:*** *An anthropomorph holding another's head at 3VB0316 (from ARAS site form)*

Another point of interest involves the geomorphic categories. Out of all motifs, celestial geomorphs are most likely to face directly south, though not by much. Percentagewise, 31.58% face south, while 26.32% face southeast, and another 26.32% face east. Initially, one might assume that the south facing astronomical motifs would predominately consist of star shapes, which would seem appropriate for facing the Milky Way in the southern sky. Interestingly enough, none of the six elements facing this direction include star or star cluster designs. All of them are either suns, sunbursts, or rayed figures. This does not necessarily imply that astronomical motifs are not related to the southern sky, but it does seem peculiar that many sun-related shapes do not directly face the southeastern winter solstice direction, while many star shapes are not oriented directly toward the Milky Way. There is a chance that they do in fact maintain visuals of these respective phenomena, though the aspect calculation done in ArcMap is limited to specific cardinal orientations.

Evidently, the southeastern trend seems to persist through all rock art motif categories. Though some motifs display higher concentrations in this cardinal direction, while others hold slight variations in different directions, the necessity for the southeast is predominant. What this means is that aspect was important for rock art production in general, and likely was not important for individual designs. This could imply that rock art is a product of similar rituals which require orientation toward southeastern areas. The resulting motifs are therefore a result of different preferences in relation to the environment.

## MOTIFS RELATIVE TO DISTANCE VARIABLES

Much like how there is a distinction between rock art patterns as they relate to elevation, there are similar signs with distances from streams and mounds. Specifically, anthropomorphic elements seem to have different locational tendencies than the other motif categories. Starting with Table 4.4, cost distance from streams, we see a noticeable quantity of anthropomorphs in the "lowest" category. While this only translates into 18.6% of all anthropomorphic elements, the percentage present here starkly differs from the other motifs. Anthropomorphs are the only motif in these areas easily accessible from streams; every other motif group holds 0% in this category

(Figure 4d). Similarly, anthropomorphic motifs are also overall closer with respect to Euclidean distance from streams. According to Table 4.5, ten anthropomorphs exist in the “closest” category, which renders a portion of 23.26% of all elements in this group (Figure 4e). Even though most anthropomorphs do in fact reside in areas difficult to reach, as well as proximally distant, from major streams, the fact that many do not follow this common pattern is worth looking into.

Unfortunately, a closer examination of the site forms does not yield much in the way of conclusiveness. All of the eight anthropomorphs with the lowest cost distance from streams come from the same site, 3NW0276. Most of these elements were listed as borderline indeterminate, with only three clearly discernable. Even so, none of these anthropomorphs are depicted in any form of activity that might indicate why ease of access from streams would be important. Another site with low cost distance from streams is 3PP1380, which contains two anthropomorphs on an exposed boulder. These figures have their arms raised and also appear to be squatting. For Euclidean distance, 3NW0276 once again provides most of the elements in the closest regions to streams. The other two anthropomorphs come from two separate sites. The first, 3ST0076, exhibits a person with ear ornamentation and his/her arms folded downward. The second, 3PP0614, portrays an individual with raised arms and a possible headdress.

It is somewhat difficult to discuss why certain locations with ease of access from streams would be preferable for some anthropomorphic rock art. This is partly due to the lack of consistency with said figures, as some are engaged in unique actions while others are simply “stick-figures.” Based purely on the statistical data, it is possible that some anthropomorphs are not produced in the context of private rituals or secluded religious experiences. Another way to think about it might be that anthropomorphs are more likely to be produced for public purposes than other rock art motifs. This suggestion is bolstered by the fact that only 37.21% of anthropomorphs appear in areas with the highest cost distances from streams. While this percentage is of considerable proportion, it is also noticeably smaller than the percentages of other motifs in the "highest" category. With respect to Euclidean distance from streams, 51.17% of anthropomorphs are split between the "closest" and "mid" categories, whereas the strongest concentrations of other motif-types are split between the "mid" and "far" categories.

Using a neuroscientific perspective, Watson (2012) argues that artistic portrayals of the human body are prioritized for attention. This is partially due to their ease of recognition, which is perceptually similar across cultural boundaries. In other words, anthropomorphic shapes tend to be easily recognizable as humans and are frequently applied in observable settings. If anthropomorphs in the Ozarks follow the same logic, then many were possibly reserved for locations where they are more likely to be seen or experienced by locals. Though not necessarily related to distance, Simek et al. (2013:434) observed that anthropomorphs are far more likely to appear in open air contexts than other motifs in Tennessee, which often resided inside caves. Perhaps this indicates a yearning for availability that is not as evident with other rock art designs. Because most of these anthropomorphs come from only one or a few sites, their ease of access from streams could simply be a statistical inconsistency. Maybe 3NW0276 was selected for reasons unrelated to the other anthropomorphs. If this is the case, then the idea presented here might be unwarranted. Nonetheless, this possible trend is worth exploring in other sections of the Ozarks to see if the pattern persists.

This, of course, leads to a discussion of mounds, which seem to hold much stronger connections with anthropomorphs than do streams. As evident by Table 4.6, anthropomorphs maintain strong concentrations in the "lowest" and "low" cost distances from mounds. In fact, all but four of these elements exist in those two categories. In terms of percentage, this amounts to 53.49% in the “lowest” and 37.21% in the “low” (Figure 4f). Also noteworthy are Middle World elements, of which 46.15% exist in the “lowest” category. While there are other motifs with relatively large concentrations in these categories, such as Beneath World and celestial geomorph elements, their distributions are too stretched between multiple categories to be connected with low cost distances from mounds. Likewise, an analysis of Euclidean distance from mounds reveals similar trends. Anthropomorphic and Middle World elements predominately reside in areas closest to mounds, whereas other motifs are either distributed through multiple categories or tend to remain farther away (Table 4.7). The pattern visible here likely explains why the tests carried out in the previous chapters showed a split between closeness and distance from mounds, with respect to rock art distributions. Proportionately, 51.16% of anthropomorphs and 42.31% of Middle World elements reside in the “closest” category (Figure 4g).

When considering Euclidean distance from mounds, it is important to note that most of the elements come from 3ST0070. This site contains thirteen anthropomorphs, six bison, and an indeterminate quadruped, all of which reside in an underground cave. Other anthropomorphs with closeness to mounds are found at 3NW0276, which was explained earlier. Interestingly enough, anthropomorphs closer to mounds seem less likely to be depicted with objects in their hands or ornaments on their bodies. The opposite can be said for many that are distant from mounds (see Figure 4.6 for examples). At 3VB0006, a site which resides in the “far” category, a human is shown holding what might be two staffs, while other human figures surround the individual. Other anthropomorphs far from mounds include those at 3VB0019, one of which might be holding a triangular-shaped object, and 3VB0316, which contains the person holding another's decapitated head, as well as a legless human. Those with "mid" level distances from mounds include the raised arm with headdress anthropomorph at 3PP0614 and the squatting human petroglyphs from 3PP1380, both of which are surrounded by unidentifiable icons. Based on this information, it is possible that anthropomorphs closer to mounds or social centers were used for public reasons, as they were more likely to be seen. Meanwhile, those distant from mounds could have been a part of religious activities that merited detachment from said centers.

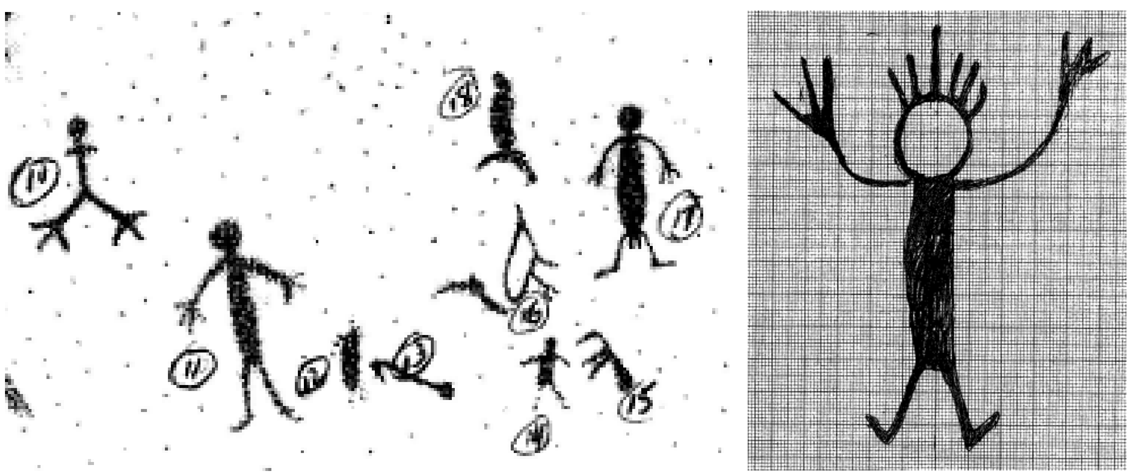


***Figure 4.6:*** *Anthropomorphs without adornment at 3ST0070 (left) and an anthropomorph with a possible headdress at 3PP0614 (right) (sketches from ARAS site forms)*

The distance of unique anthropomorphic rock art from mounds is noteworthy because it touches upon themes of polity. Settlement patterns of Mississippian mounds shed light on regional organization, potentially displaying a political sphere of influence (Livingood 2010). Keeping anthropomorphs that depict individuals with important roles, or perhaps even named people, outside of these social boundaries might arise from desires of isolation. Much like how rock art generally appears away from streams, anthropomorphic shapes displaying distinctive activities or paraphernalia might be the result of a religious, secluded ritual. Though not necessarily related to rock art, Smith and Miller (2009) examine the distribution of Mississippian anthropomorphic stone statuary in the Cumberland area of Tennessee. Based on anecdotal information, they note that many of these figurines are found near mounds (though this might be because mounds are very archaeologically visible). Still, many are found in locations with no evidence for mounds. Smith and Miller suggest that these specific locales might represent forms of Mississippian ceremonial architecture. Though anthropomorphic rock art often lacks the clarity of form present in stone statuettes, small details, such as the held objects discussed above, possibly indicate similar uses of space.

Alternatively, keeping these elements away from mounds might protect them from damage. In Mississippian conflict, one goal of raid-style warfare might have been the desecration of religious grounds which legitimized a chief's authority (Dye and King 2007). If any of the secluded anthropomorphs portray important political or religious figures, then it could be useful to keep them away from mounds to avoid iconoclastic destruction. The more mundane anthropomorphs, which may or may not be public displays, are then left closer to mounds for use. For some, warfare might seem too extreme of an explanation. In which case, protection from prehistoric vandalism or ideological conflict might be a more appropriate perspective to utilize here. This idea is hypothetical, but might yield interesting results if applied to other anthropomorphic rock art in the southeast.

MOTIFS RELATIVE TO VISUAL VARIABLES

Finally returning the visual variables, we once again see some contextual disparities between rock art motifs. Patterns found with respect to both viewshed and directional prominence draw somewhat parallel results with the elevation analysis presented above. With the exception of anthropomorphs, most of the worldly motif categories maintain lower viewsheds and topographic prominences. Viewshed statistics include two tables. The first (Table 4.8a) shows how many pixels are observable from each rock art site, as well as how many elements within each motif category are present at these sites. The second (Table 4.8b) reveals the average viewsheds for each motif type. Evidently, basic geomorphs, celestial geomorphs, anthropomorphs, and abstracts tend to have the highest viewsheds, all of which hold averages over 30000 pixels. Beneath World, Middle World, Above World, and special motifs generally hold lower viewsheds; none of their averages exceed 25000.

A comparable trend occurs with directional prominence. According to Table 4.9, it appears that the largest quantities of basic and celestial geomorphs reside in the “highest” category, while Beneath, Middle, and Above World, as well as anthropomorphic elements are more likely to exist in categories beneath. About 50.54% of basic geomorphs and 68.42% of celestial geomorphs exist in locations with the highest available directional prominences. Meanwhile, all Beneath and Above World, 69.23% of Middle World, and 90.7% of anthropomorphic elements appear in locations lower than the “highest” category (Figure 4h). These statistics present an interesting contrast between rock art motif locations relative to height and visibility, which fit well with the discussion above regarding landscape cosmograms.

Ethnohistoric studies on the Osage suggest cosmological dualisms are present in their village organization. Traditionally, sky clan moieties occupied northern sides of villages, while earth clans resided in southern sections (Bailey 2010:18). Edging and Ahler (2004) applied this notion to rock art distributions in the Ozarks of southern Missouri. Much like Sabo et al. (2015), they too saw locational juxtapositions between spiritual motifs vs. the more mundane symbols that fit into this north/south dichotomy (see Figure 4.7). If these patterns do indeed exist with respect to elevation, then geomorphs likely afford stronger topographic prominences and viewsheds than the more worldly motif types. In South Carolina, for example, prehistoric petroglyphs located in the highlands typically consist of circles, triangles, squares, and sunbursts. Meanwhile, areas in the lowlands tend to reveal anthropomorphs and zoomorphs (Charles 2007:13-17). One implication we can draw from these analogous patterns is that basic geomorphs and celestial geomorphs were possibly produced for similar reasons, or held similar meanings. Furthermore, the tendency for zoomorphs to reside in less topographically prominent locations might denote a more "earthly" connotation.

***Figure 4.7:*** *Bison elements at 3ST0070, a lower elevation and less topographically prominent site (left) and a sunburst at 3MR0094, a higher elevation and more prominent site (right) (from ARAS site form and ARAS rock art website)*

One exception to this supposition are the anthropomorphs, which frequently holds lower elevation and prominence than geomorphs, but still maintains large viewsheds. Nine of these elements come from 3VB0006, which was considered an outlier in the previous chapters. This is the site depicting human figures surrounding around an important individual with a staff in hand. The existence of a potential ritual scene at a location with a spectacular view might lead one to assume that areas with high viewsheds were preferable for religiously-oriented anthropomorphs. Upon closer examination of the site forms, however, there is a lack of consistency to support this possibility. Another anthropomorph exists at 3SE0406, which is the other outlier for viewshed. The human figure here does not show signs of any objects, whether they be held on worn on the body. Conversely, 3VB0316, which contains the human figure holding another's head, maintains a relatively poor view of the surrounding areas. Hence, there does not seem to be a connection between specific types of anthropomorphs and strong viewsheds.

The last set of variables, which deal with winter solstice phenomena, show signs of motif-related preferences with respect to sunsets, but are generally similar with sunrises. For winter solstice sunrises, a vast majority of all motifs reside in locations that receive large amounts of light (Table 4.10). In fact, all motif-types maintain percentages that are either close to, or above, 70% in the "highest" category (Figure 4i). Upon reviewing the rock art elements which appear in the "lowest" category, few consistent patterns exist for geomorphs. Middle World elements in these areas primarily consist of turkey tracks, which could mean that this specific motif was produced with the intent of shielding them from winter solstice sunrises. However, because turkey tracks also appear in locations that do receive much light, and because the sample size is relatively small, this might not truly be the case. No Beneath or Above World motifs fall outside of highly illuminated areas, and the few anthropomorphs that do inhabit low light conditions do not provide any iconographic reasons as to why. Hence, orientation toward winter solstice sunrises may have been a concern for rock art placement in general and not preferred for any specific motif.

Winter solstice sunsets, on the other hand, provide far less consistent results. According to Table 4.11, many motifs are located in areas that receive variable amounts of light from these sunsets. Celestial geomorphs maintain the largest percentage in the "highest" category (47.37%); however, there is also a respectable concentration in the "low" category (31.58%) (Figure 4j).

This is probably a result of their aspects, many of which faced directly south and therefore allow this motif to receive light from both winter solstice sunrises and sunsets. Middle World and anthropomorphic elements both hold notable quantities in the "lowest" category, with 46.15% and 53.49% respectively. Most of these elements come from 3ST0070, which contains panels with bison, unidentified quadrupeds, and human figures. Because these elements are underground, however, they are unlikely to see much of anything in the landscape anyway. For most of the rock art, there is not much information to suggest why some motifs hold stronger patterns than others with respect to winter solstice sunsets. Because generally all motifs receive light from sunrises, it is likely that sites which also receive light from sunsets just so happen to face slightly more toward the south than the others. As a result, these sites receive light from both sunrises and sunsets.

Given that most rock art, no matter which motif is conveyed, faces the southeast-south cardinal directions, winter solstice sunrises maintain far stronger connections than sunsets. Much like the discussion provided with the aspect results, this could mean that orientation toward winter solstice sunrises was preferred for all rock art in general, and therefore not specific to any individual motif. Because the eastern cardinal direction and sunrise were potent symbols for life, "east-facing rituals accordingly would be associated with life-affirming events" (Sabo 2012:441). Due to the pattern we see with rock art with respect to aspect and sunrise visuals, the rituals or activities involved with their production might hold an association with themes of life. Thus, the act of creating rock art possibly holds this symbolic connotation, rather than individual motifs themselves.

LOOKING FOR MEANING

The analysis of motifs presented in this chapter yields some interesting results that possibly indicate locational preferences for different rock art motifs. Given the differing distributions of geomorphs in relation to many zoomorphic motifs in the worldly categories, there possibly exists a duality that is represented in the landscape. Basic and celestial geomorphs tend to occupy higher, more prominent locations. Meanwhile, several Beneath, Middle, and Above World motifs typically reside in slightly less conspicuous locations. This pattern might represent a cosmogram, or an assignment of motifs to locations based on symbolic connotations. If there were legitimate attempts to place these motifs in their respective locations based on height or topographic prominence, then we have room to interpret their meanings, or at the very least, the types of activities involved with their creation.

Because basic geomorphs and celestial geomorphs frequently exhibited similar patterns, they might be characteristically related. Perhaps basic geomorphs are a figurative representation of cosmic shapes, as they too are higher up in the landscape and therefore closer to the stars and other astral phenomena. This suggestion, however, might be a bit of a stretch. An alternative explanation is that they were the result of similar rituals. Though studying a different geographic area and time, Lewis-William and Dawson (1988) argued that geometric symbols might have been the result of altered states of consciousness from shamanistic activities. If this is the case, then perhaps the geometric motifs represent figures one would see during the rituals associated with their production. It is worth stressing that this is merely speculation, as the influence of neuropsychology and altered states of consciousness on geomorph creation has received criticism (see Hodgson 2006). Regardless, the juxtaposition of basic and celestial geomorphs with zoomorphic motifs in the worldly categories is notable. Because a majority of these animals are readily observable on the land (with the exception of the winged serpents) it is possible that their motifs hold a more earthly connotation. Meanwhile, the geomorphs might represent concepts that are not of the immediate land.

Due to the wide array of activities anthropomorphic figures are depicted in, it is difficult to establish an all-encompassing meaning behind them. That being said, the differing contexts in which they are represented potentially reveal their purposes. Anthropomorphs generally exist in areas that are more easily accessible from streams and, to a greater degree, mounds. While there are only a few examples of anthropomorphs with adornment or objects in hand, it is curious that they tend to be somewhat more isolated than their bare counterparts. Explanations for this particular distribution vary, but it could be a result of desires based on public vs. private access to these sites. If adorned figures signify a specific individual who held an important role or status, then placement of these elements in secluded locations might be an attempt to keep them private. Given the notion that secluded locations are suitable for rituals and vision quests, it is possible that these anthropomorphs were used or created in a similar fashion. As those closer to streams and mounds generally seem more mundane in appearance, they potentially resulted from or were used in public actions. All of this possibly represents an organization of ritual authority, much like Wright (2015) noted with Hohokam rock art patterning.

Many of the suggestions provided above are admittedly speculative. One issue is the limited sample size for most motifs, which makes it problematic to come up with concrete explanations behind rock art distributions. There are, for example, few Above World, abstract, and hand-crafted object designs throughout the study area. With so few examples, we cannot effectively apply a contextual approach to improve our scant understanding of their meanings. Analyzing them alongside other motifs certainly helps, but an exceptional quantitative study of motifs requires similar testing as the previous chapters to help established an unbiased perspective on these patterns. When we reach this point, perhaps we will gain a better understanding of rock art motifs and their meanings.

# CHAPTER 5: CONCLUSION

GIS offer potent applications to rock art spatial distributions, as illustrated throughout this thesis. Discerning which patterns persist throughout the landscape allows archaeologists to understand which environments were considered among a group of people. Rock art in particular offers symbolism and meaning which, as they are rooted in their original locations, offer a look into the worldviews held by those who created them. At the beginning of this thesis, two questions were presented to guide the research. In light of the results discussed throughout, it is useful to briefly review the findings and see where we currently stand. The first question dealt with locational desires:

1. What were the environmental preferences for rock art location selection among the Pre-Columbian Native Americans who lived in the Ozarks?

If we are looking at rock art as a whole, it appears that there are some strong connections held with respect to environmental criteria. Preferred locations involve southeastern aspects, orientation toward winter solstice sunrises, seclusion from major streams, potential for accessibility from local mounds, and occasionally areas with substantial views of their surroundings. Explanations for these trends primarily include religion, drawing upon the importance of cardinal directions and isolation. The southern night sky affords a good view of the Milky Way's "disk" or Path of Souls, while southeastern orientations provide light from winter solstice sunrises. This southeastern direction possibly holds life-related symbolism, as the eastern sky and risings sun represented life, while the south would then provide connection with ancestors. Areas distant from streams or public spaces were potentially selected for their privacy, which would allow an individual to experience a vision quest and ultimately develop rock art.

When considering the motifs present at each rock art site, a few patterns reveal themselves. Geomorphs, both basic and celestial, exhibit differing locational tendencies from worldly designs. The former category generally resides in higher elevations with more defined directional prominences, while also holding stronger viewsheds. Motifs from the Below, Middle, and Above World classifications hold the opposite pattern. Though not necessarily low in elevation or prominence, their distributions tend to be lower in the landscape and hold less impressive viewsheds. This pattern possibly represents a cosmogram, where duality between astronomical or geometric shapes hold different locations than zoomorphic motifs of the land. Anthropomorphic motifs are slightly more likely to be more accessible from major streams, but far more likely to be accessible from local mounds. The subtle artistic differences between anthropomorphs close to mounds vs. those farther away might indicate that accessible motifs were a result of public activities, while those further away functioned in private rituals or were purposefully hidden away from communal view.

The inferences provided here are based on quantitative data, which are derived from the GIS techniques applied to spatial patterns. With rock art we see multiple approaches one can take to effectively analyze patterns with respect to the landscape. This ultimately leads to the second question asked in the introduction:

2. What geographical landscape perspectives can we apply to the study of rock art, namely those in the Southeastern United States?

It is still somewhat unclear as to whether rock art sites or element totals are better indicators of locational preference. Based on the decision frameworks offered in Chapter 3, a site-based approach allows researchers to focus on the p-values obtained directly from chi-square and t-tests. As a result, one has potentially better certainty regarding which variables were most important. The element approach, on the other hand, highlights all variables that are significant, which then allows researchers to make informed observations based on percentages. Both have their merits, but using elements as an input allowed for a more streamlined process (at least for this particular study).

One strong conclusion is that bluff shelters serve as great reference points for comparing rock art distributions. The shared environmental contexts in which they exist hold potential to eliminate superfluous variables. For example, rock art generally resides at high elevations and steep slopes. One might therefore assume that these criteria were purposefully selected for rock art creation. However, because bluff shelters tend to inhabit the same areas, it is likely that these areas were not uniquely selected for rock art as a whole, and that the areas favorable for rock art already existed at these locations. This allows for more specific results that determine which variables were truly ideal.

For rock art motifs, one can apply a different style of contextual analysis. Specifically, referencing motif distributions with other motifs proves useful for ascertaining which environmental criteria were desired for different designs. If a high concentration of one motif differs significantly from others with respect to an environmental variable, then one can infer that said variable was important for the motif. This proves most useful when multiple motifs exist in a study area, then researchers can define multiple categories based on themes, styles, or symbolism. When juxtapositions present themselves, there grows room for interpretation of a motif's meaning, or perhaps the functions that resulted in its creation.

Of course, this thesis contains some issues which are important to keep in mind. Firstly, there are occasional sample size problems that either lead to imprecise results or make it difficult to be certain about connections with variables. While 29 rock art sites are enough to maintain statistical security when split between five equal-area sections, a larger sample size will likely lead to better results. Some statistical tests, such as those for aspect and many throughout the bluff shelter comparison, maintained low expected values, potentially skewing the data. This means the discovery of new sites will potentially confirm or invalidate the suggestions provided in this thesis. For the motif analysis, some categories maintained scarce totals. There are, for example, only four Above World motifs, three of which exist in the same bluff shelter. As a result, whatever environmental context this bluff shelter resides in will determine which variables are connected with Above World designs. The same can be said for abstracts and other motifs that do no fall into the categorical scheme of Chapter 4. This makes it difficult to solidify any conclusions about their locational preferences.

Because this thesis was confined to archived information in the AMASDA database, it is limited to data that has already been extrapolated. There is probably other rock art existing in the study area that has not yet been documented. If these undiscovered rock art show patterns with significant differences from those exposed in this study, then the results presented here are less indicative of locational preference. Furthermore, a few of the extant site forms lack clarity in regards to how many elements exist at a site, or which motifs are present. One site (3NW0037) is heavily vandalized and the quantity of elements present is unclear. Another (3SE0605) does not have a registered site form in the database. Naturally, additional data on these sites would be useful, as it would provide additional samples to help confirm whether or not locational preferences exist.

## SUGGESTIONS FOR FUTURE RESEARCH

Many of the flaws outlined above could be fixed though continued surveys of rock art sites in the Ozarks, namely those lacking specific information on how many elements or what types of motifs exist at the site. In a few cases, the site forms were rather vague as to what motifs are depicted at their respective sites, which could ultimately lead to inaccurate results. These sites, such as 3BA0030, 3NW0681, and 3VB0006, lack field records and instead rely on archival transcriptions. Some of these have not been personally visited in several decades. It is therefore worthwhile to take a second look at these sites to gain improved data regarding what is unambiguously present at them.

Faulkner et al. (2004:87-88) explain how the special contexts in which rock art exists can make it difficult to find. Because Ozark rock art generally appears within isolated bluff shelters, the likelihood of stumbling upon it is relatively small. One suggestion is to integrate the community with rock art discovery and preservation. Faulkner (2008) discusses the dynamic relationships between archaeologists and cavers, who are responsible for finding many elements and informing local experts about their location. By potentially working with local hikers and conservationists, and by teaching them about the importance of protecting cultural heritage, perhaps they will be more likely to share their findings with experts should they find undocumented rock art elements.

As for GIS, there are multiple variables one could add to this study. Perhaps watershed or runoff influence where rock art was placed in the landscape. Additionally, one might elect to calculate terrain variance or curvature to see if landform topography plays a role in ways not related to prominence. These are environmental analyses that might prove useful. Other variables might deal with social variables aside from mounds. One could, for example, test cost and Euclidean distances to hunting grounds or established campsites. Doing so, however, would require additional solid information about Mississippian social patterns as they relate to space, as well as point data based on collected distributions. The pursuit would prove time consuming, but would potentially reveal unique information about rock art and its distributions.

The results provided throughout this thesis show that a site-based approach to rock art spatial analysis provides solid results that are not skewed by tight clustering in single locations. The same cannot be said for elements, which commonly revealed high levels of statistical significance. Because it might be fallacious to assume independence for rock art element placement in the landscape, it would be useful to look for other methods that use element quantity as a measure for environmental preferences. With this in mind, one suggestion is to apply a rank-based analysis to rock art. Each site could be weighted by the total number of individual elements present within. For example, rock art sites with less than ten elements can be assigned a value of 1, those with element totals between eleven and twenty could have a value of 2, those between twenty-one and thirty a value of 3, and so on. The assigned values would certainly require fine-tuning so as to afford each site a proper weight, but the potential for improved data is intriguing. This technique would possibly allow one to emphasize environmental variables associated with large-quantity rock art sites, while avoiding the skewing issues that pervaded through the element statistical tests. Furthermore, these weighted variables would produce results that better reflect "the decisions made by people when they choose their activity locations" (Bona 2000:77). Hence, a ranking system should serve as a good compromise between the site and element-based analyses used in this study.

GIS offer powerful contextual results that help us to understand people in the past. Archaeologists should continue to develop innovative ways to integrate spatial analytical methods into archaeological studies. The more we experiment with methodologies, the more likely we are to learn better techniques. This is especially important for rock art, as it likely held symbolic and religious significance to those who created it. Ascertaining the locational preferences behind these symbols, as well as the decision-making processes involved with site selection, reveals what was important to that particular cultural group. When an idea is set in stone, in the same location it was originally produced in, we are presented with a great opportunity to study the ways in which people mapped out their ideologies into the landscape.

References Cited


Aldenderfer, Mark

1996 Introduction. In *Anthropology, Space and Geographic Information Systems*, edited by Mark Aldenderfer and Herbert D.G. Maschner, pp. 3-18. Oxford University Press, Oxford.

Bailey, Garrick A. (editor)

2010 *Traditions of the Osage: Stories Collected and Translated by Francis La Flesche*. University of New Mexico Press, Albuquerque.

Baxter, Michael

2003 *Statistics in Archaeology*. Arnold, London.

Blitz, John H., and Patrick Livingood

2004 Sociopolitical Implications of Mississippian Mound Volume. *American Antiquity* 69(2): 291-301.

Bona, Luke Dalla

2000 Protecting Cultural Resources through Forest Management Planning in Ontario Using Archaeological Predictive Modeling. In *Practical Applications of GIS for Archaeologists: A Predictive Modeling Toolkit*, edited by Konnie Wescott and R. Joe Brandon, pp. 73-99. Taylor and Francis, London.

Brandt, Roel, Bert J. Groenewoudt, and Kenneth L. Kvamme

1992 An Experiment in Archaeological Site Location: Modeling in the Netherlands using GIS Techniques. *World Archaeology* 24(2): 268-282.

Brown, James A.

2011 The Regional Culture Signature of the Braden Art Style. In *Visualizing the Sacred: Cosmic Visions, Regionalism, and the Art of the Mississippian World*, edited by George E. Lankford, F. Kent Reilly, and James F. Garber, pp. 37-63. University of Texas Press, Austin.

Butzer, Karl M.

1982 *Archaeology as Human Ecology: Method and Theory for a Contextual Approach*. Cambridge University Press, Cambridge.

Charles, Tommy

2010 *Discovering South Carolina's Rock Art*. The University of South Carolina Press, Columbia.

Chippindale, Christopher R., and George H. Nash

2004 Pictures in Place: Approaches to the Figured Landscapes of Rock-Art. In *Pictures in Place: The Figured Landscapes of Rock-Art*, edited by Christopher Chippindale and George Nash, pp. 1-36. Cambridge University Press, Cambridge.

Cosgrove, Dennis
1984 *Social Formation and Symbolic Landscape*. Croom Helm, London.

Diaz-Granados, Carol
2011 Early Manifestations of Mississippian Iconography in Middle Mississippi Valley Rock-Art. In *Visualizing the Sacred: Cosmic Visions, Regionalism, and the Art of the Mississippian World*, edited by George E. Lankford, F. Kent Reilly, and James F. Garber, pp. 64-95. University of Texas Press, Austin.

Diaz-Granados, Carol, and James Duncan
2000 *The Petroglyphs and Pictographs of Missouri*. The University of Alabama Press, Tuscaloosa.

Diaz-Granados, Carol, James R. Duncan, and F. Kent Reilly
2015 *Picture Cave: Unraveling the Mysteries of the Mississippian Cosmos*. University of Texas Press, Austin.

Diaz-Granados, Carol, Jan Simek, George Sabo III, and Mark Wagner (editors)
2018 *Transforming the Landscape: Rock Art and the Mississippian Cosmos*. Oxbow Books, Oxford.

Dobrez, Livio, and Patricia Dobrez
2013 Rock Art Animals in Profile: Visual Recognition and the Principles of Canonical Form. *Rock Art Research* 30(1): 75-90.

Dorsey, George A.
1997 [1905] *Traditions of the Caddo*. University of Nebraska Press, Lincoln. Originally published 1905, Washington Publication No. 41, Carnegie Institute, Washington D.C.

Dowd, Elsbeth L.
2011 Amphibian and Reptilian Imagery in Caddo Art. *Southeastern Archaeology* 30(1): 79-95.

Duncan, James R.
2011 The Cosmology of the Osage: The Star People and Their Universe. In *Visualizing the Sacred: Cosmic Visions, Regionalism, and the Art of the Mississippian World*, edited by George E. Lankford, F. Kent Reilly, and James F. Garber, pp. 18-33. University of Texas Press, Austin.

Dye, David H., and Adam King
2007 Desecrating the Sacred Ancestor Temples: Chiefly Conflict and Violence in the American Southeast. In *North American Indigenous Warfare and Ritual*, edited by R. J. Chacon and R. G. Mendoza, pp. 160-181. University of Arizona Press, Tucson.

Edging, Richard, and Steven R. Ahler
2004 Rock-Art and Late Woodland Settlement in the Northern Ozarks. In *Rock-Art of Eastern North America: Capturing Images and Insight*, edited by Carol Diaz-Granados and James R. Duncan, pp. 90-109. The University of Alabama Press, Tuscaloosa.

Fairén-Jiménez, Sara
2007 British Neolithic Rock Art in Its Landscape. *Journal of Field Archaeology* 32(3): 283-295.

Faulkner, Charles H.
2008 Cavers and Archaeologists: The Study of Mud Glyph Cave. In *Cave Archaeology of the Eastern Woodlands: Essays in Honor of Patty Jo Watson*, edited by David H. Dye, pp. 193-201. The University of Tennessee Press, Knoxville.

Faulkner, Charles H., Jan F. Simek, and Alan Cressler
2004 On the Edges of the World: Prehistoric Open-Air Rock-Art in Tennessee. In *Rock-Art of Eastern North America: Capturing Images and Insight*, edited by Carol Diaz-Granados and James R. Duncan, pp. 77-89. The University of Alabama Press, Tuscaloosa.

Felis De Espinosa, Fray Isidro
1927 [1718] Description of the Tejas or Asinai Indians, 1691-1722. Translated by Mattie Austin Hatcher. *Southwestern Historical Quarterly* 31: 150-180.

Fletcher, Alice C., and Francis La Flesche
1992 [1911] *The Omaha Tribe, Volume 2*. Reprinted. University of Nebraska Press, Lincoln. Originally published 1911, Bulletin No. 27, Bureau of American Ethnology, Smithsonian Institution, Washington D.C.

Fritz, Gayle J., and Robert Ray
1982 Rock Art Sites in the Southern Arkansas Ozarks and Arkansas River Valley. In *Arkansas Archeology in Review*, edited by Neal Trubowitz and Marvin Jeter, pp. 240-276. Arkansas Archeological Survey Research Series 15, Fayetteville.

Golden, Charles, and Bryce Davenport
2013 The Promise and Problem of Modeling Viewsheds in the Western Maya Lowlands. In *Mapping Archaeological Landscapes from Space*, edited by Douglas C. Comer and Michael J. Harrower, pp. 145-157. Springer, New York.

Haley, Boyd R., Ernest E. Glick, William V. Bush, Benjamin F. Clardy, Charles G. Stone, Mac B. Woodward, and Doy L. Zachry
1993 *Geologic Map of Arkansas*. Arkansas Geological Survey, Little Rock.

Henry, Donald O.
1983 Archaeological Overview of Investigations in Hominy Creek Valley. In *The Prehistory and Paleoenvironment of Hominy Creek Valley: Excavations at Copperhead Cave (34OS85) and Archaeological Overview Investigations in Hominy Creek Valley*. Compiled by Chèrie H. Haury, pp. 117-185. University of Tulsa Laboratory of Archaeology and the U.S. Army Corps of Engineers, Tulsa.

Hilliard, Jerry E.
1993 Arkansas Rock Art Landscape. *Field Notes: Newsletter of the Arkansas Archeological Society* 255: 3-5.

Hilliard, Jerry E., George Sabo III, and Deborah Sabo
2005 Rock Art in the Cultural Landscape. In *Rock Art in Arkansas*, edited by George Sabo III and Deborah Sabo, pp. 44-58. Arkansas Archeological Survey Popular Series 5, Fayetteville.

Hodgson, Derek
2006 Altered States of Consciousness and Palaeoart: An Alternative Neurovisual Explanation. *Cambridge Archaeological Journal* 16(1): 27-37.

Jenness, Jeff
2007 *Some Thoughts on Analyzing Topographic Habitat Characteristics*. Jenness Enterprises, Flagstaff.

Kay, Marvin, and George Sabo III
2006 Mortuary Ritual and Winter Solstice Imagery of the Harlans-Style Charnel House. *Southeastern Archaeology* 25(1): 29-48.

Kelly, John E., James A. Brown, Jenna M. Hamlin, Lucretia S. Kelly, Laura Kozuch, Kathryn Parker, and Julieann Van Nest
2007 The Context for the Early Evidence of the Southeastern Ceremonial Complex at Cahokia. In *Southeastern Ceremonial Complex: Chronology, Content, Context*, edited by Adam King, pp. 57-87. The University of Alabama Press, Tuscaloosa.

Keyser, James D.
1977 Writing-On-Stone: Rock Art on the Northwestern Plains. *Canadian Journal of Archaeology* 1: 15-80.

King, Adam
2007 Mound C and the Southeastern Ceremonial Complex in the History of the Etowah Site. In *Southeastern Ceremonial Complex: Chronology, Content, Context*, edited by Adam King, pp. 107-133. The University of Alabama Press, Tuscaloosa.

Knight, Vernon J.
2013 *Iconographic Method in New World Prehistory.* Cambridge University Press, New York.

Knight, Vernon J., Susan L. Scott, and H. Edwin Jackson
2010 *Mound Excavations at Moundville: Architecture, Elites and Social Order*. The University of Alabama Press, Tuscaloosa.

Kvamme, Kenneth L.
1990 One-Sample Tests in Regional Archaeological Analysis: New Possibilities through Computer Technology. *American Antiquity* 55(2): 367-381.
1992 A Predictive Site Location Model on the High Plains: An Example with an Independent Test. *Plains Anthropologist* 37: 19-40.

Lankford, George E.
2007a Some Cosmological Motifs in the Southeastern Ceremonial Complex. In *Ancient Objects and Sacred Realms: Interpretations of Mississippian Iconography*, edited by F. Kent Reilly and James F. Garber, pp. 8-38. University of Texas Press, Austin.

2007b *Reachable Stars: Patterns in the Ethnoastronomy of Eastern North America*. The University of Alabama Press, Tuscaloosa.

2007c The "Path of Souls": Some Death Imagery in the Southeastern Ceremonial Complex. In *Ancient Objects and Sacred Realms: Interpretations of Mississippian Iconography*, edited by F. Kent Reilly and James F. Garber, pp. 174-212. University of Texas Press, Austin.

Lewis-Williams, J. David
2002 *A Cosmos in Stone: Interpreting Religion and Society through Rock Art*. AltaMira Press, Walnut Creek.

Lewis-William, J. David, and Thomas A. Dowson
1988 The Signs of All Times: Entropic Phenomena in Upper Paleolithic Art. *Current Anthropology* 29(2): 201-245.

Livingood, Patrick C.
2010 *Mississippian Polity and Politics on the Gulf Coastal Plain: A View from the Pearl River, Mississippi*. The University of Alabama Press, Tuscaloosa.

Llobera, Marcos
2001 Building Past Landscape Perception with GIS: Understanding Topographic Prominence. *Journal of Archaeological Science* 28: 1005-1014.

Maschner, Herbert D.G.
1996 The Politics of Settlement Choice on the Northwest Coast: Cognition, GIS, and Coastal Landscapes. In *Anthropology, Space and Geographic Information Systems*, edited by Mark Aldenderfer and Herbert D.G. Maschner, pp. 175-189. Oxford University Press, New York.

Müller, Johannes
1988 The Chambered Cairns of the Northern and Western Isles: Architectural Structure, Information Transfer and Locational Processes. *Issue 16 of Occasional Paper*. University of Edinburgh, Department of Archaeology, Edinburgh.

Muller, Jon
2007 Prolegomena for the Analysis of the Southeastern Ceremonial Complex. In *Southeastern Ceremonial Complex: Chronology, Content, Context*, edited by Adam King, pp. 15-37. The University of Alabama Press, Tuscaloosa.

Nimura, Courtney
2015 *Prehistoric Rock Art in Scandinavia: Agency and Environmental Change*. Oxbow Books, Oxford.

Pauketat, Timothy
2004 *Ancient Cahokia and the Mississippians*. Cambridge University Press, Cambridge.

2013 *An Archaeology of the Cosmos: Rethinking Agency and Religion in Ancient America*. Routledge: New York.

Popa, Cătălin Nicolae, and Daniel Knitter
2016 From Environment to Landscape. Reconstructing Environment Perception Using Numerical Data. *Journal of Archaeological Method and Theory* 23: 1285-1306.

Prentice, Guy
1996 Site Distribution Modeling for Mammoth Cave National Park. In *Of Caves and Shell Mounds*, edited by Kenneth C. Carstens and Patty Jo Watson, pp. 12-32. The University of Alabama Press, Tuscaloosa.

Reilly, F. Kent
2004 People of Earth, People of Sky: Visualizing the Sacred in Native American Art of the Mississippi Period. In *Hero, Hawk, and Open Hand: American Indian Art of the Ancient Midwest and South*, edited by Richard F. Townsend, pp. 125-138. The Art Institute of Chicago, Chicago.

2007 The Petaloid Motif: A Celestial Symbolic Locative in the Shell Art of Spiro. In *Ancient Objects and Sacred Realms: Interpretations of Mississippian Iconography*, edited by F. Kent Reilly and James F. Garber, pp. 39-55. University of Texas Press, Austin.

Robinson, David W.
2013 Drawing Upon the Past: Temporal Ontology and Mythological Ideology in South-central Californian Rock Art. *Cambridge Archaeological Journal* 23(3): 373-394.

Sabo, George III

2005 A Plethora of Images. In *Rock Art in Arkansas*, edited by George Sabo III and Deborah Sabo, pp. 16-34. Arkansas Archeological Survey Popular Series 5, Fayetteville.

2008 Rock Art and the Study of Ancient Religions in Southeastern North America. In *Religion, Archaeology, and the Material World*, edited by Lars Fogelin, pp. 279-296. Center for Archaeological Investigations, Carbondale.

2012 The Terán Map and Caddo Cosmology. In *The Archaeology of the Caddo*, edited by Timothy K. Perttula and Chester P. Walker, pp. 431-447. University of Nebraska Press, Lincoln.

Sabo, George III, and Ann M. Early

1990 Prehistoric Culture History. In *Human Adaptation in the Ozark and Ouachita Mountains*, edited by George Sabo III, Ann M. Early, Jerome C. Rose, Barbara A. Burnett, Louis Vogele Jr., and James P. Harcourt, pp. 34-120. Research Series No. 31, Arkansas Archeological Survey, Fayetteville.

Sabo, George III, and Jerry E. Hilliard

2005 The History of Rock Art Research in Arkansas. In *Rock Art in Arkansas*, edited by George Sabo III and Deborah Sabo, pp. 16-34. Arkansas Archeological Survey Popular Series 5, Fayetteville.

Sabo, George III, Jerry E. Hilliard, and Jami J. Lockhart

2012 The Ritual Use of Caves and Rockshelters in Ozark Prehistory. In *Sacred Darkness: A Global Perspective on the Ritual Use of Caves*, edited by Holley Moyes, pp. 237-252. University Press of Colorado, Boulder.

Sabo, George III, Jerry E. Hilliard, and Leslie C. Walker

2015 Cosmological Landscapes and Exotic Gods: American Indian Rock Art in Arkansas. *Cambridge Archaeological Journal* 25(1): 261-273.

Sabo, George III, and Deborah Sabo (editors)

2005a *Rock Art in Arkansas*. Arkansas Archeological Survey Popular Series 5, Fayetteville.

2005b What is Rock Art and What Can it Tell Us About the Past?. In *Rock Art in Arkansas*, edited by George Sabo III and Deborah Sabo, pp. 1-15. Arkansas Archeological Survey Popular Series 5, Fayetteville.

Simek, Jan, and Alan Cressler

2008 On the Backs of Serpents: Prehistoric Cave Art in the Southeastern Woodlands. In *Cave Archaeology of the Eastern Woodlands: Essays in Honor of Patty Jo Watson*, edited by David H. Dye, pp. 169-191. The University of Tennessee Press, Knoxville.

Simek, Jan, Alan Cressler, and Nicholas Herrmann
2013 Prehistoric Rock Art from Painted Bluff and the Landscape of North Alabama Rock Art. *Southeastern Archaeology* 32(2): 218-234.

Simek, Jan, Alan Cressler, Nicholas Herrmann, and Sarah Sherwood
2013 Sacred Landscapes of the South-Eastern USA: Prehistoric Rock and Cave Art in Tennessee. *Antiquity* 87(336): 430-446.

Smith, Kevin E., and James V. Miller
2009 *Speaking with the Ancestors: Mississippian Stone Statuary of the Tennessee-Cumberland Region*. The University of Alabama Press, Tuscaloosa.

Sofaer, Anna, Volker Zinser, and Rolf Sinclair
1979 A Unique Solar Marking Construct. *Science* 206(4416): 283-291.

Surface-Evans, Sarah, and Devin White
2012 An Introduction to the Least Cost Analysis of Social Landscapes. In *Least Cost Analysis of Social Landscapes: Archaeological Case Studies*, edited by Devin White and Sarah Surface-Evans, pp. 1-10. The University of Utah Press, Salt Lake City.

Swanton, J. R.
1942 *Indian Tribes of the Lower Mississippi Valley and Adjacent Coast of the Gulf of Mexico*. Bulletin No. 132, Bureau of American Ethnology, Smithsonian Institution, Washington, DC.

Taçon, Paul
1999 Identifying Ancient Sacred Landscapes in Australia: From Physical to Social. In *Archaeologies of Landscape: Contemporary Perspectives*, edited by Wendy Ashmore and A. Bernard Knapp, pp. 33-57. Blackwell Publishers, Malden.

Vogele, Louis E., Jr.
1990 Environmental Setting. In *Human Adaptation in the Ozark and Ouachita Mountains*, edited by George Sabo III, Ann M. Early, Jerome C. Rose, Barbara A. Burnett, Louis Vogele Jr., and James P. Harcourt, pp. 3-14. Research Series No. 31, Arkansas Archeological Survey, Fayetteville.

Warren, Robert E., and David L. Asch
2000 A Predictive Model of Archaeological Site Location in the Eastern Prairie Peninsula. In *Practical Applications of GIS for Archaeologists: A Predictive Modeling Toolkit*, edited by Konnie Wescott and R. Joe Brandon, pp. 5-32. Taylor and Francis, London.

Watson, Ben
2012 The Body and the Brain: Neuroscience and the Representation of Anthropomorphs in Palaeoart. *Rock Art Research* 29(1): 3-18.

Wedel, Walter

1979 House Floors and Native Settlement Populations in the Central Plains. *Plains Anthropologist* 24: 85-98.

Wescott, Konnie, and James Kuiper

2000 Using a GIS to Model Prehistoric Site Distributions in the Upper Chesapeake Bay. In *Practical Applications of GIS for Archaeologists: A Predictive Modeling Toolkit*, edited by Konnie Wescott and R. Joe Brandon, pp. 59-72. Taylor and Francis, London.

Wheatley, David

1993 Going Over Old Ground: GIS, Archaeological Theory and the Act of Perception. In *Computing the Past: Computer Applications and Quantitative Methods in Archaeology. CAA92*, edited by Jens Andresen, Torsten Madsen, and Irwin Scollar, pp. 133-138. Aarhus University Press, Aarhus.

Wright, Aaron M.

2015 *Religion on the Rocks: Hohokam Rock Art, Ritual Practice, and Social Transformation*. University of Utah Press, Salt Lake City.

# APPENDIX 1:

# RAW RASTER AND RECLASSIFIED VARIABLE MAPS

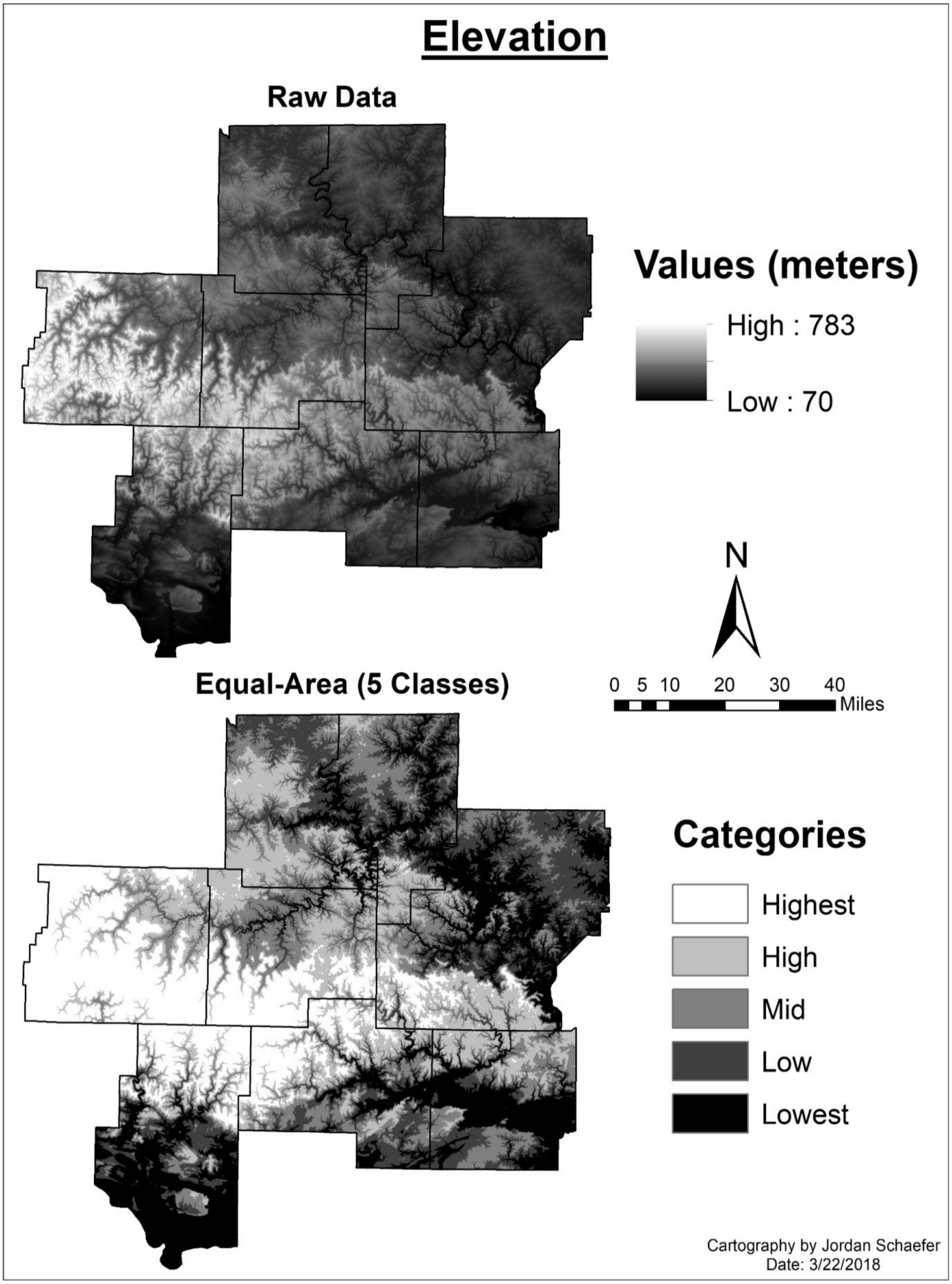



***Figure 1a:*** *Map of raw raster and equal-area classification for elevation*

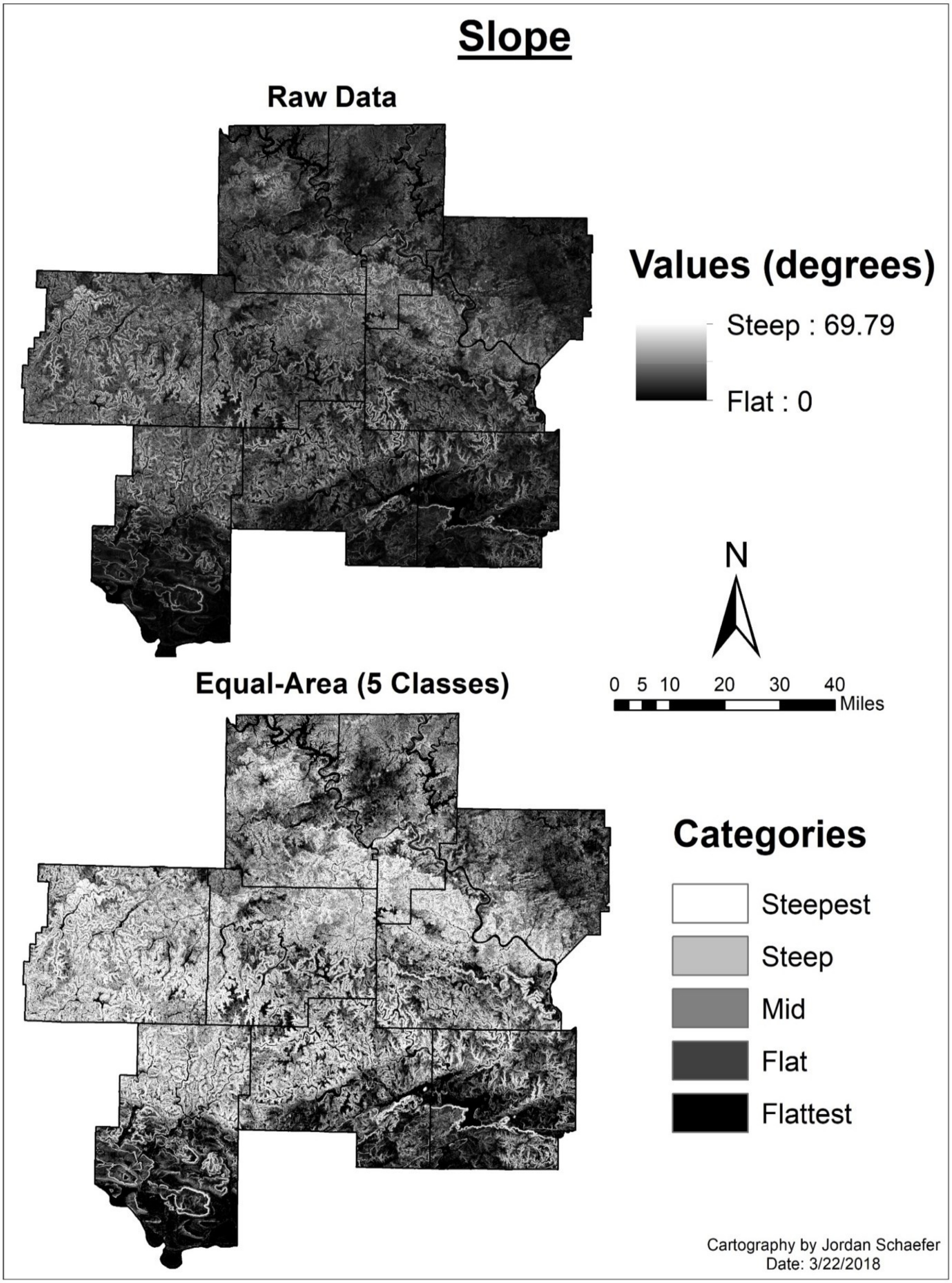



***Figure 1b:*** *Map of raw raster and equal-area classification for slope*

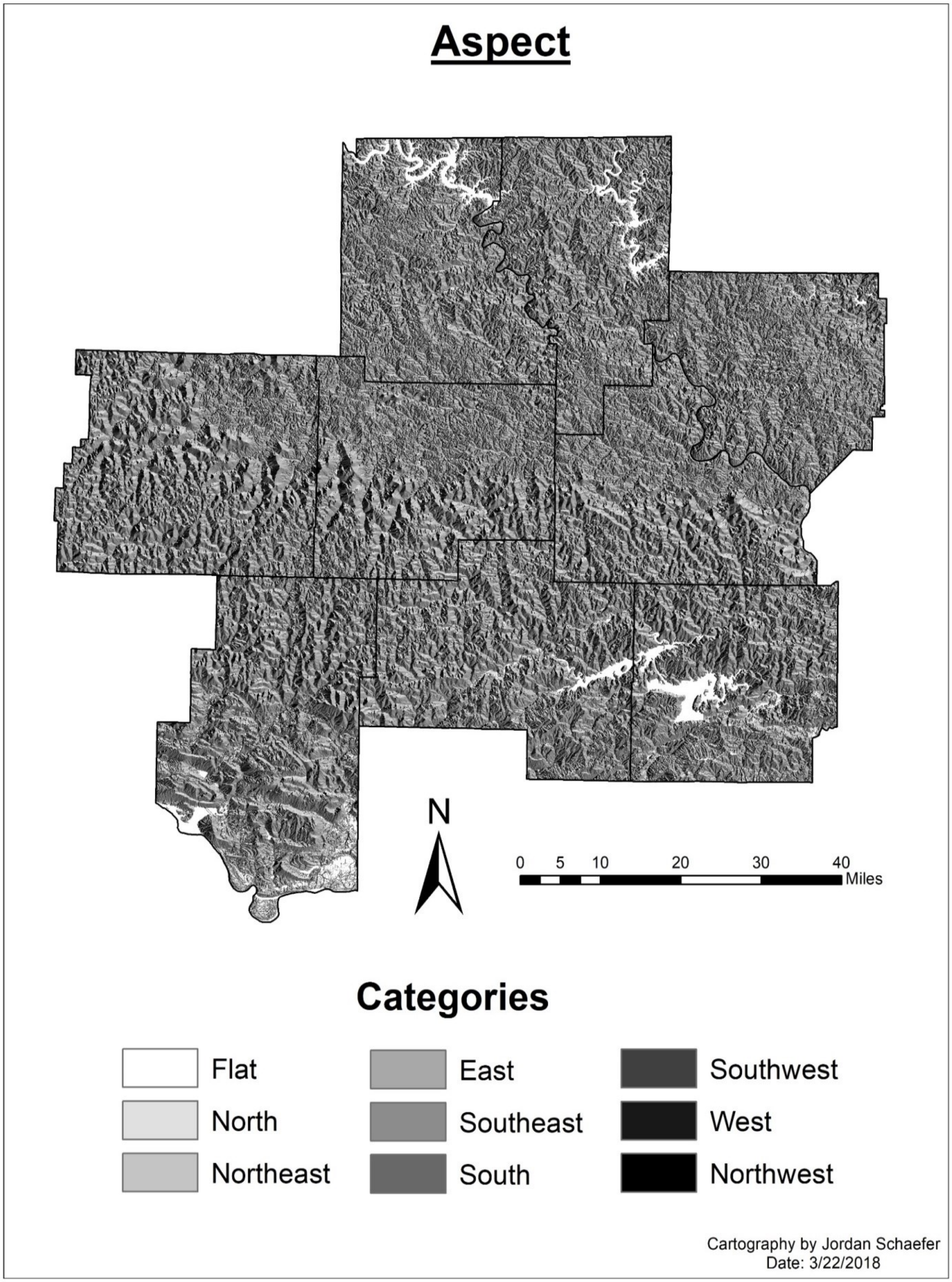



***Figure 1c:*** *Map of aspect categories*

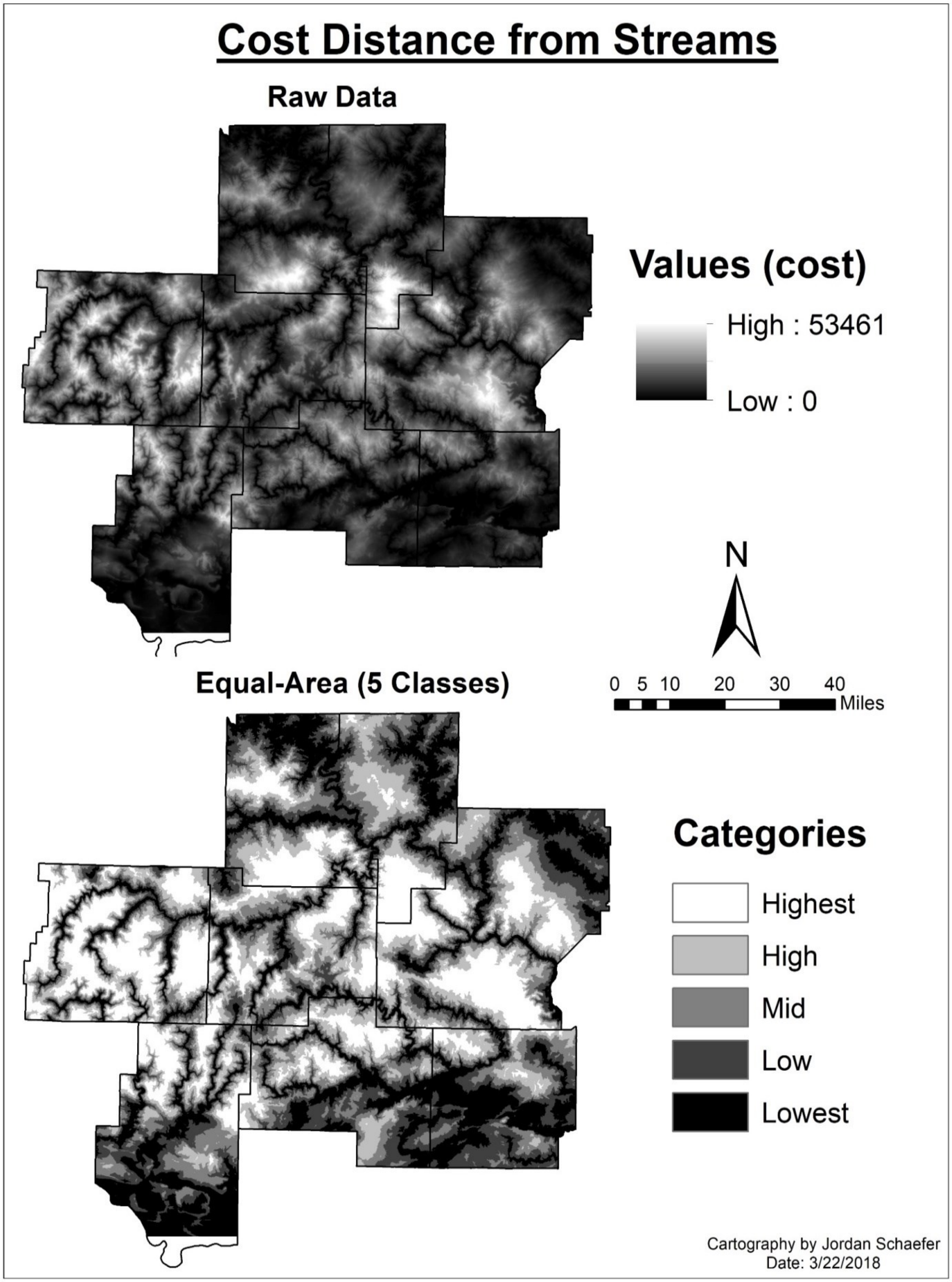



***Figure 1d:*** *Map of raw raster and equal-area classifications for cost distance from streams*

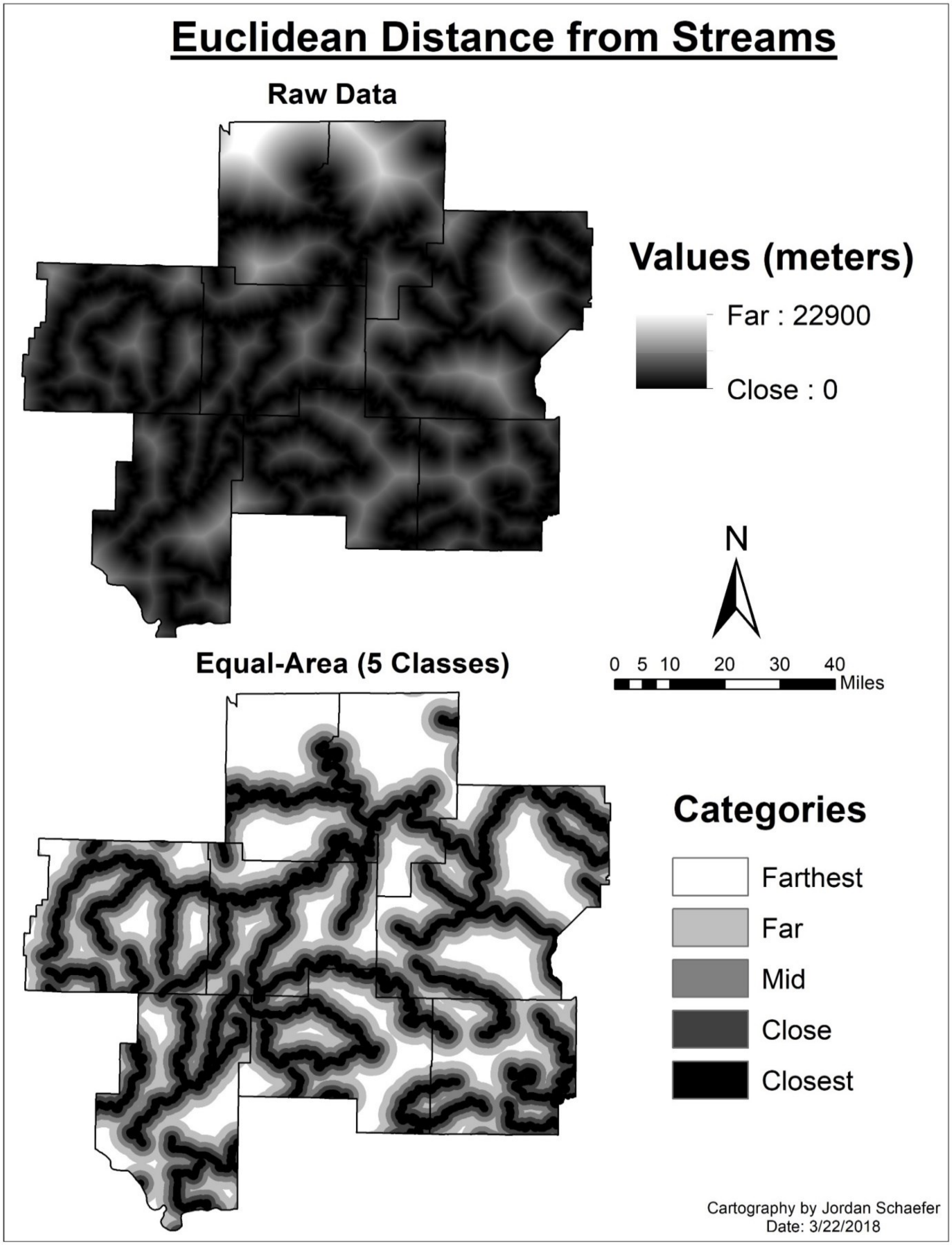



***Figure 1e:*** *Map of raw raster and equal area-classifications for Euclidean distance from streams*

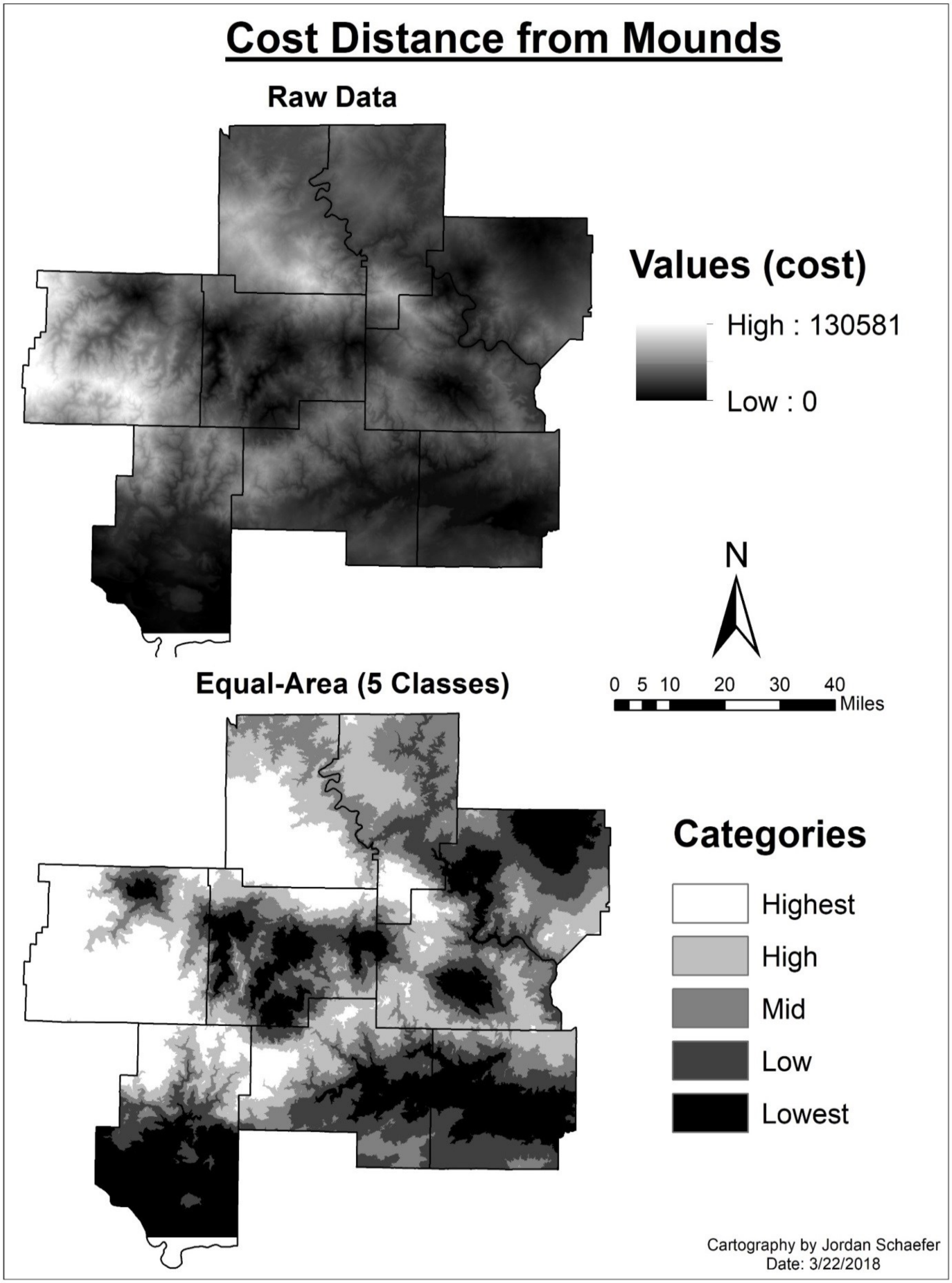



***Figure 1f:*** *Map of raw raster and equal-area classifications for cost distance from mounds*

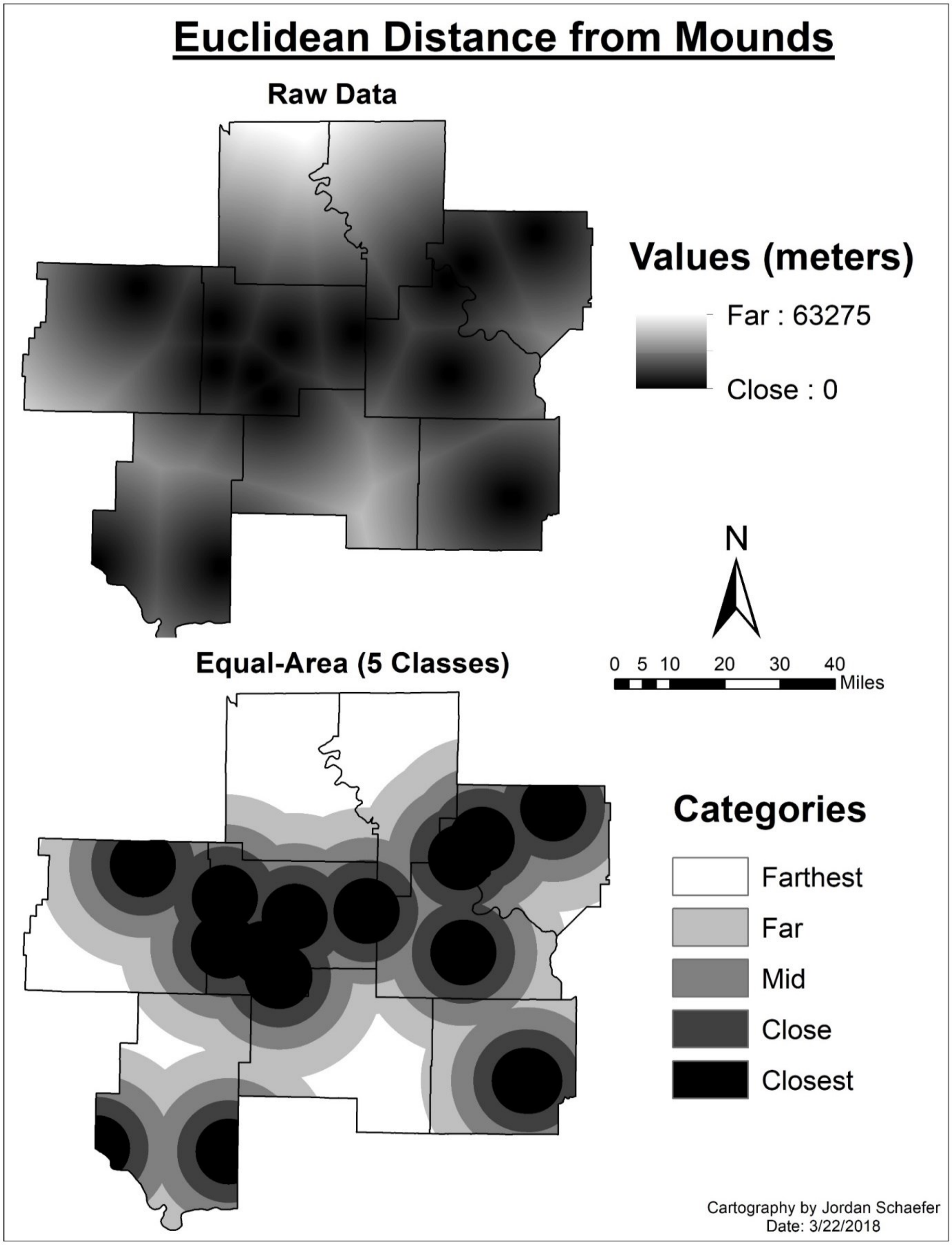



***Figure 1g:*** *Map of raw raster and equal-area classifications for Euclidean distance from mounds*

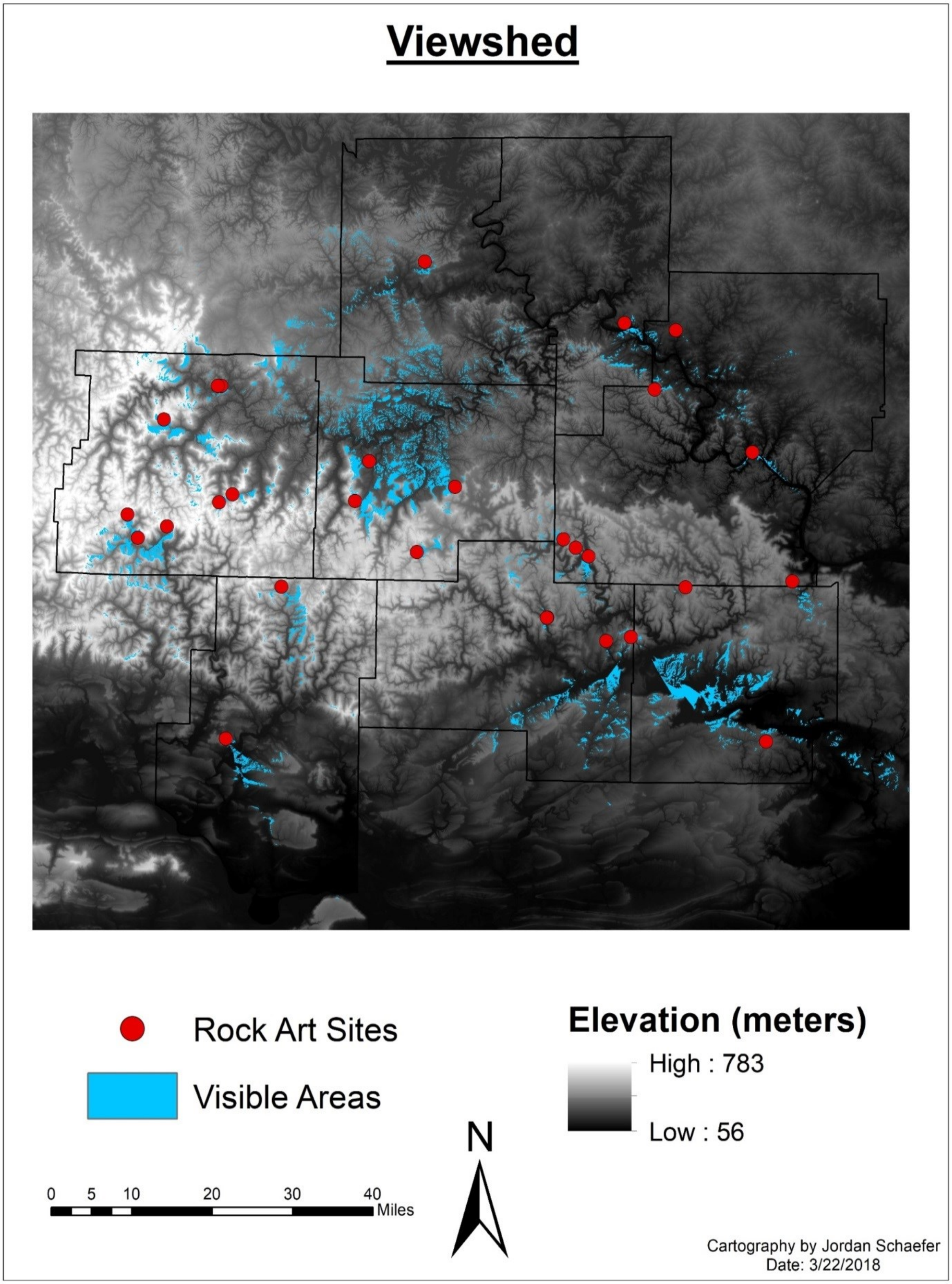



***Figure 1h:*** *Map of rock art site viewsheds*

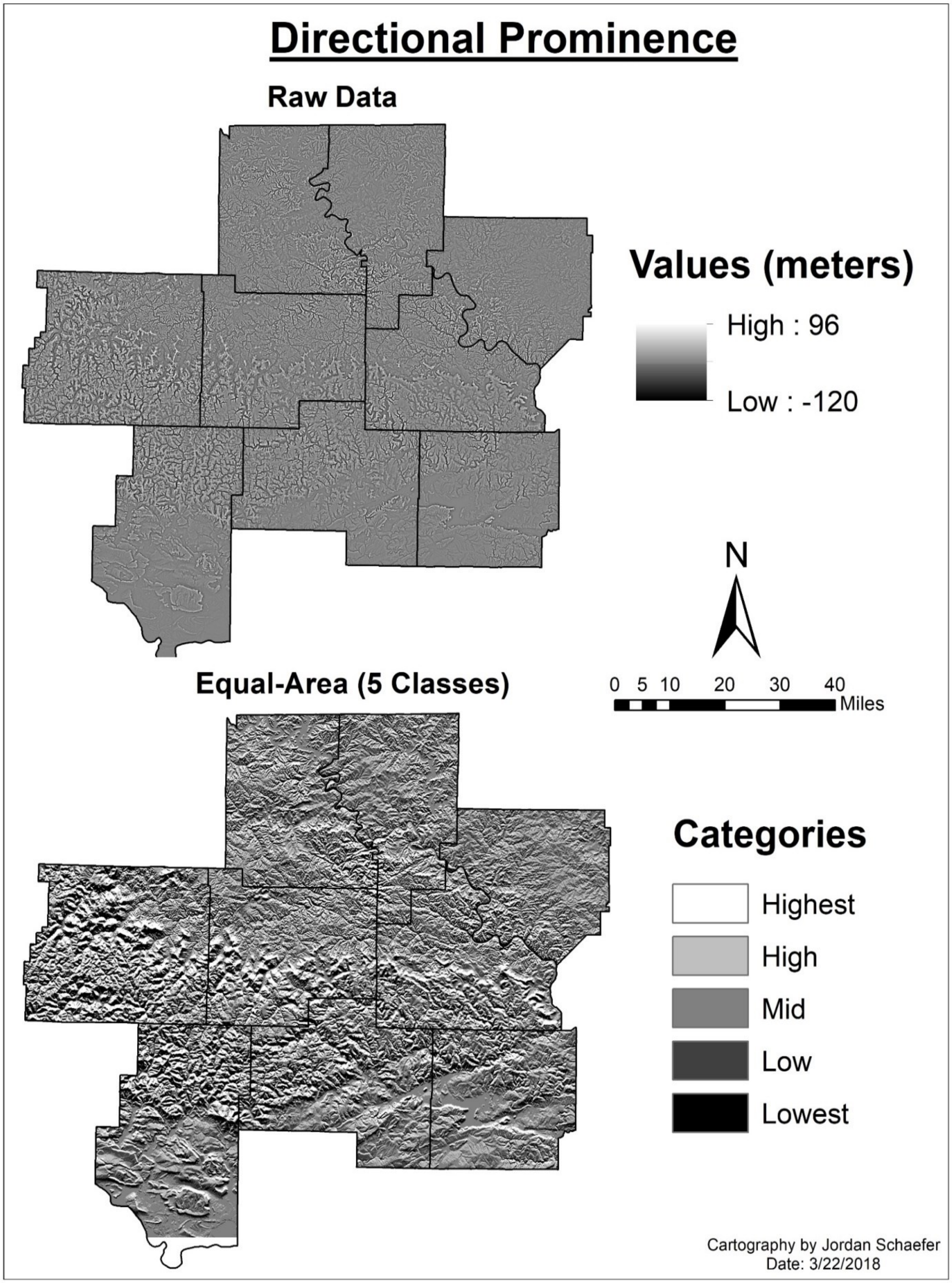



***Figure 1i:*** *Map of raw raster and equal-area classifications for directional prominence*

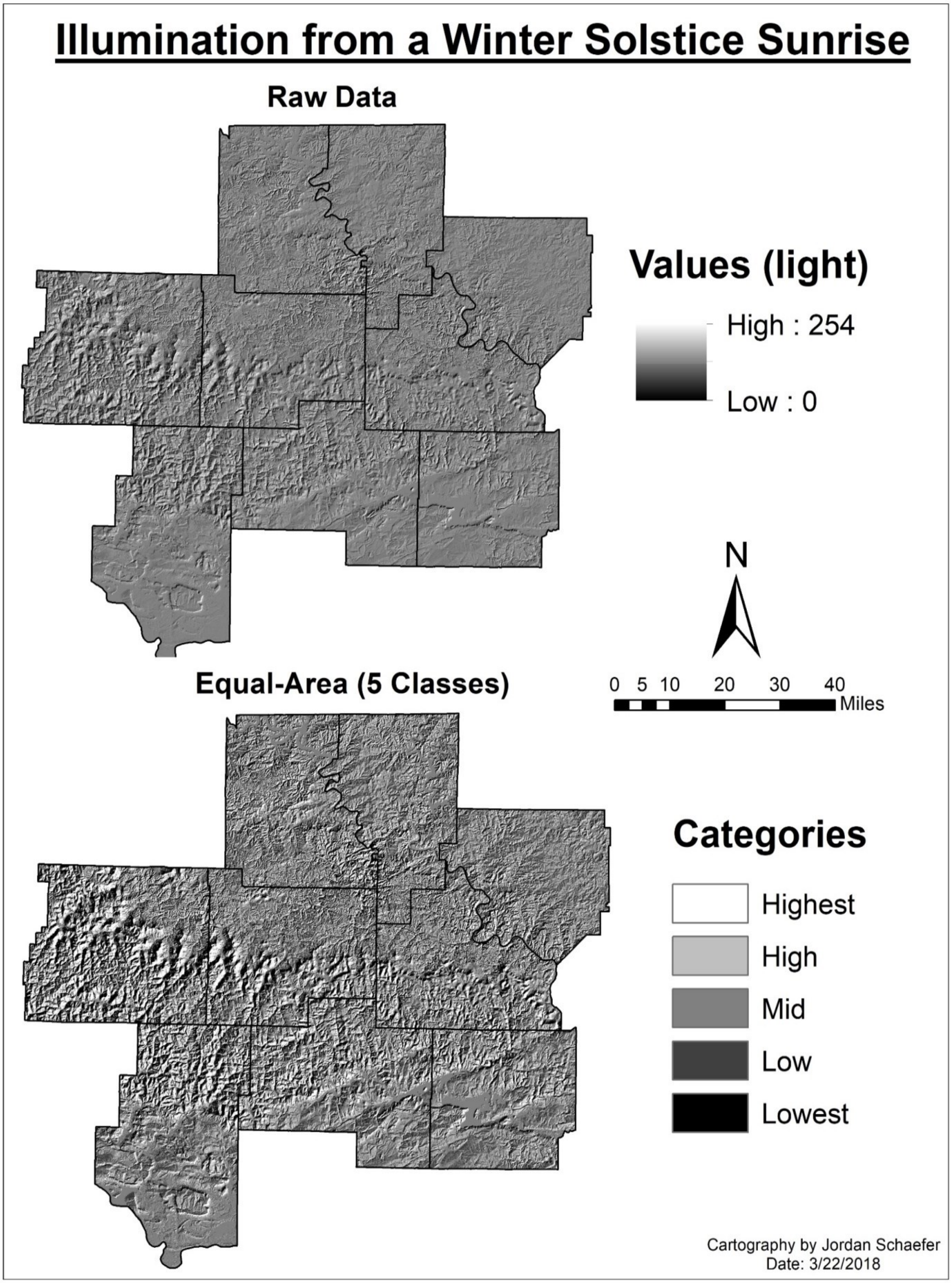



***Figure 1j:*** *Map of raw raster and equal-area classifications for light from winter solstice sunrise*

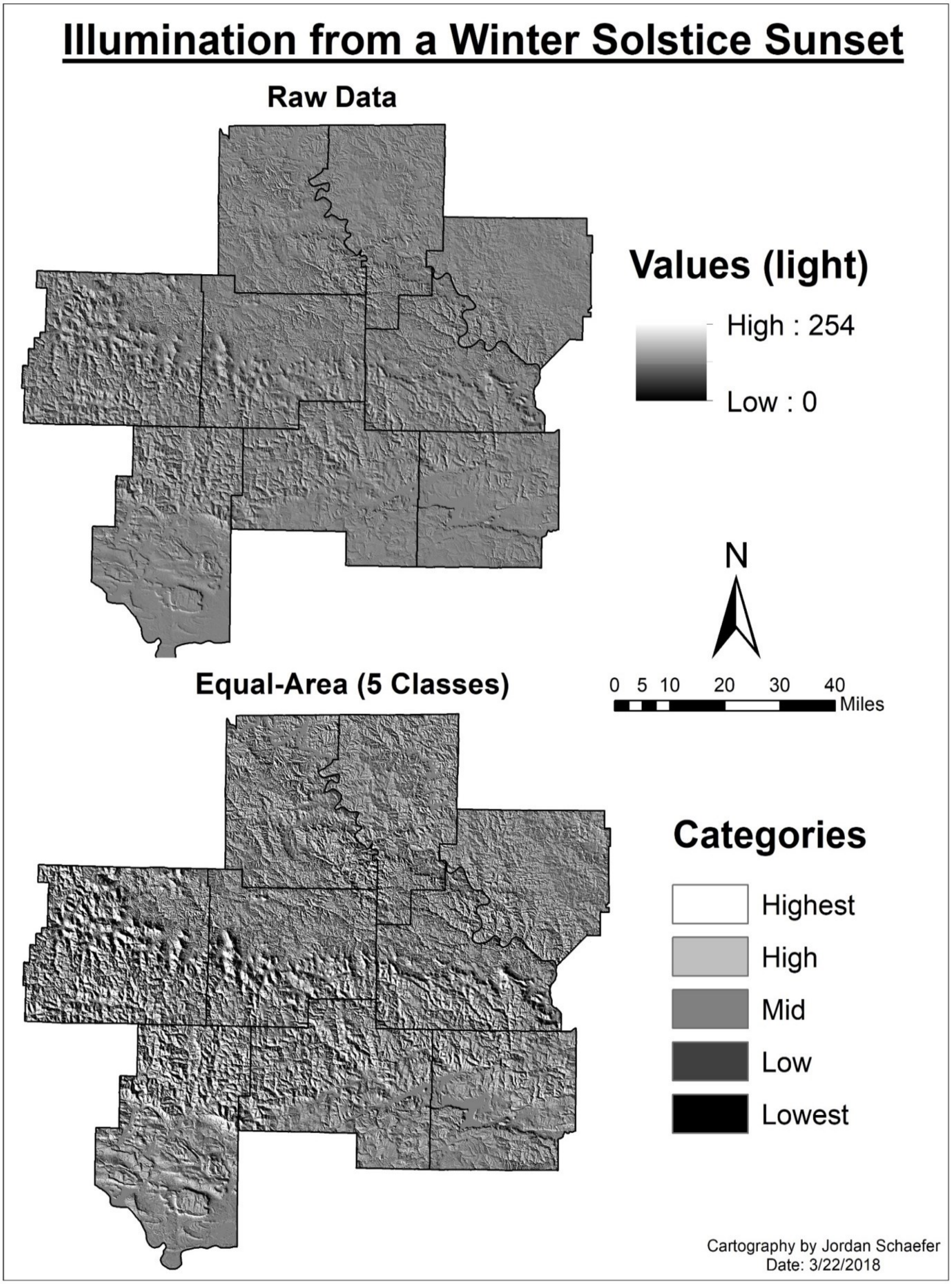



***Figure 1k:*** *Map of raw raster and equal-area classifications for light from winter solstice sunset*

## APPENDIX 2:
## STATISTICS FOR CHAPTER 2

**Table 2.1a:** Chi-square results for elevation

| Values | Lowest | Low | Mid | High | Highest | Total Chi-Square | p-value |
|---|---|---|---|---|---|---|---|
| Observed Sites | 3 | 4 | 6 | 4 | 12 | | |
| Expected Sites | 5.8 | - | - | - | - | **9.103** | **0.0586** |
| Chi-Square | 1.352 | 0.559 | 0.007 | 0.559 | 6.628 | | |
| Observed Elements | 6 | 40 | 80 | 21 | 96 | | |
| Expected Elements | 48.6 | - | - | - | - | **121.053** | **<0.0001** |
| Chi-Square | 37.341 | 1.522 | 20.287 | 15.674 | 46.230 | | |

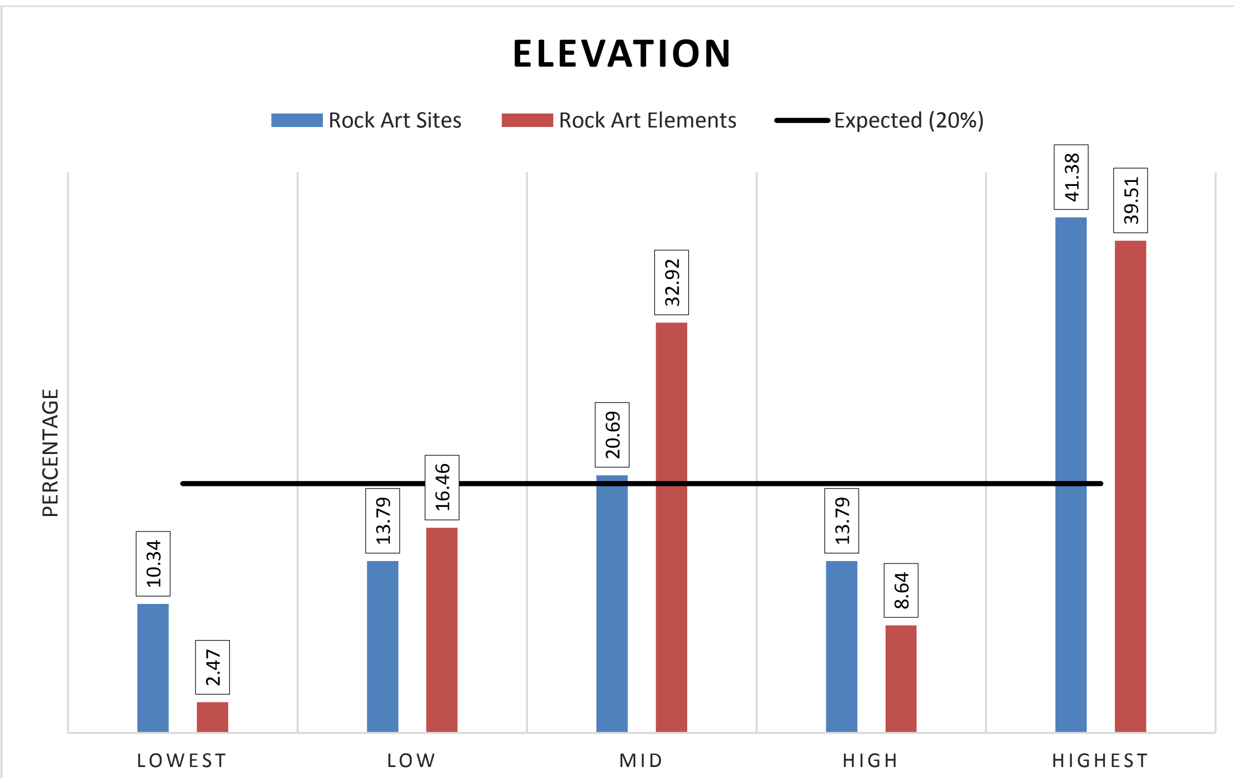



***Figure 2a:*** *Site and element locations relative to elevation*

**Table 2.1b:** T-test results for elevation (meters)

| Values | Mean | SD | N | p-value |
|---|---|---|---|---|
| Rock Art Sites | 353.103 | 159.691 | 29 | **0.0558** |
| Random Sample | 279.759 | 123.520 | 29 | |
| Rock Art Elements | 344.691 | 157.905 | 243 | **<0.0001** |
| Random Sample | 273.782 | 116.001 | 243 | |

**Table 2.2a:** Chi-square results for slope

| Values | Flattest | Flat | Mid | Steep | Steepest | Total Chi-Square | p-value |
|---|---|---|---|---|---|---|---|
| Observed Sites | 0 | 1 | 3 | 7 | 18 | | |
| Expected Sites | 5.8 | - | - | - | - | **37.034** | **<0.0001** |
| Chi-Square | 5.800 | 3.972 | 1.352 | 0.248 | 25.662 | | |
| Observed Elements | 0 | 2 | 7 | 79 | 155 | | |
| Expected Elements | 48.6 | - | - | - | - | **380.848** | **<0.0001** |
| Chi-Square | 48.600 | 44.682 | 35.608 | 19.016 | 232.942 | | |

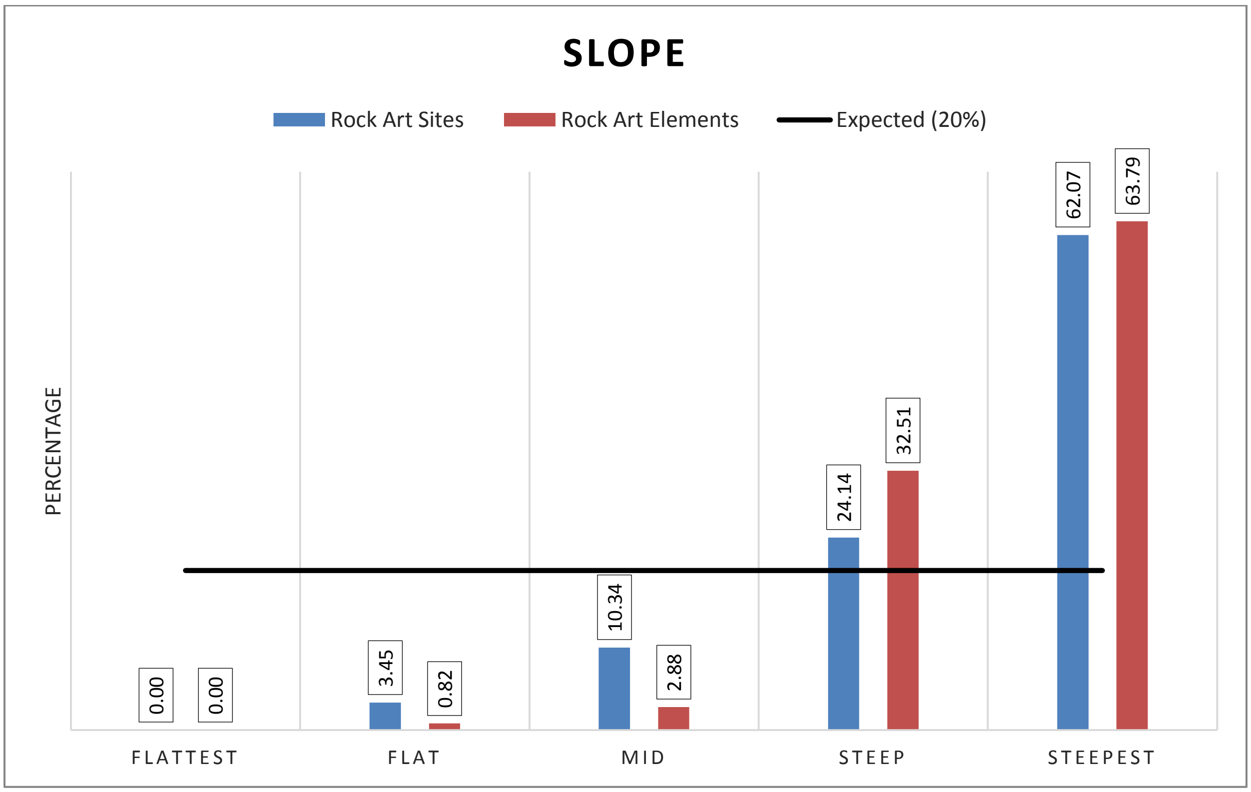



***Figure 2b:*** *Site and element locations relative to slope*

**Table 2.2b:** T-test results for slope (degrees)

| Values | Mean | SD | N | p-value |
|---|---|---|---|---|
| Rock Art Sites | 19.311 | 10.524 | 29 | **<0.0001** |
| Random Sample | 10.041 | 5.682 | 29 | |
| Rock Art Elements | 19.453 | 9.161 | 243 | **<0.0001** |
| Random Sample | 9.784 | 6.835 | 243 | |

**Table 2.3a:** Chi-square results for aspect

| Values | Flat | N | NE | E | SE | S | SW | W | NW | Total Chi-Square | p-value |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Observed Sites | 0 | 1 | 1 | 2 | 11 | 5 | 8 | 1 | 0 | | |
| Expected Sites | 1 | 3 | 3 | 4 | 4 | 4 | 4 | 4 | 3 | **26.417** | **0.0017** |
| Chi-Square | 1.00 | 1.33 | 1.33 | 1.00 | 12.25 | 0.25 | 4.00 | 2.25 | 3.00 | | |
| Observed Elements | 0 | 1 | 0 | 34 | 132 | 48 | 26 | 2 | 0 | | |
| Expected Elements | 7 | 28 | 28 | 30 | 31 | 31 | 30 | 30 | 28 | **454.623** | **<0.0001** |
| Chi-Square | 7.00 | 26.04 | 28.00 | 0.53 | 329.06 | 9.32 | 0.53 | 26.13 | 28.00 | | |

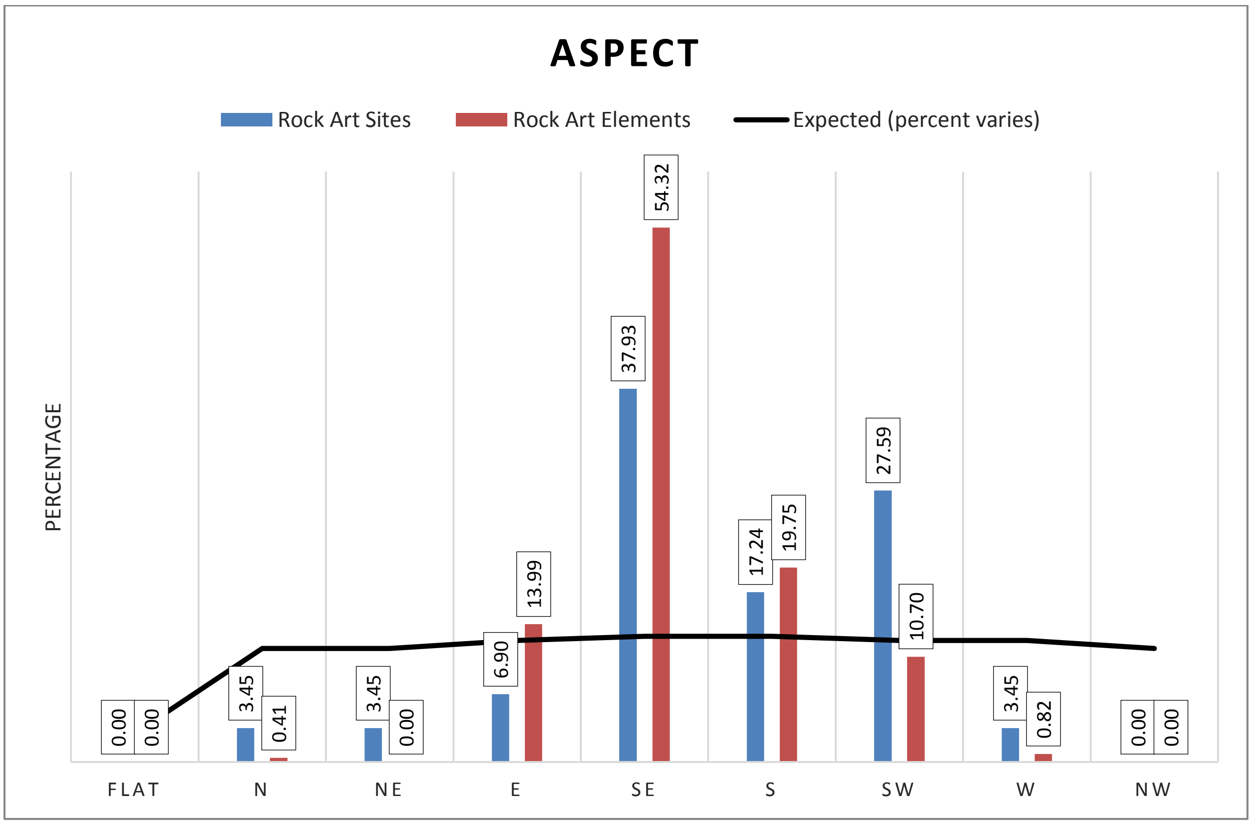



***Figure 2c:*** *Site and element locations relative to aspect*

**Table 2.3b:** Rayleigh z test results for aspect (degrees)

| Values | Mean | R | N | Z | p-value |
|---|---|---|---|---|---|
| Rock Art Sites | 165.29 | 0.606 | 29 | **10.641** | **<0.0001** |
| Rock Art Elements | 147.795 | 0.426 | 243 | **44.084** | **<0.0001** |

**Table 2.4a:** Chi-square results for cost distance from streams

| Values | Lowest | Low | Mid | High | Highest | Total Chi-Square | p-value |
|---|---|---|---|---|---|---|---|
| Observed Sites | 3 | 3 | 5 | 8 | 10 | | |
| Expected Sites | 5.8 | - | - | - | - | **6.690** | **0.1532** |
| Chi-Square | 1.352 | 1.352 | 0.110 | 0.834 | 3.041 | | |
| Observed Elements | 12 | 8 | 39 | 24 | 160 | | |
| Expected Elements | 48.6 | - | - | - | - | **331.177** | **<0.0001** |
| Chi-Square | 27.563 | 33.917 | 1.896 | 12.452 | 255.349 | | |

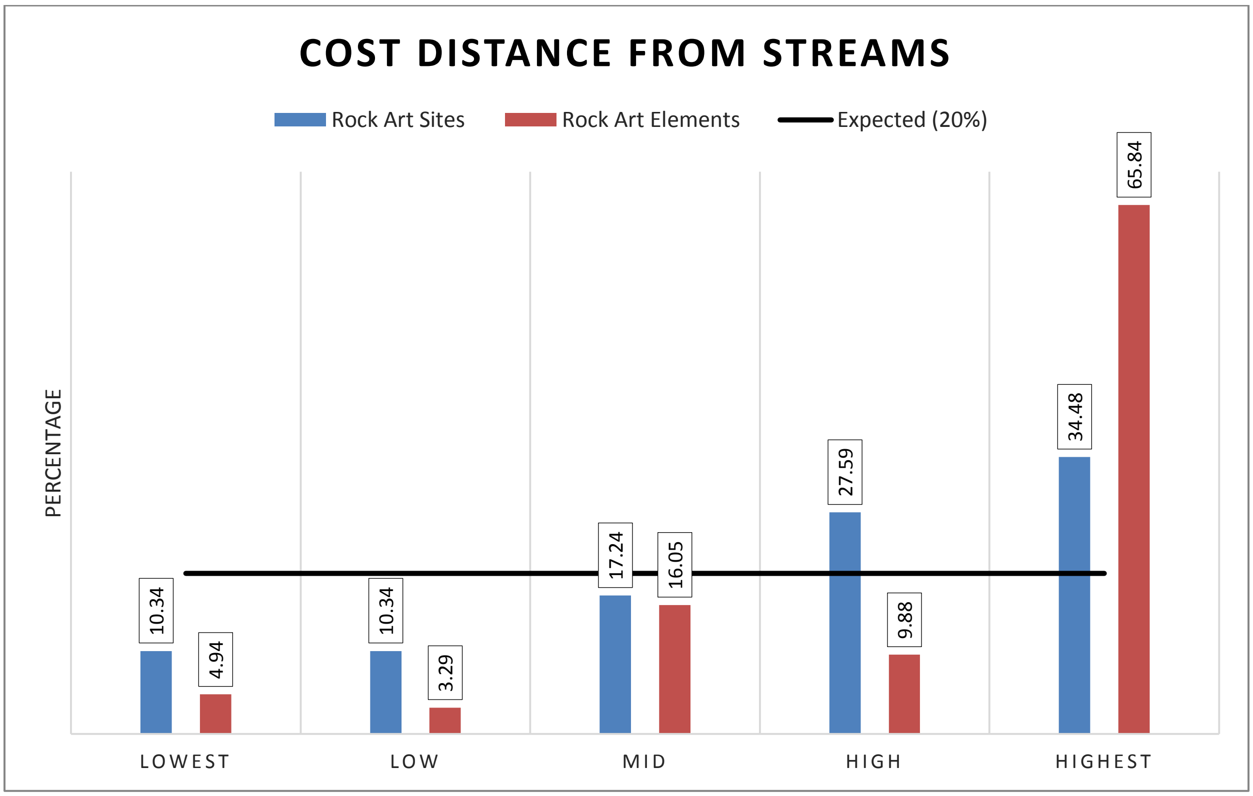



***Figure 2d:** Site and element locations relative to their cost distances from streams*

**Table 2.4b:** T-test results for cost distance from streams (cost)

| Values | Mean | SD | N | p-value |
|---|---|---|---|---|
| Rock Art Sites | 14368.525 | 9088.437 | 29 | **0.3026** |
| Random Sample | 11717.133 | 10279.432 | 29 | |
| Rock Art Elements | 19510.482 | 9062.988 | 243 | **<0.0001** |
| Random Sample | 11205.599 | 8842.715 | 243 | |

**Table 2.5a:** Chi-square results for Euclidean distance from streams

| Values | Closest | Close | Mid | Far | Farthest | Total Chi-Square | p-value |
|---|---|---|---|---|---|---|---|
| Observed Sites | 7 | 3 | 8 | 10 | 1 | **9.448** | **0.0508** |
| Expected Sites | 5.8 | - | - | - | - | | |
| Chi-Square | 0.248 | 1.352 | 0.834 | 3.041 | 3.972 | | |
| Observed Elements | 19 | 4 | 59 | 133 | 28 | **216.486** | **<0.0001** |
| Expected Elements | 48.6 | - | - | - | - | | |
| Chi-Square | 18.028 | 40.929 | 2.226 | 146.571 | 8.732 | | |

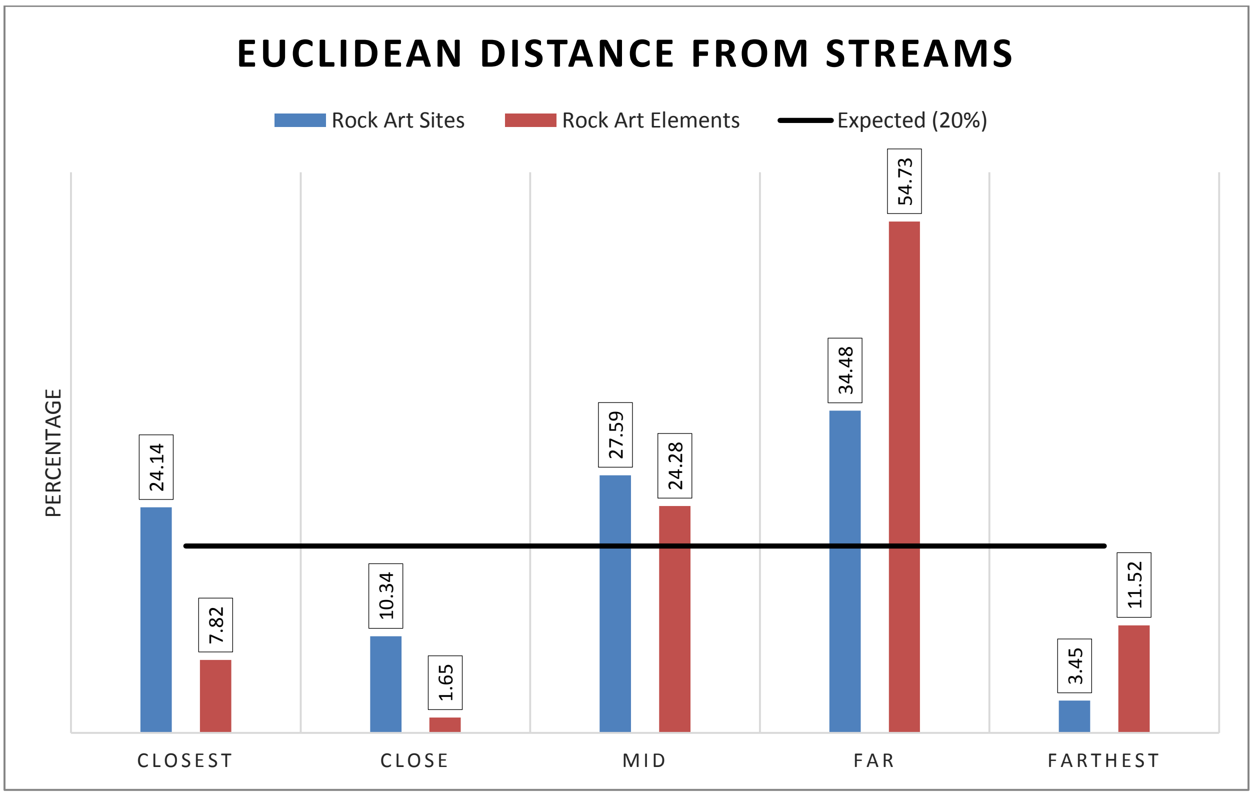



***Figure 2e:*** *Site and element locations relative to their Euclidean distances from streams*

**Table 2.5b:** T-test results for Euclidean distance from streams (meters)

| Values | Mean | SD | N | p-value |
|---|---|---|---|---|
| Rock Art Sites | 2854.13 | 1734.884 | 29 | **0.6768** |
| Random Sample | 3092.112 | 2516.284 | 29 | |
| Rock Art Elements | 3896.228 | 1506.738 | 243 | **0.1581** |
| Random Sample | 3587.867 | 3045.563 | 243 | |

**Table 2.6a:** Chi-square results for cost distance from mounds

| Values | Lowest | Low | Mid | High | Highest | Total Chi-Square | p-value |
|---|---|---|---|---|---|---|---|
| Observed Sites | 7 | 8 | 1 | 6 | 7 | | |
| Expected Sites | 5.8 | - | - | - | - | **5.310** | **0.2569** |
| Chi-Square | 0.248 | 0.834 | 3.972 | 0.007 | 0.248 | | |
| Observed Elements | 57 | 53 | 34 | 40 | 59 | | |
| Expected Elements | 48.6 | - | - | - | - | **9.984** | **0.0407** |
| Chi-Square | 1.452 | 0.398 | 4.386 | 1.522 | 2.226 | | |

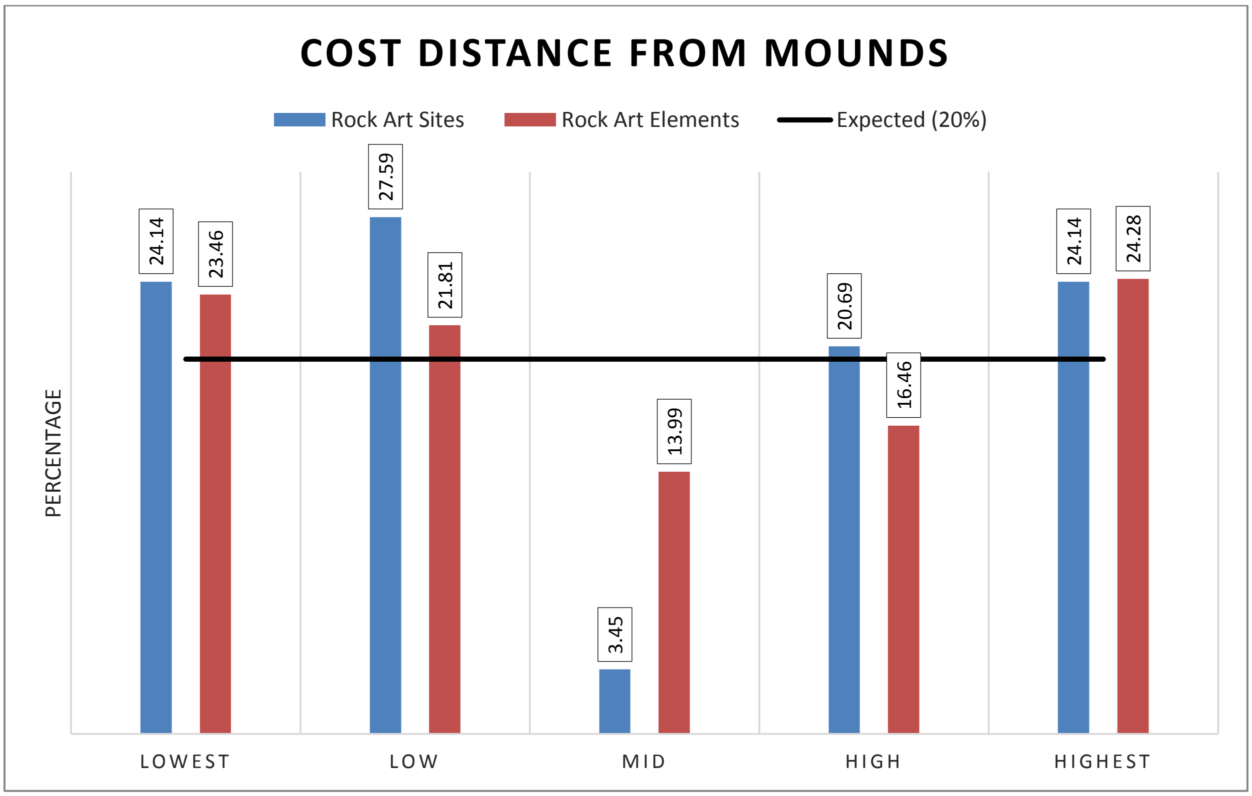



***Figure 2f:*** *Site and element locations relative to their cost distances from mounds*

**Table 2.6b:** T-test results for cost distance from mounds (cost)

| Values | Mean | SD | N | p-value |
|---|---|---|---|---|
| Rock Art Sites | 36215.801 | 26283.557 | 29 | **0.7909** |
| Random Sample | 34512.278 | 22243.751 | 29 | |
| Rock Art Elements | 36858.629 | 25502.838 | 243 | **0.3166** |
| Random Sample | 34784.614 | 20634.97 | 243 | |

**Table 2.7a:** Chi-square results for Euclidean distance from mounds

| Values | Closest | Close | Mid | Far | Farthest | Total Chi-Square | p-value |
|---|---|---|---|---|---|---|---|
| Observed Sites | 9 | 2 | 8 | 7 | 3 | | |
| Expected Sites | 5.8 | - | - | - | - | **6.690** | **0.1532** |
| Chi-Square | 1.766 | 2.490 | 0.834 | 0.248 | 1.352 | | |
| Observed Elements | 91 | 13 | 34 | 77 | 28 | | |
| Expected Elements | 48.6 | - | - | - | - | **92.782** | **<0.0001** |
| Chi-Square | 36.991 | 26.077 | 4.386 | 16.596 | 8.732 | | |

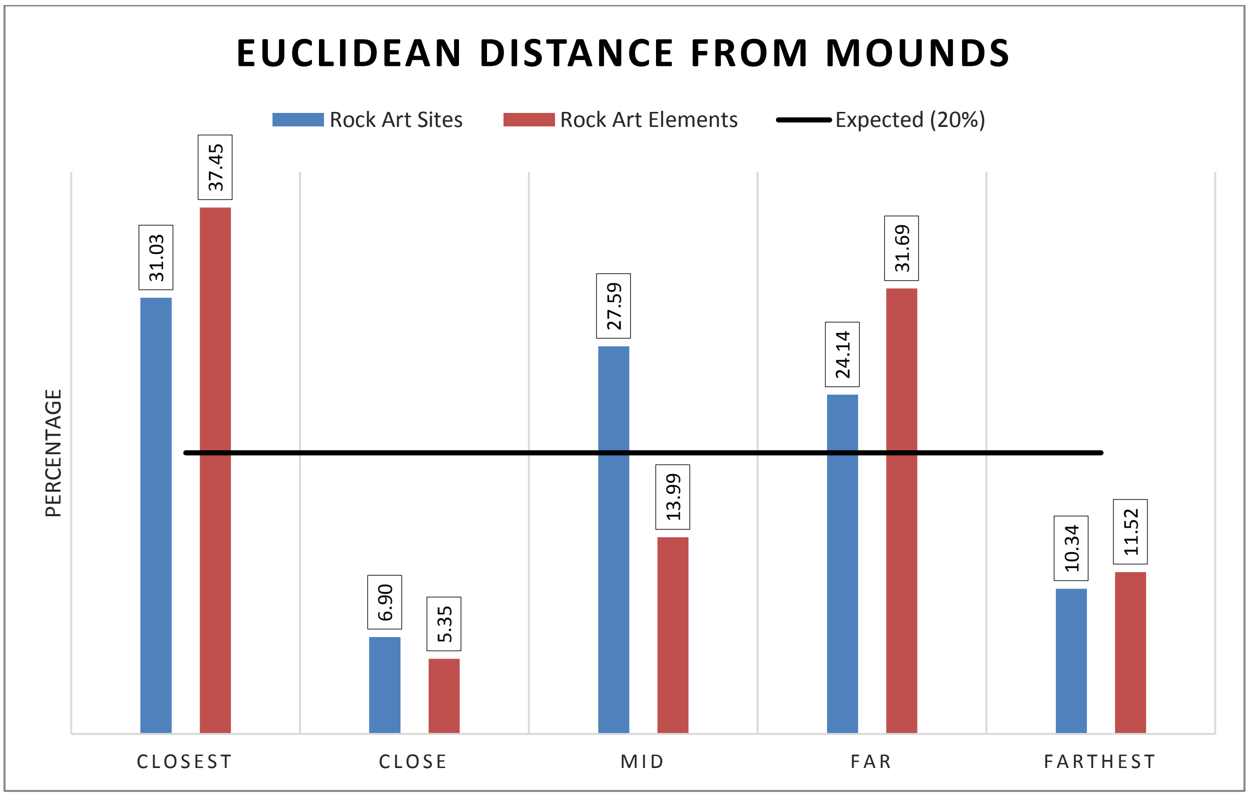



***Figure 2g:*** *Site and element locations relative to their Euclidean distances from mounds*

**Table 2.7b:** T-test results for Euclidean distance from mounds (meters)

| Values | Mean | SD | N | p-value |
|---|---|---|---|---|
| Rock Art Sites | 17307.294 | 10645.139 | 29 | **0.511** |
| Random Sample | 19335.266 | 12612.948 | 29 | |
| Rock Art Elements | 17106.787 | 11448.02 | 243 | **0.0005** |
| Random Sample | 20837.957 | 12118.577 | 243 | |

**Table 2.8a:** Viewsheds for rock art sites in the study area (outliers bolded)

| Site Number | Site Name | Total Elements | Pixels Observed |
|---|---|---|---|
| 3BA0030 | Old Joe | 2 | 26098 |
| 3CE0060 | Rockhouse Hollow | 3 | 1873 |
| 3CE0073 | Dollar Bluff | 6 | 370 |
| 3IZ0143 | (No Site Name) | 2 | 8173 |
| 3IZ0149 | Goat Hollow Cave | ? | 400 |
| 3MR0094 | Sunburst Shelter | 7 | 48346 |
| 3NW0037 | Painted Bluff Site | 2 | 2915 |
| 3NW0076 | East Rock Shelter | 1 | 30507 |
| 3NW0079 | Owens Mountain | 20 | 8425 |
| 3NW0276 | Hiner Shelter | 10 | 4127 |
| 3NW0459 | East Cole Creek Bluff | 20 | 12993 |
| 3NW0626 | (No Site Name) | 1 | 26875 |
| 3NW0681 | Lambdin Hollow Shelter | 3 | 3889 |
| 3NW1054 | Goat Cave | 7 | 37748 |
| 3PP0614 | Pedestal Rock | 2 | 29150 |
| 3PP1380 | Myer Petroglyph | 4 | 26484 |
| 3SE0105 | Jacobs Rock | 34 | 55433 |
| 3SE0321 | Hubbard Petroglyphs | 1 | 30982 |
| 3SE0406 | Conner Pictographs | 5 | **245357** |
| 3SE0605 | (No Site Name) | ? | 7697 |
| 3ST0018 | Paxton Shelter | 2 | 11934 |
| 3ST0054 | Pictograph Cave | 28 | 7509 |
| 3ST0070 | Gustafson Cave | 36 | 4016 |
| 3ST0076 | Fox | 1 | 10050 |
| 3ST0400 | Lewis | 1 | 5709 |
| 3VB0006 | Edgemont | 7 | **200460** |
| 3VB0019 | Lynn Creek | 5 | 740 |
| 3VB0316 | Sprott 1 | 31 | 1996 |
| 3VB0317 | Sprott 2 | 2 | 1685 |

**Table 2.8b:** T-test results for viewshed (the left table includes 3SE0406 and 3VB0006, while the right table excludes them) (pixels observed)

| Values | Mean | SD | N | p-val. | Values | Mean | SD | N | p-val. |
|---|---|---|---|---|---|---|---|---|---|
| R.A Sites | 29377.276 | 55024.41 | 29 | **0.3707** | R.A. Sites | 15041.63 | 15320.712 | 27 | **0.4531** |
| Rand. Sample | 19232.138 | 25241.266 | 29 | | Rand. Sample | 19232.138 | 25241.266 | 29 | |
| R.A. Elements | 26324.667 | 48051.27 | 243 | **0.3298** | R.A. Elements | 16306.88 | 19266.73 | 231 | **0.1568** |
| Rand. Sample | 21715.025 | 31954.02 | 80 | | Rand. Sample | 21715.025 | 31954.02 | 80 | |

**Table 2.8c:** Mann-Whitney U test results for viewshed (pixels observed)

| Values | Mean | N | U | Z | p-value |
|---|---|---|---|---|---|
| Rock Art Sites | 29377.276 | 29 | **388** | **0.4976** | **0.6171** |
| Random Sample | 19232.138 | 29 | | | |
| Rock Art Elements | 26324.667 | 243 | **9518** | **0.2781** | **0.7795** |
| Random Sample | 21715.025 | 80 | | | |

**Table 2.9a:** Chi-square results for directional prominence

| Values | Lowest | Low | Mid | High | Highest | Total Chi-Square | p-value |
|---|---|---|---|---|---|---|---|
| Observed Sites | 4 | 2 | 1 | 8 | 14 | | |
| Expected Sites | 5.8 | - | - | - | - | **19.448** | **0.0006** |
| Chi-Square | 0.559 | 2.490 | 3.972 | 0.834 | 11.593 | | |
| Observed Elements | 73 | 3 | 2 | 59 | 106 | | |
| Expected Elements | 48.6 | - | - | - | - | **169.737** | **<0.0001** |
| Chi-Square | 12.250 | 42.785 | 44.682 | 2.226 | 67.793 | | |

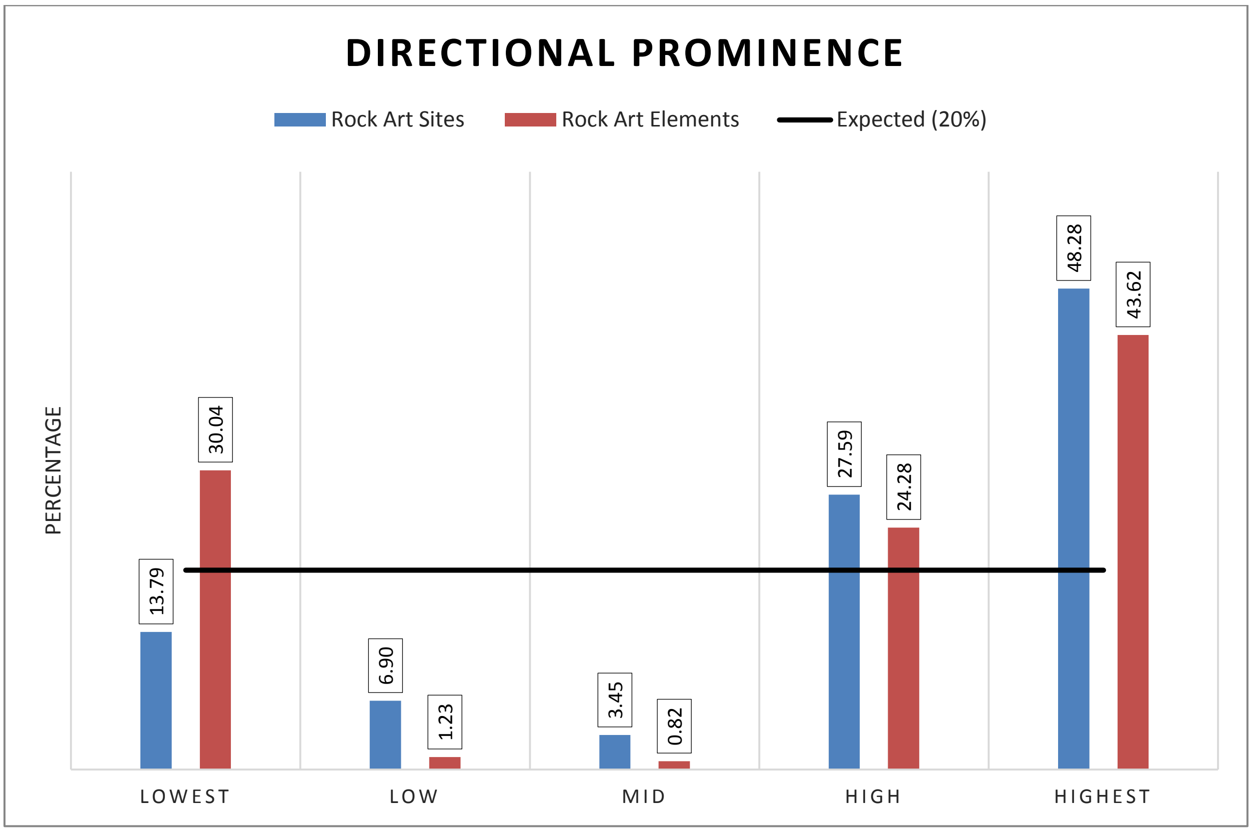



***Figure 2h:*** *Site and element locations relative to directional prominence*

**Table 2.9b:** T-test results for directional prominence (meters)

| Values | Mean | SD | N | p-value |
|---|---|---|---|---|
| Rock Art Sites | 20.187 | 34.283 | 29 | **0.7284** |
| Random Sample | 17.551 | 21.835 | 29 | |
| Rock Art Elements | 17.378 | 35.841 | 243 | **0.0308** |
| Random Sample | 11.48 | 22.693 | 243 | |

**Table 2.10a:** Chi-square results for illumination from winter solstice sunrise

| Values | Lowest | Low | Mid | High | Highest | Total Chi-Square | p-value |
|---|---|---|---|---|---|---|---|
| Observed Sites | 3 | 3 | 3 | 3 | 17 | | |
| Expected Sites | 5.8 | - | - | - | - | **27.034** | **<0.0001** |
| Chi-Square | 1.352 | 1.352 | 1.352 | 1.352 | 21.628 | | |
| Observed Elements | 14 | 7 | 5 | 10 | 207 | | |
| Expected Elements | 48.6 | - | - | - | - | **646.280** | **<0.0001** |
| Chi-Square | 24.633 | 35.608 | 39.114 | 30.658 | 516.267 | | |

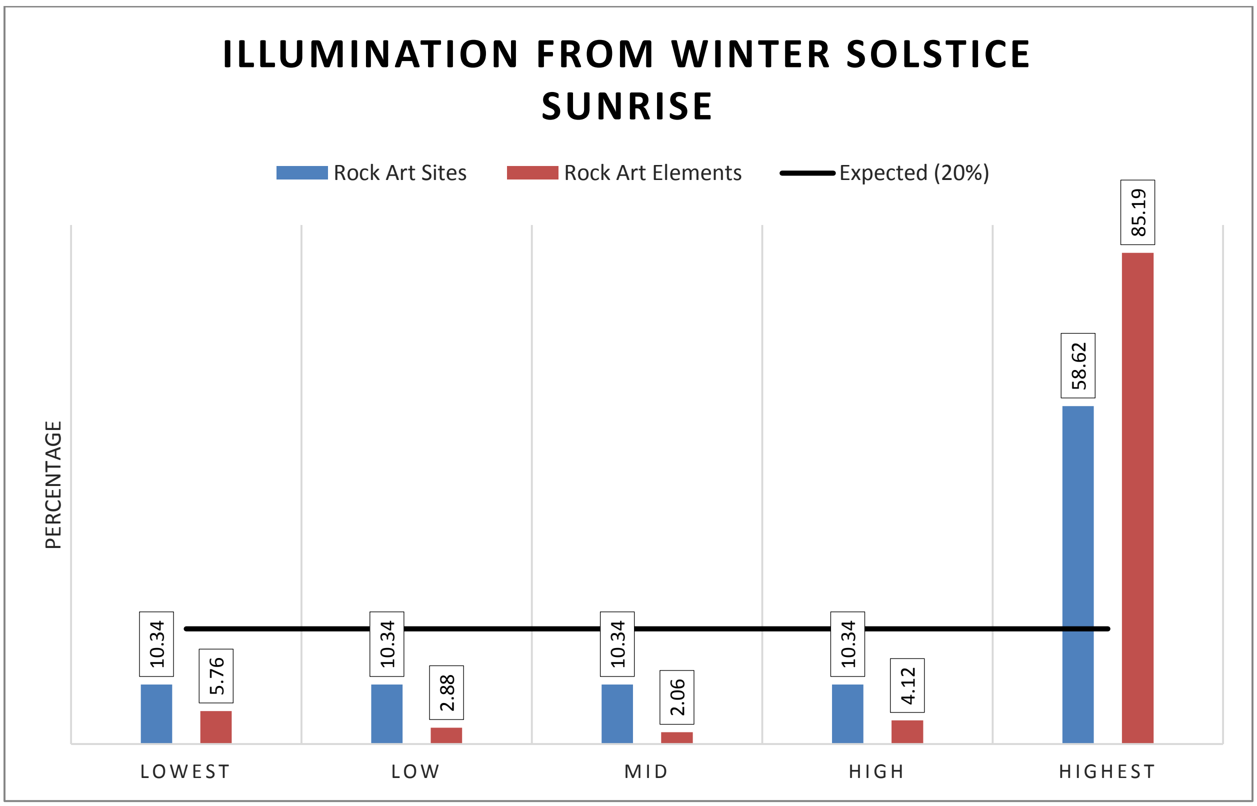



***Figure 2i:*** *Site and element locations relative to light from a winter solstice sunrise*

**Table 2.10b:** T-test results for illumination from winter solstice sunrise (light)

| Values | Mean | SD | N | p-value |
|---|---|---|---|---|
| Rock Art Sites | 158.793 | 42.255 | 29 | **<0.0001** |
| Random Sample | 123.724 | 27.988 | 29 | |
| Rock Art Elements | 176.358 | 35.569 | 243 | **<0.0001** |
| Random Sample | 125.004 | 31.251 | 243 | |

**Table 2.11a:** Chi-square results for illumination from winter solstice sunset

| Values | Lowest | Low | Mid | High | Highest | Total Chi-Square | p-value |
|---|---|---|---|---|---|---|---|
| Observed Sites | 7 | 6 | 2 | 1 | 13 | | |
| Expected Sites | 5.8 | - | - | - | - | **15.655** | **0.0035** |
| Chi-Square | 0.248 | 0.007 | 2.490 | 3.972 | 8.938 | | |
| Observed Elements | 89 | 43 | 35 | 2 | 74 | | |
| Expected Elements | 48.6 | - | - | - | - | **95.992** | **<0.0001** |
| Chi-Square | 33.584 | 0.645 | 3.806 | 44.682 | 13.275 | | |

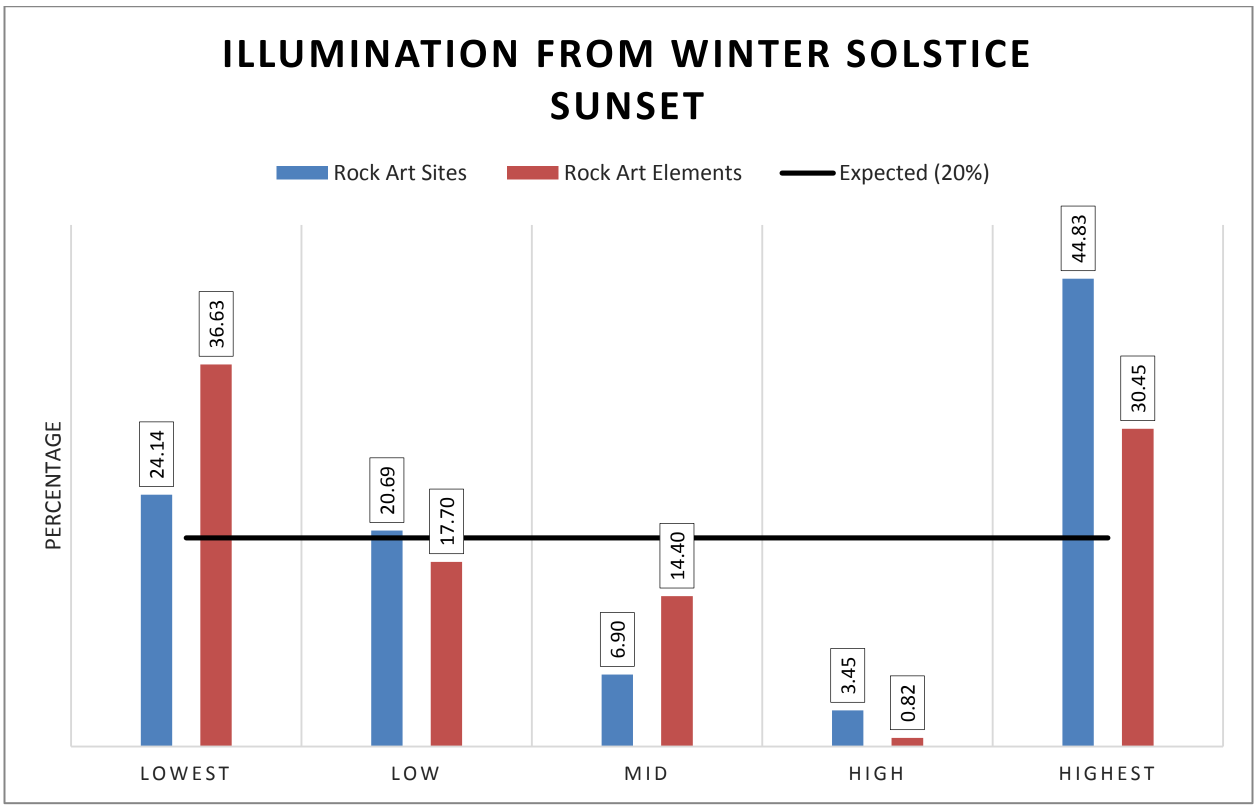



***Figure 2j:*** *Site and element locations relative to light received from a winter solstice sunset*

**Table 2.11b:** T-test results for illumination from winter solstice sunset (light)

| Values | Mean | SD | N | p-value |
|---|---|---|---|---|
| Rock Art Sites | 136.276 | 41.919 | 29 | **0.4354** |
| Random Sample | 128.586 | 31.906 | 29 | |
| Rock Art Elements | 120.284 | 38.299 | 243 | **0.1036** |
| Random Sample | 125.56 | 32.807 | 243 | |

# APPENDIX 3:

# STATISTICS FOR CHAPTER 3

**Table 3.1a:** Chi-square results for elevation

| Values | Lowest | Low | Mid | High | Highest | Total Chi-Square | p-value |
|---|---|---|---|---|---|---|---|
| Observed Sites | 3 | 4 | 6 | 4 | 12 | | |
| Bluff Shelters | 103 | 125 | 174 | 158 | 384 | **0.249** | **0.9928** |
| Chi-Square | 0.009 | 0.007 | 0.080 | 0.150 | 0.004 | | |
| Observed Elements | 6 | 40 | 80 | 21 | 96 | | |
| Bluff Shelters | 103 | 125 | 174 | 158 | 384 | **55.049** | **<0.0001** |
| Chi-Square | 15.872 | 1.902 | 27.678 | 9.515 | 0.082 | | |

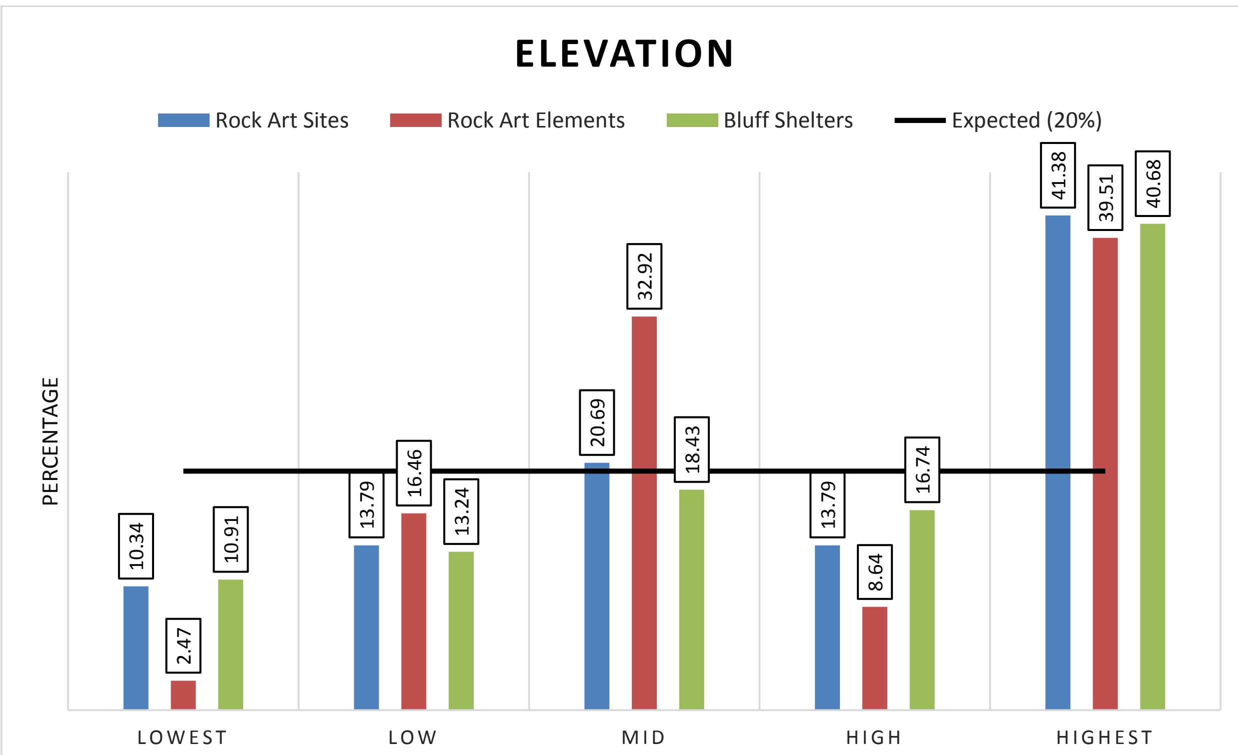



***Figure 3a:*** *Site, element, and bluff shelter locations relative to elevation*

**Table 3.1b:** T-test results for elevation (meters)

| Values | Mean | SD | N | p-value |
|---|---|---|---|---|
| Rock Art Sites | 353.103 | 159.691 | 29 | **0.6948** |
| Bluff Shelters | 365.012 | 149.534 | 944 | |
| Rock Art Elements | 344.691 | 157.905 | 243 | **0.0714** |
| Bluff Shelters | 365.012 | 149.534 | 944 | |

**Table 3.2a:** Chi-square results for slope

| Values | Flattest | Flat | Mid | Steep | Steepest | Total Chi-Square | p-value |
|---|---|---|---|---|---|---|---|
| Observed Sites | 0 | 1 | 3 | 7 | 18 | | |
| Bluff Shelters | 21 | 34 | 67 | 149 | 673 | **2.706** | **0.6083** |
| Chi-Square | 0.645 | 0.002 | 0.431 | 1.282 | 0.346 | | |
| Observed Elements | 0 | 2 | 7 | 79 | 155 | | |
| Bluff Shelters | 21 | 34 | 67 | 149 | 673 | **61.695** | **<0.0001** |
| Chi-Square | 5.406 | 5.209 | 6.088 | 43.072 | 1.921 | | |

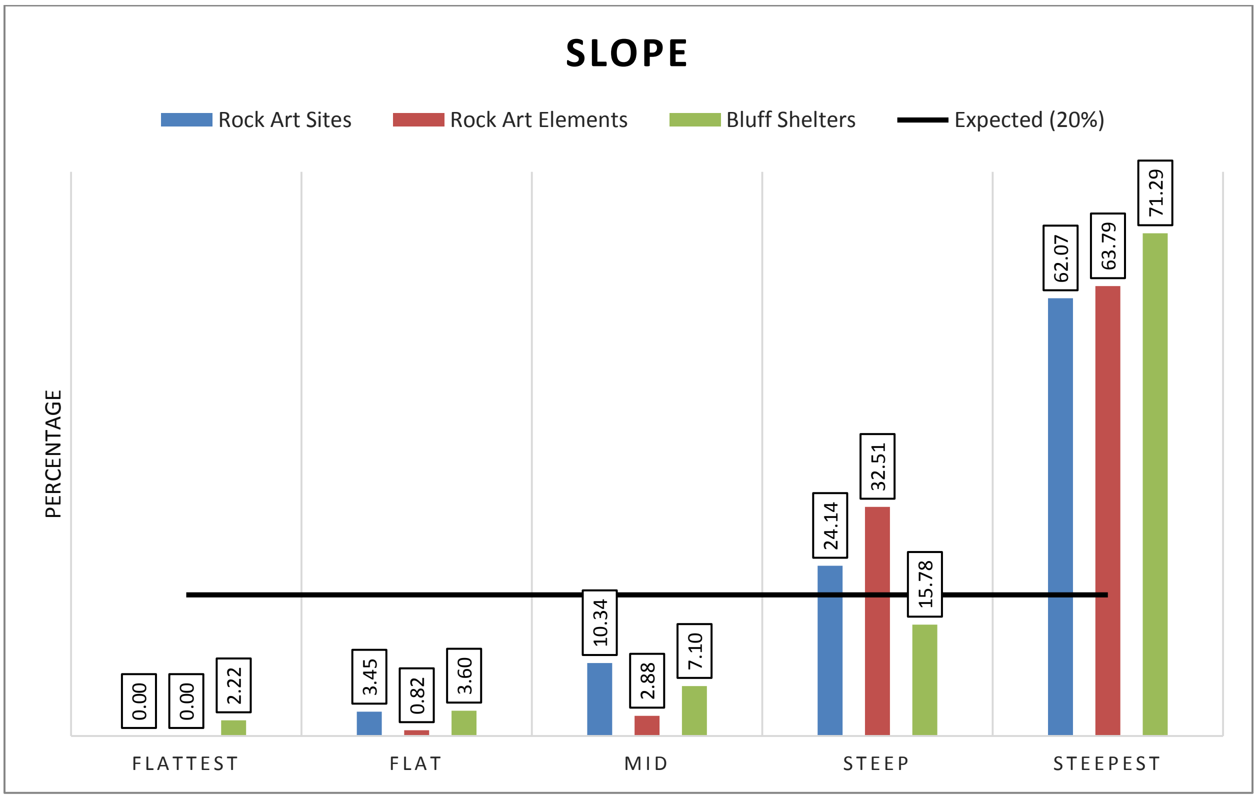



***Figure 3b:*** *Site, element, and bluff shelter locations relative to slope*

**Table 3.2b:** T-test results for slope (degrees)

| Values | Mean | SD | N | p-value |
|---|---|---|---|---|
| Rock Art Sites | 19.311 | 10.524 | 29 | **0.6488** |
| Bluff Shelters | 20.222 | 9.46 | 944 | |
| Rock Art Elements | 19.453 | 9.161 | 243 | **0.2474** |
| Bluff Shelters | 20.222 | 9.46 | 944 | |

**Table 3.3a:** Chi-square results for aspect

| Values | Flat | N | NE | E | SE | S | SW | W | NW | Total Chi-Square | p-value |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Observed Sites | 0 | 1 | 1 | 2 | 11 | 5 | 8 | 1 | 0 | **16.105** | **0.0409** |
| Bluff Shelters | 3 | 55 | 72 | 119 | 161 | 180 | 152 | 118 | 84 | | |
| Chi-Square | 0.09 | 0.28 | 0.66 | 0.75 | 7.41 | 0.05 | 2.38 | 1.90 | 2.58 | | |
| Observed Elements | 0 | 1 | 0 | 34 | 132 | 48 | 26 | 2 | 0 | **282.366** | **<0.0001** |
| Bluff Shelters | 3 | 55 | 72 | 119 | 161 | 180 | 152 | 118 | 84 | | |
| Chi-Square | 0.77 | 12.23 | 18.53 | 0.37 | 197.87 | 0.06 | 4.40 | 26.51 | 21.62 | | |

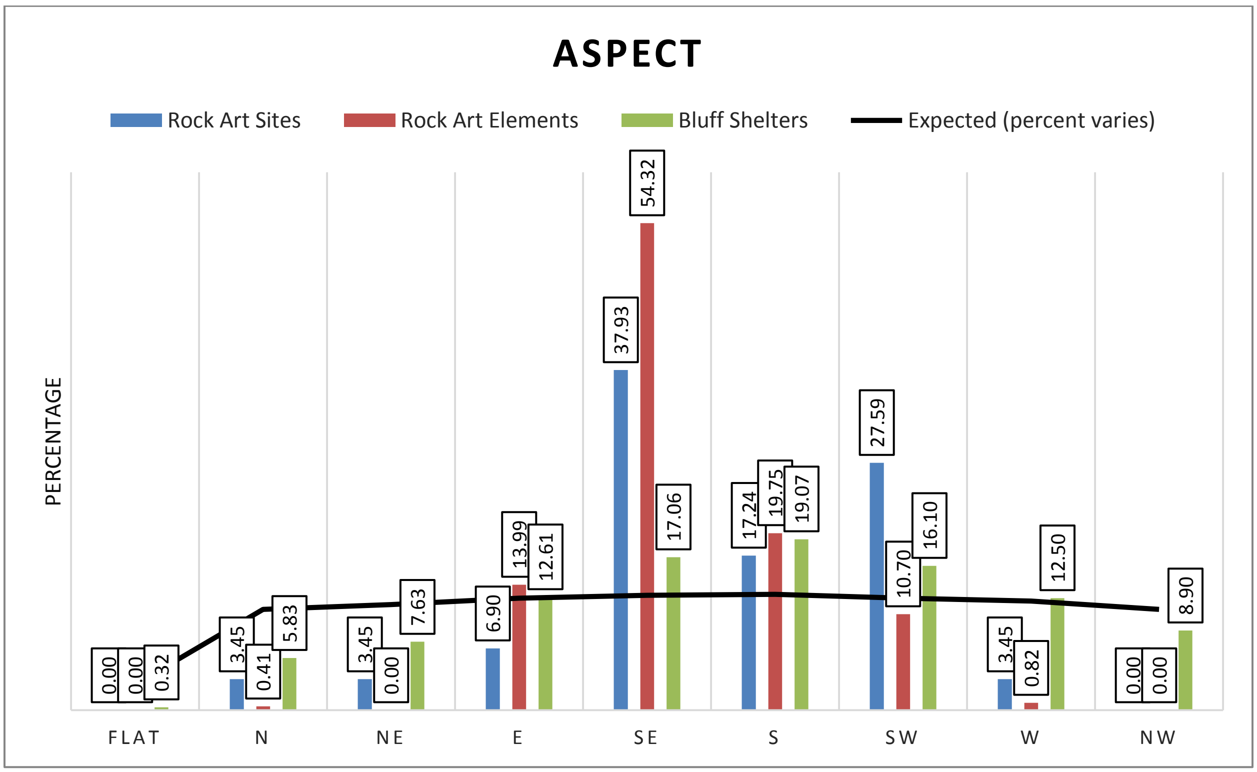



***Figure 3c:*** *Site, element, and bluff shelter locations relative to aspect*

**Table 3.3b:** Watson's $U^2$ test results for aspect (degrees)

| Values | Mean | R | N | $U^2$ | p-value |
|---|---|---|---|---|---|
| Rock Art Sites | 165.29 | 0.606 | 29 | **0.221** | **<0.05** |
| Bluff Shelters | 180.088 | 0.261 | 944 | | |
| Rock Art Elements | 147.795 | 0.426 | 243 | **4.545** | **<0.0001** |
| Bluff Shelters | 180.088 | 0.261 | 944 | | |

**Table 3.4a:** Chi-square results for cost distance from streams

| Values | Lowest | Low | Mid | High | Highest | Total Chi-Square | p-value |
|---|---|---|---|---|---|---|---|
| Observed Sites | 3 | 3 | 5 | 8 | 10 | | |
| Bluff Shelters | 166 | 128 | 143 | 190 | 317 | **1.978** | **0.7401** |
| Chi-Square | 0.864 | 0.221 | 0.084 | 0.802 | 0.007 | | |
| Observed Elements | 12 | 8 | 39 | 24 | 160 | | |
| Bluff Shelters | 166 | 128 | 143 | 190 | 317 | **129.132** | **<0.0001** |
| Chi-Square | 22.101 | 18.892 | 0.130 | 12.686 | 75.324 | | |

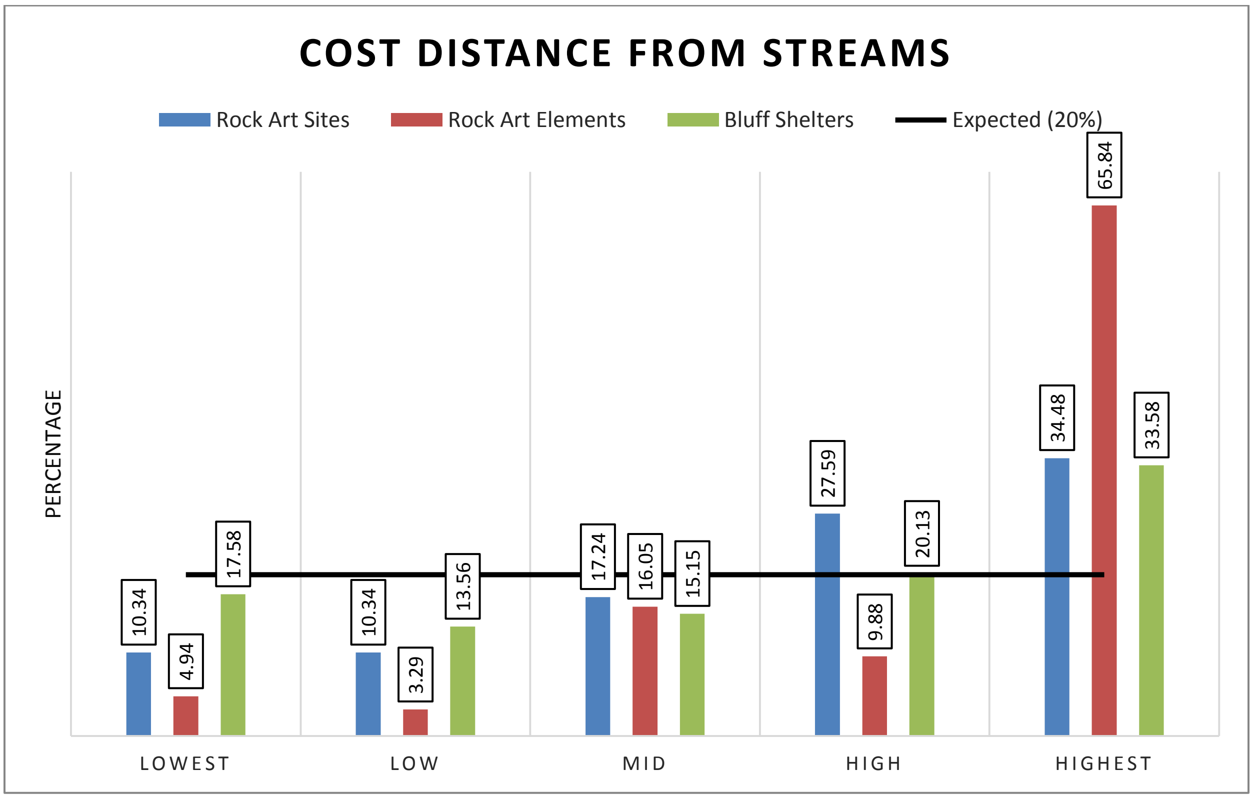



***Figure 3d:*** *Site, element, and bluff shelter locations relative to their cost distances from streams*

**Table 3.4b:** T-test results for cost distance from streams (cost)

| Values | Mean | SD | N | p-value |
|---|---|---|---|---|
| Rock Art Sites | 14368.525 | 9088.437 | 29 | **0.7729** |
| Bluff Shelters | 13868.059 | 10015.601 | 944 | |
| Rock Art Elements | 19510.482 | 9062.988 | 243 | **<0.0001** |
| Bluff Shelters | 13868.059 | 10015.601 | 944 | |

**Table 3.5a:** Chi-square results for Euclidean distance from streams

| Values | Closest | Close | Mid | Far | Farthest | Total Chi-Square | p-value |
|---|---|---|---|---|---|---|---|
| Observed Sites | 7 | 3 | 8 | 10 | 1 | | |
| Bluff Shelters | 320 | 230 | 188 | 144 | 58 | **11.383** | **0.0226** |
| Chi-Square | 0.815 | 2.339 | 0.857 | 7.029 | 0.343 | | |
| Observed Elements | 19 | 4 | 59 | 133 | 28 | | |
| Bluff Shelters | 320 | 230 | 188 | 144 | 58 | **362.271** | **<0.0001** |
| Chi-Square | 48.755 | 51.476 | 2.324 | 248.274 | 11.442 | | |

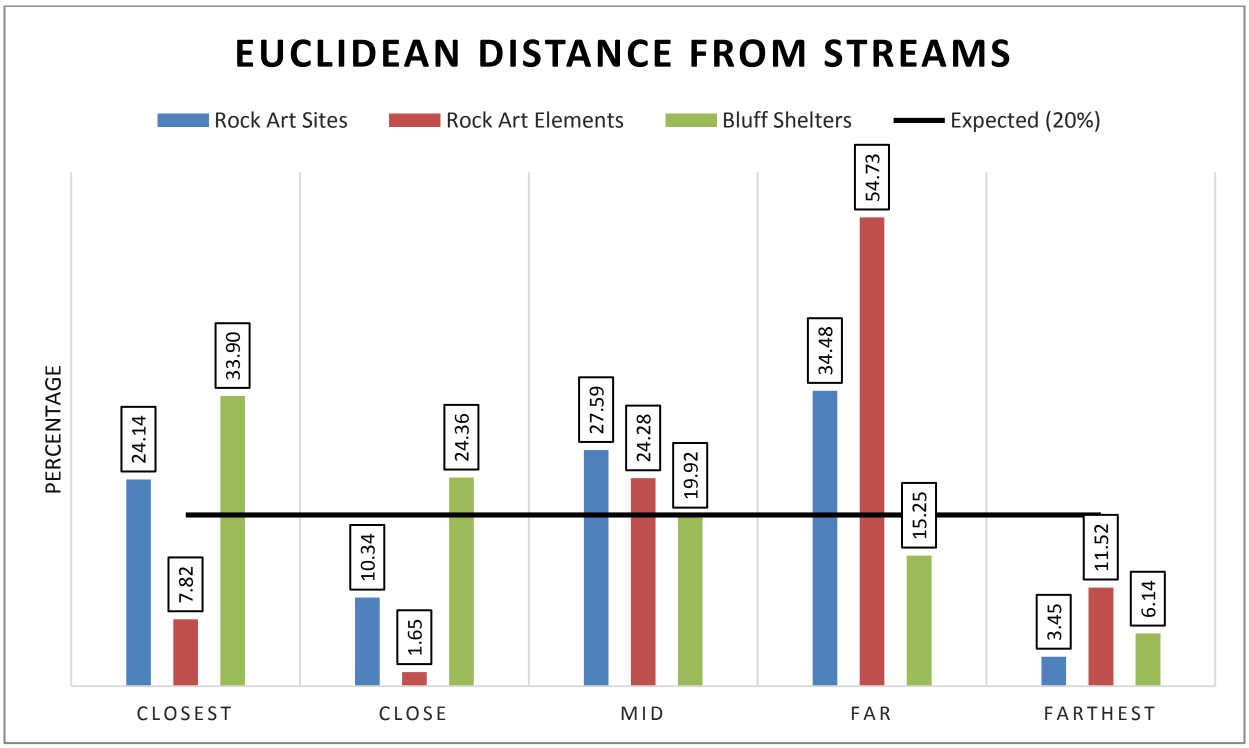



***Figure 3e:** Site, element, and bluff shelter locations relative to their Euclidean distances from streams*

**Table 3.5b:** T-test results for Euclidean distance from streams (meters)

| Distribution Type | Mean | SD | N | p-value |
|---|---|---|---|---|
| Rock Art Sites | 2854.13 | 1734.884 | 29 | **0.1583** |
| Bluff Shelters | 2376.688 | 2190.031 | 944 | |
| Rock Art Elements | 3896.228 | 1506.738 | 243 | **<0.0001** |
| Bluff Shelters | 2376.688 | 2190.031 | 944 | |

**Table 3.6a:** Chi-square results for cost distance from mounds

| Values | Lowest | Low | Mid | High | Highest | Total Chi-Square | p-value |
|---|---|---|---|---|---|---|---|
| Observed Sites | 7 | 8 | 1 | 6 | 7 | | |
| Bluff Shelters | 72 | 116 | 118 | 153 | 485 | **22.337** | **0.0002** |
| Chi-Square | 10.365 | 5.523 | 1.901 | 0.359 | 4.188 | | |
| Observed Elements | 57 | 53 | 34 | 40 | 59 | | |
| Bluff Shelters | 72 | 116 | 118 | 153 | 485 | **132.937** | **<0.0001** |
| Chi-Square | 79.834 | 17.932 | 0.433 | 0.010 | 34.729 | | |

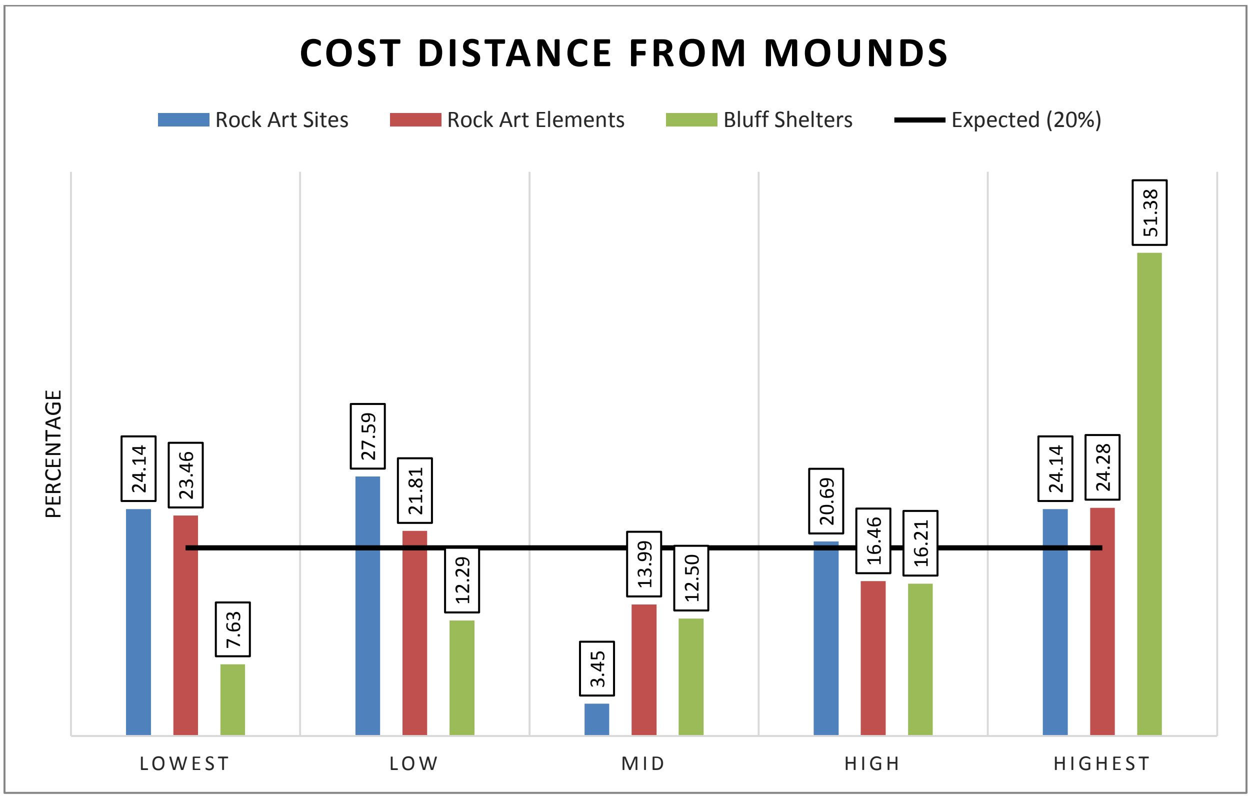



***Figure 3f:*** *Site, element, and bluff shelter locations relative to their cost distances from mounds*

**Table 3.6b:** T-test results for cost distance from mounds (cost)

| Values | Mean | SD | N | p-value |
|---|---|---|---|---|
| Rock Art Sites | 36215.801 | 26283.557 | 29 | **0.0041** |
| Bluff Shelters | 51655.246 | 25739.881 | 944 | |
| Rock Art Elements | 36858.629 | 25502.838 | 243 | **<0.0001** |
| Bluff Shelters | 51655.246 | 25739.881 | 944 | |

**Table 3.7a:** Chi-square results for Euclidean distance from mounds

| Values | Closest | Close | Mid | Far | Farthest | Total Chi-Square | p-value |
|---|---|---|---|---|---|---|---|
| Observed Sites | 9 | 2 | 8 | 7 | 3 | **7.131** | **0.1293** |
| Bluff Shelters | 178 | 231 | 183 | 227 | 125 | | |
| Chi-Square | 2.281 | 3.660 | 1.006 | 0.000 | 0.184 | | |
| Observed Elements | 91 | 13 | 34 | 77 | 28 | **90.943** | **<0.0001** |
| Bluff Shelters | 178 | 231 | 183 | 227 | 125 | | |
| Chi-Square | 44.549 | 36.305 | 3.647 | 5.899 | 0.542 | | |

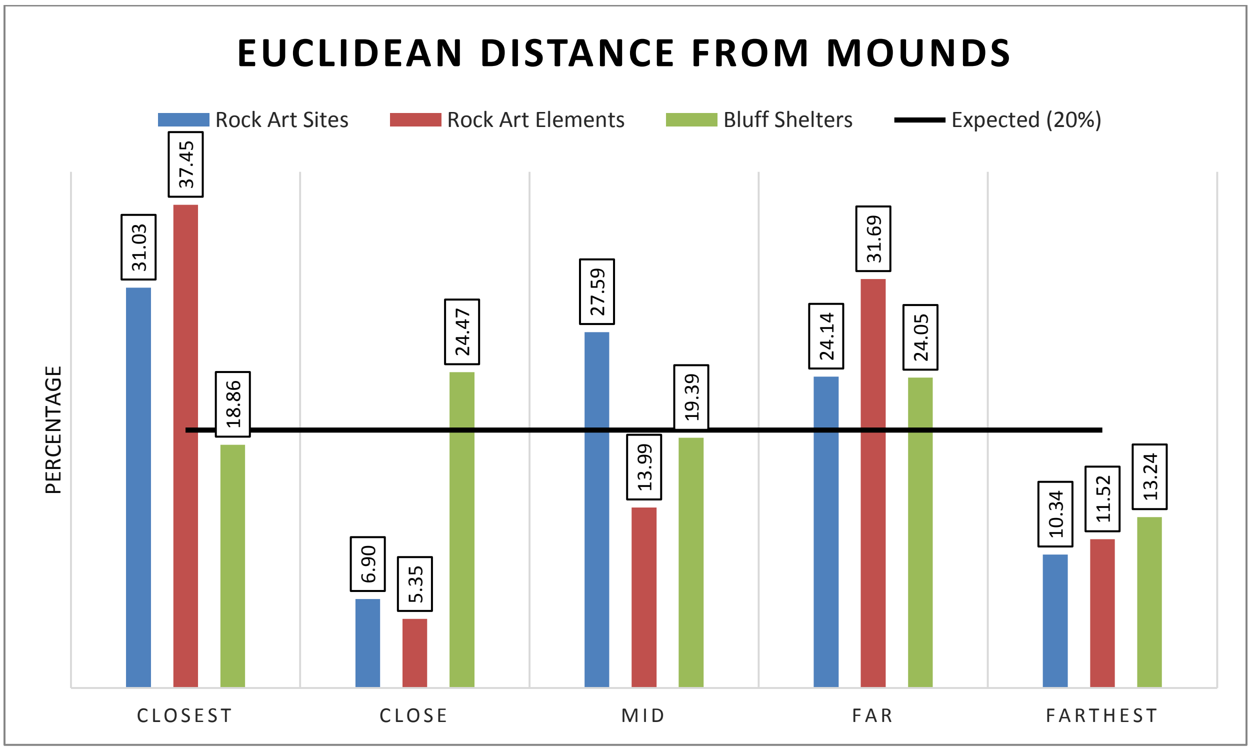



***Figure 3g:*** *Site, element, and bluff shelter locations relative to their Euclidean distances from mounds*

**Table 3.7b:** T-test results for Euclidean distance from mounds (meters)

| Distribution Type | Mean | SD | N | p-value |
|---|---|---|---|---|
| Rock Art Sites | 17307.294 | 10645.139 | 29 | **0.6328** |
| Bluff Shelters | 18274.28 | 9811.406 | 944 | |
| Rock Art Elements | 17106.787 | 11448.02 | 243 | **0.1458** |
| Bluff Shelters | 18274.28 | 9811.406 | 944 | |

**Table 3.8a:** Viewsheds for rock art sites in the study area (outliers bolded)

| Site Number | Site Name | Total Elements | Pixels Observed |
|---|---|---|---|
| 3BA0030 | Old Joe | 2 | 26098 |
| 3CE0060 | Rockhouse Hollow | 3 | 1873 |
| 3CE0073 | Dollar Bluff | 6 | 370 |
| 3IZ0143 | (No Site Name) | 2 | 8173 |
| 3IZ0149 | Goat Hollow Cave | ? | 400 |
| 3MR0094 | Sunburst Shelter | 7 | 48346 |
| 3NW0037 | Painted Bluff Site | 2 | 2915 |
| 3NW0076 | East Rock Shelter | 1 | 30507 |
| 3NW0079 | Owens Mountain | 20 | 8425 |
| 3NW0276 | Hiner Shelter | 10 | 4127 |
| 3NW0459 | East Cole Creek Bluff | 20 | 12993 |
| 3NW0626 | (No Site Name) | 1 | 26875 |
| 3NW0681 | Lambdin Hollow Shelter | 3 | 3889 |
| 3NW1054 | Goat Cave | 7 | 37748 |
| 3PP0614 | Pedestal Rock | 2 | 29150 |
| 3PP1380 | Myer Petroglyph | 4 | 26484 |
| 3SE0105 | Jacobs Rock | 34 | 55433 |
| 3SE0321 | Hubbard Petroglyphs | 1 | 30982 |
| 3SE0406 | Conner Pictographs | 5 | **245357** |
| 3SE0605 | (No Site Name) | ? | 7697 |
| 3ST0018 | Paxton Shelter | 2 | 11934 |
| 3ST0054 | Pictograph Cave | 28 | 7509 |
| 3ST0070 | Gustafson Cave | 36 | 4016 |
| 3ST0076 | Fox | 1 | 10050 |
| 3ST0400 | Lewis | 1 | 5709 |
| 3VB0006 | Edgemont | 7 | **200460** |
| 3VB0019 | Lynn Creek | 5 | 740 |
| 3VB0316 | Sprott 1 | 31 | 1996 |
| 3VB0317 | Sprott 2 | 2 | 1685 |

**Table 3.8b:** T-test results for viewshed (the left table includes 3SE0406 and 3VB0006, while the right table excludes them) (pixels observed)

| Values | Mean | SD | N | p-val. | Values | Mean | SD | N | p-val. |
|---|---|---|---|---|---|---|---|---|---|
| R.A. Sites | 29377.276 | 55024.41 | 29 | **0.0953** | R.A. Sites | 15041.63 | 15320.712 | 27 | **0.3426** |
| Bluff Shelters | 11193.425 | 24545.360 | 80 | | Bluff Shelters | 11193.425 | 24545.360 | 80 | |
| R.A. Elements | 26324.667 | 48051.27 | 243 | **<0.0001** | R.A. Elements | 16306.88 | 19266.73 | 231 | **0.0935** |
| Bluff Shelters | 11193.425 | 24545.36 | 80 | | Bluff Shelters | 11193.425 | 24545.36 | 80 | |

**Table 3.8c:** Mann-Whitney U test results for viewshed (pixels observed)

| Values | Mean | N | U | Z | p-value |
|---|---|---|---|---|---|
| Rock Art Sites | 29377.276 | 29 | **722** | **-2.6572** | **0.0078** |
| Bluff Shelters | 11193.425 | 80 | | | |
| Rock Art Elements | 26324.667 | 243 | **6469** | **4.4867** | **<0.0001** |
| Bluff Shelters | 11193.425 | 80 | | | |

**Table 3.9a:** Chi-square results for directional prominence

| Values | Lowest | Low | Mid | High | Highest | Total Chi-Square | p-value |
|---|---|---|---|---|---|---|---|
| Observed Sites | 4 | 2 | 1 | 8 | 14 | **6.097** | **0.1918** |
| Bluff Shelters | 190 | 111 | 62 | 125 | 456 | | |
| Chi-Square | 0.578 | 0.583 | 0.430 | 4.507 | 0.000 | | |
| Observed Elements | 73 | 3 | 2 | 59 | 106 | **70.429** | **<0.0001** |
| Bluff Shelters | 190 | 111 | 62 | 125 | 456 | | |
| Chi-Square | 11.867 | 22.888 | 12.210 | 22.360 | 1.104 | | |

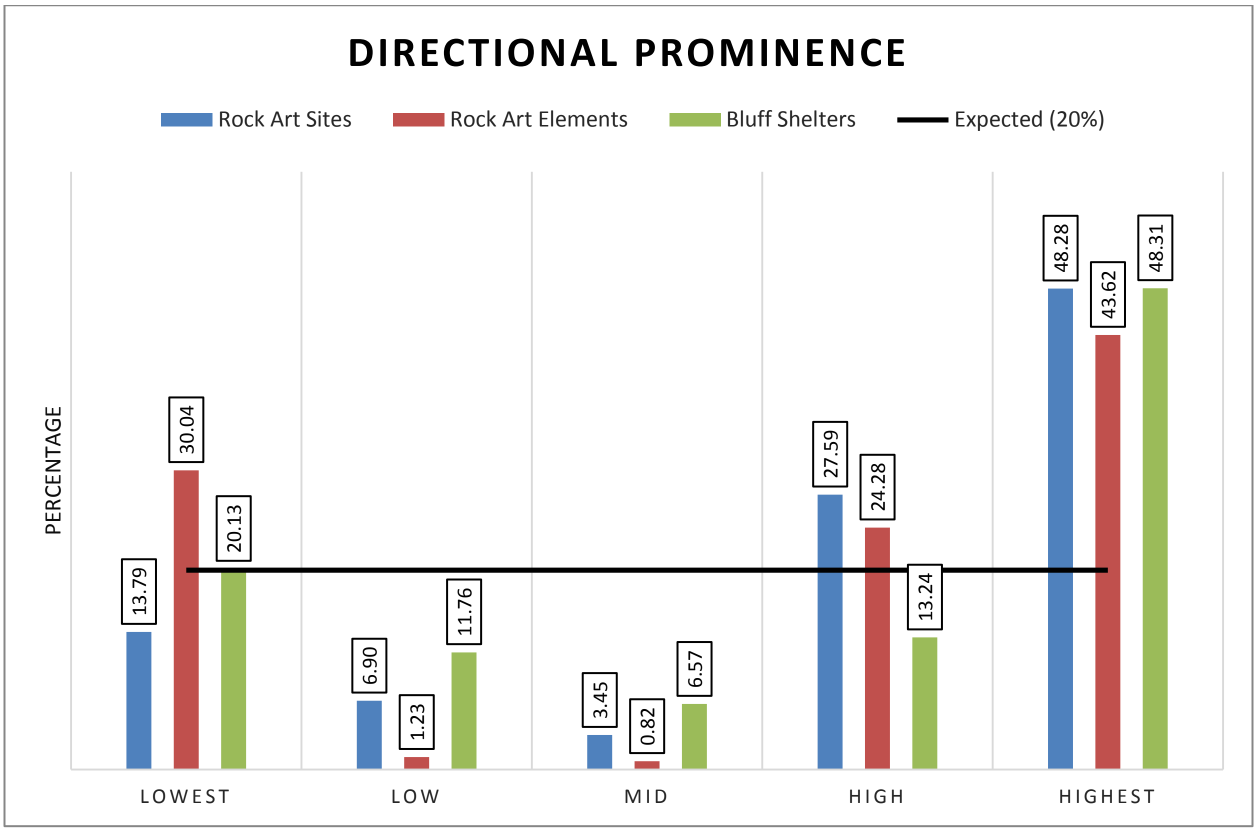



***Figure 3h:*** *Site, element, and bluff shelter locations relative to directional prominence*

**Table 3.9b:** T-test results for directional prominence (meters)

| Values | Mean | SD | N | p-value |
|---|---|---|---|---|
| Rock Art Sites | 20.187 | 34.283 | 29 | **0.4999** |
| Bluff Shelters | 15.768 | 35.302 | 944 | |
| Rock Art Elements | 17.378 | 35.841 | 243 | **0.5316** |
| Bluff Shelters | 15.768 | 35.302 | 944 | |

**Table 3.10a:** Chi-square results for illumination from winter solstice sunrise

| Values | Lowest | Low | Mid | High | Highest | Total Chi-Square | p-value |
|---|---|---|---|---|---|---|---|
| Observed Sites | 3 | 3 | 3 | 3 | 17 | | |
| Bluff Shelters | 290 | 70 | 71 | 111 | 402 | **6.363** | **0.1436** |
| Chi-Square | 3.919 | 0.336 | 0.307 | 0.049 | 1.751 | | |
| Observed Elements | 14 | 7 | 5 | 10 | 207 | | |
| Bluff Shelters | 290 | 70 | 71 | 111 | 402 | **181.289** | **<0.0001** |
| Chi-Square | 49.276 | 6.738 | 9.644 | 12.073 | 103.557 | | |

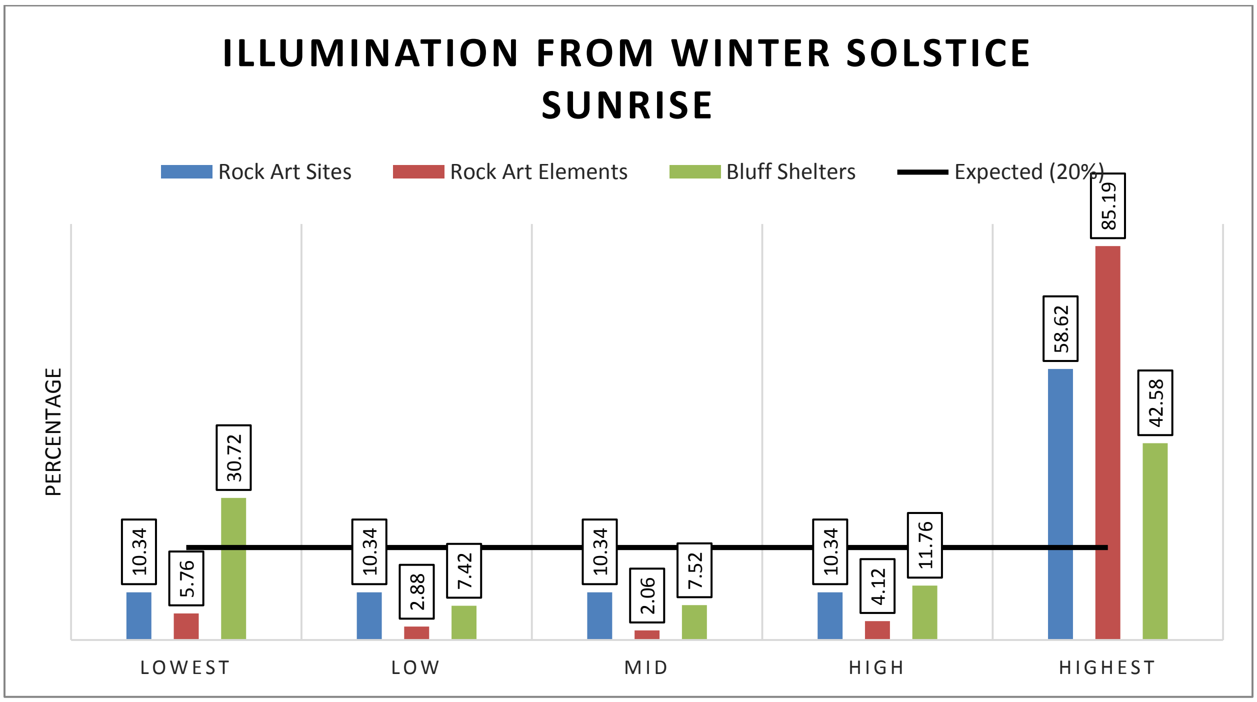



***Figure 3i:*** *Site, element, and bluff shelter locations relative to light from a winter solstice sunrise*

**Table 3.10b:** T-test results for illumination from winter solstice sunrise (light)

| Values | Mean | SD | N | p-value |
|---|---|---|---|---|
| Rock Art Sites | 158.793 | 42.255 | 29 | **0.0015** |
| Bluff Shelters | 130.798 | 55.984 | 944 | |
| Rock Art Elements | 176.358 | 35.569 | 243 | **<0.0001** |
| Bluff Shelters | 130.798 | 55.984 | 944 | |

**Table 3.11a:** Chi-square results for illumination from winter solstice sunset

| Values | Lowest | Low | Mid | High | Highest | Total Chi-Square | p-value |
|---|---|---|---|---|---|---|---|
| Observed Sites | 7 | 6 | 2 | 1 | 13 | | |
| Bluff Shelters | 275 | 92 | 71 | 92 | 414 | **5.014** | **0.2863** |
| Chi-Square | 0.248 | 3.564 | 0.015 | 1.180 | 0.006 | | |
| Observed Elements | 89 | 43 | 35 | 2 | 74 | | |
| Bluff Shelters | 275 | 92 | 71 | 92 | 414 | **65.550** | **<0.0001** |
| Chi-Square | 4.685 | 15.758 | 15.303 | 19.851 | 9.954 | | |

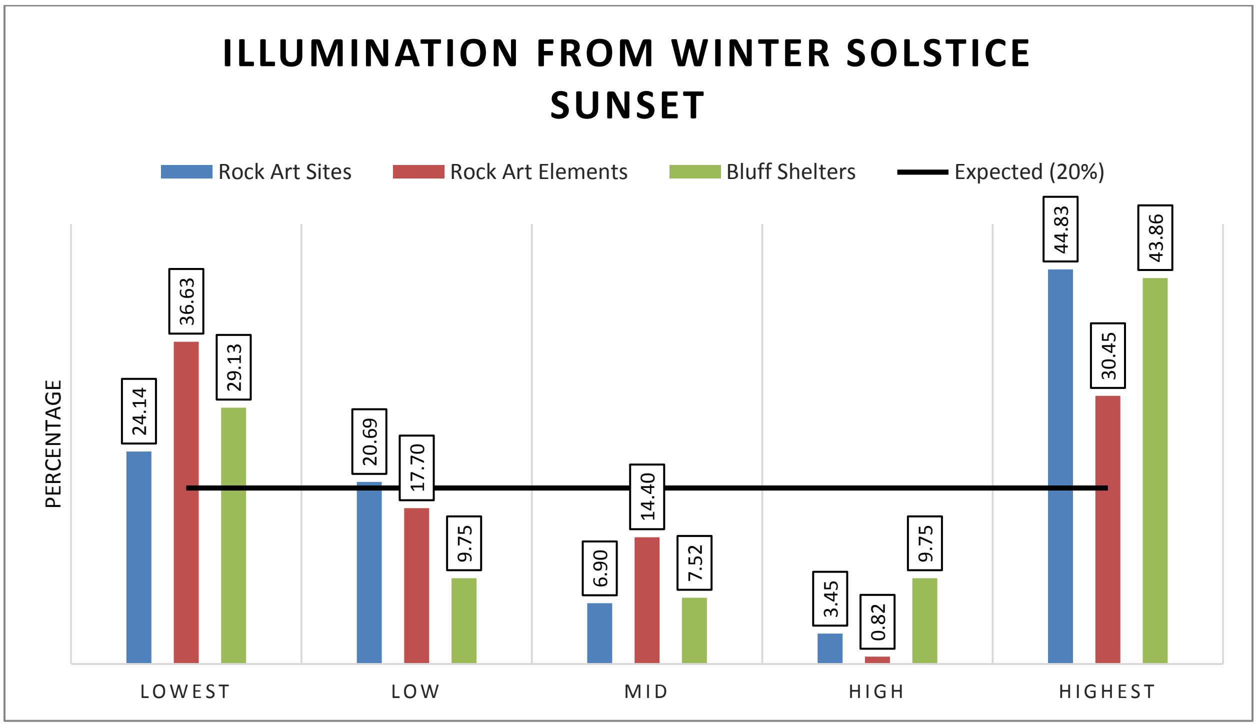



***Figure 3j:*** *Site and element locations relative to the amount of light received from a winter solstice sunset*

**Table 3.11b:** T-test results for illumination from winter solstice sunset (light)

| Values | Mean | SD | N | p-value |
|---|---|---|---|---|
| Rock Art Sites | 136.276 | 41.919 | 29 | **0.6125** |
| Bluff Shelters | 132.189 | 54.509 | 944 | |
| Rock Art Elements | 120.284 | 38.299 | 243 | **<0.0001** |
| Bluff Shelters | 132.189 | 54.509 | 944 | |

**APPENDIX 4:**

**STATISTICS FOR CHAPTER 4**

**Table 4.1:** Motif totals relative to elevation

| Motif | Lowest | Low | Mid | High | Highest |
|---|---|---|---|---|---|
| Basic Geo | 0 | 19 | 19 | 12 | 43 |
| Celestial Geo | 1 | 5 | 2 | 2 | 9 |
| Beneath World | 0 | 1 | 8 | 1 | 0 |
| Middle World | 1 | 3 | 10 | 3 | 9 |
| Above World | 0 | 1 | 3 | 0 | 0 |
| Anthropomorph | 2 | 6 | 21 | 10 | 4 |
| Abstract | 0 | 1 | 0 | 2 | 6 |
| Special | 0 | 0 | 2 | 0 | 4 |

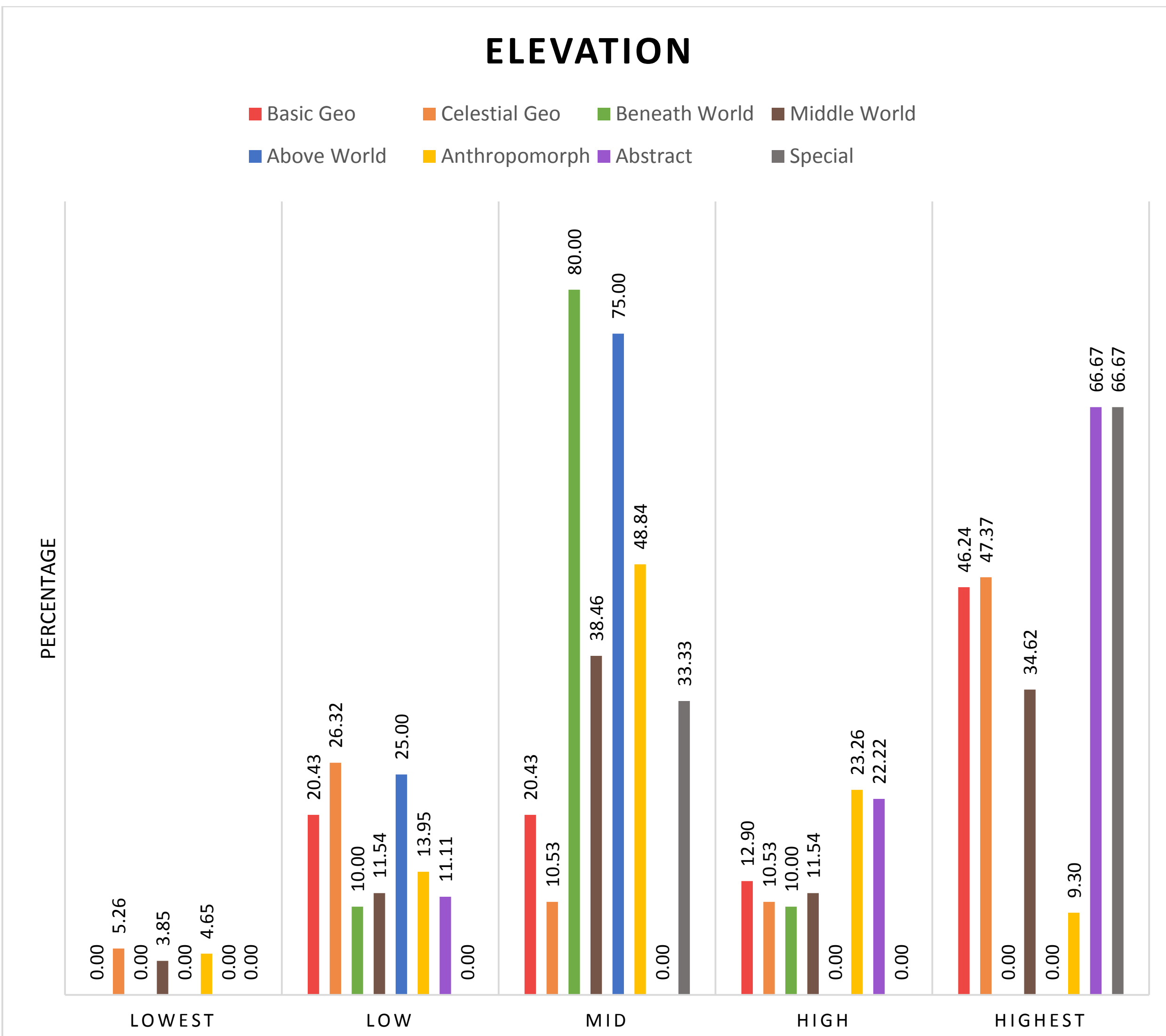



***Figure 4a:*** *Motif percentages relative to elevation*

**Table 4.2:** Motif totals relative to slope

| Motif | Flattest | Flat | Mid | Steep | Steepest |
|---|---|---|---|---|---|
| Basic Geo | 0 | 0 | 0 | 35 | 58 |
| Celestial Geo | 0 | 0 | 0 | 13 | 6 |
| Beneath World | 0 | 0 | 0 | 1 | 9 |
| Middle World | 0 | 0 | 4 | 2 | 20 |
| Above World | 0 | 0 | 0 | 1 | 3 |
| Anthropomorph | 0 | 0 | 2 | 5 | 36 |
| Abstract | 0 | 0 | 0 | 6 | 3 |
| Special | 0 | 0 | 0 | 1 | 5 |

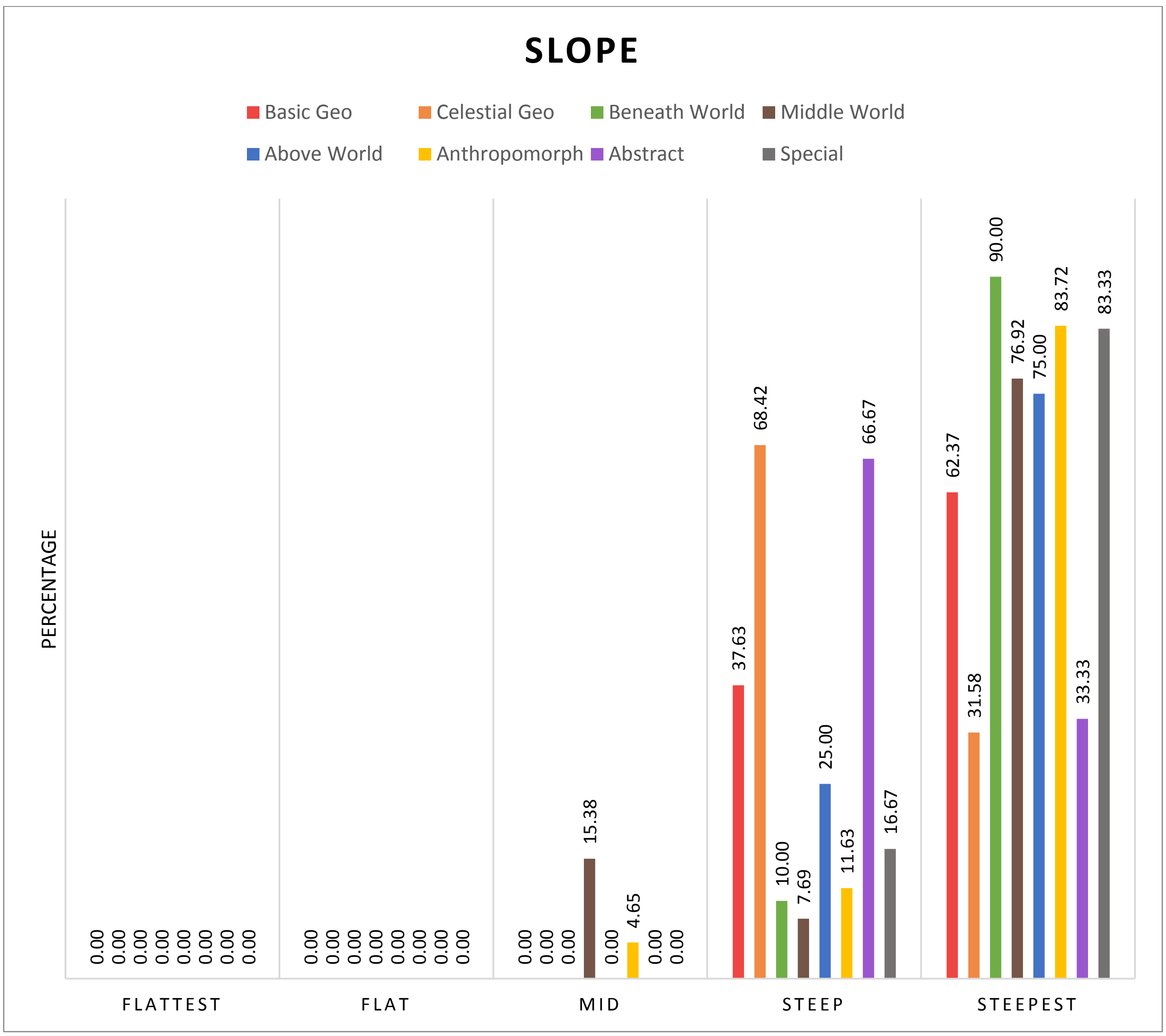



***Figure 4b:** Motif percentages relative to slope*

**Table 4.3:** Motif totals relative to aspect

| Motif | Flat | N | NE | E | SE | S | SW | W | NW |
|---|---|---|---|---|---|---|---|---|---|
| Basic Geo | 0 | 0 | 0 | 12 | 49 | 25 | 7 | 0 | 0 |
| Celestial Geo | 0 | 0 | 0 | 5 | 5 | 6 | 3 | 0 | 0 |
| Beneath World | 0 | 0 | 0 | 0 | 8 | 1 | 1 | 0 | 0 |
| Middle World | 0 | 1 | 0 | 1 | 14 | 5 | 3 | 2 | 0 |
| Above World | 0 | 0 | 0 | 0 | 3 | 1 | 0 | 0 | 0 |
| Anthropomorph | 0 | 0 | 0 | 0 | 35 | 5 | 3 | 0 | 0 |
| Abstract | 0 | 0 | 0 | 5 | 3 | 1 | 0 | 0 | 0 |
| Special | 0 | 0 | 0 | 1 | 5 | 0 | 0 | 0 | 0 |

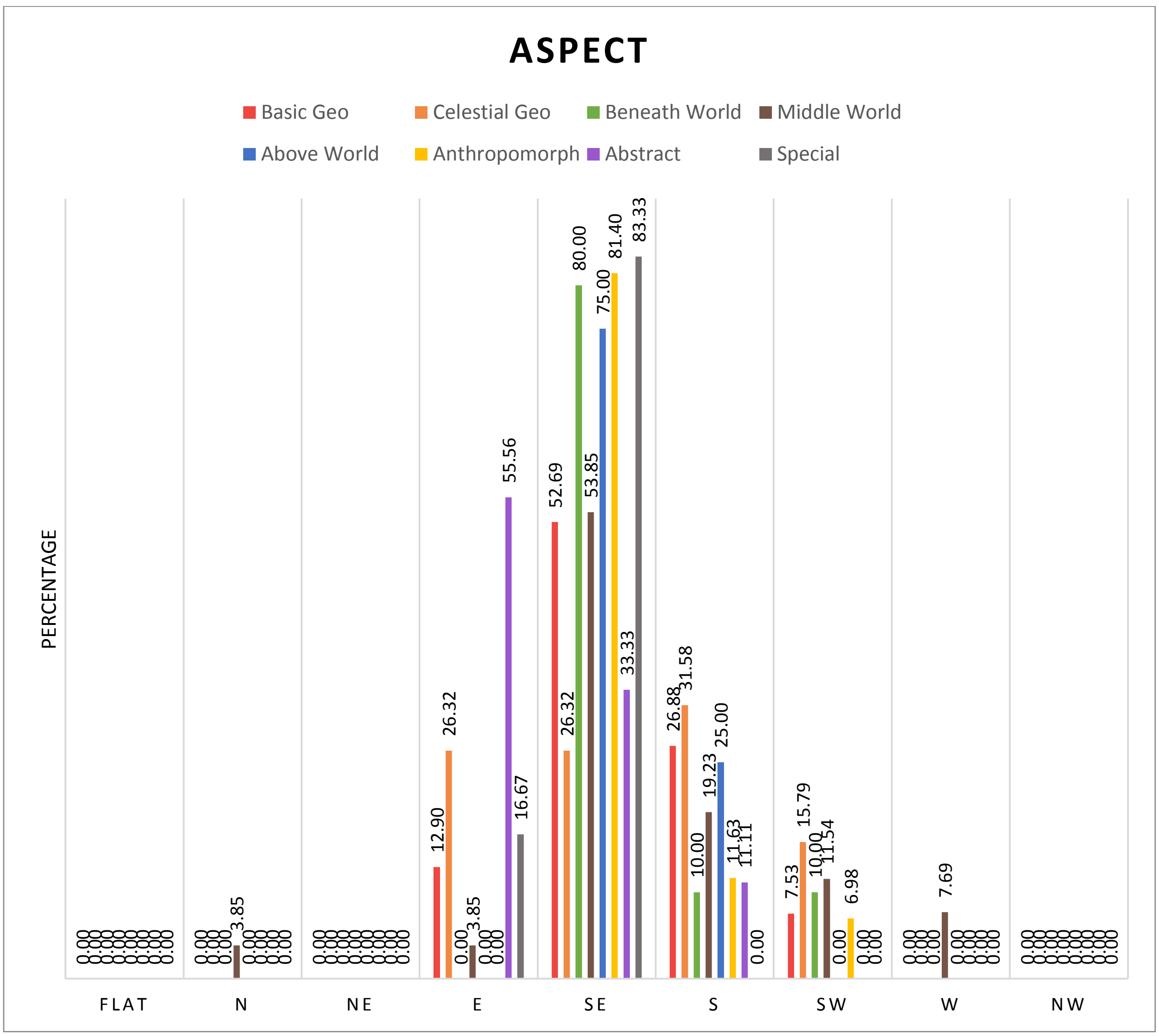



***Figure 4c:*** *Motif percentages relative to aspect*

**Table 4.4:** Motif totals relative to their cost distances from streams

| Motif | Lowest | Low | Mid | High | Highest |
|---|---|---|---|---|---|
| Basic Geo | 0 | 1 | 20 | 10 | 62 |
| Celestial Geo | 0 | 2 | 4 | 2 | 11 |
| Beneath World | 0 | 0 | 2 | 1 | 7 |
| Middle World | 0 | 1 | 3 | 5 | 17 |
| Above World | 0 | 0 | 1 | 0 | 3 |
| Anthropomorph | 8 | 2 | 6 | 11 | 16 |
| Abstract | 0 | 0 | 1 | 2 | 6 |
| Special | 0 | 0 | 0 | 0 | 6 |

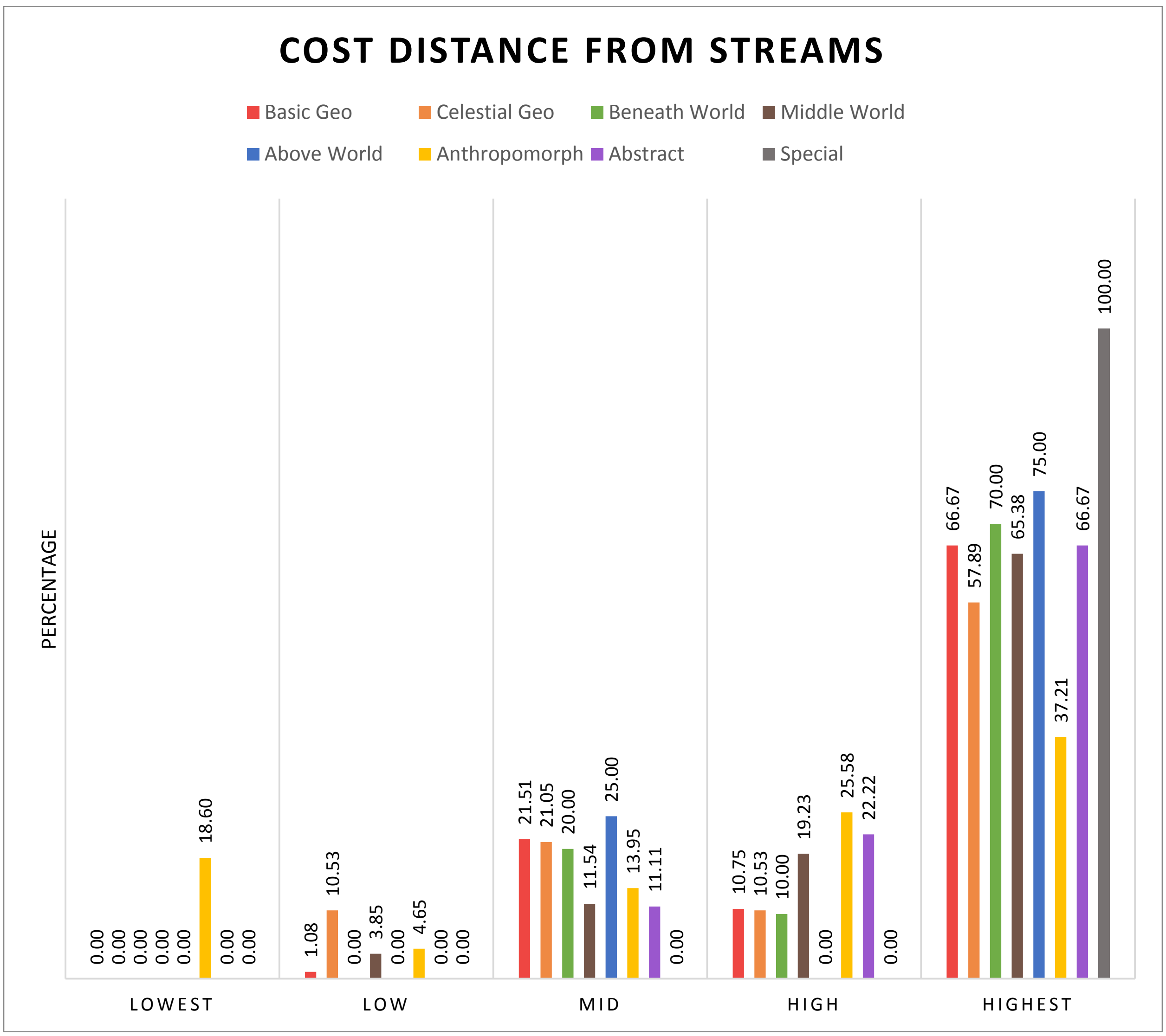



***Figure 4d:*** *Motif percentages relative to their cost distances from streams*

**Table 4.5:** Motif totals relative to their Euclidean distances from streams

| Motif | Closest | Close | Mid | Far | Farthest |
|---|---|---|---|---|---|
| Basic Geo | 0 | 2 | 25 | 52 | 14 |
| Celestial Geo | 1 | 1 | 6 | 9 | 2 |
| Beneath World | 0 | 0 | 2 | 4 | 4 |
| Middle World | 2 | 1 | 6 | 17 | 0 |
| Above World | 0 | 0 | 0 | 1 | 3 |
| Anthropomorph | 10 | 0 | 12 | 21 | 0 |
| Abstract | 0 | 0 | 7 | 2 | 0 |
| Special | 0 | 0 | 1 | 3 | 2 |

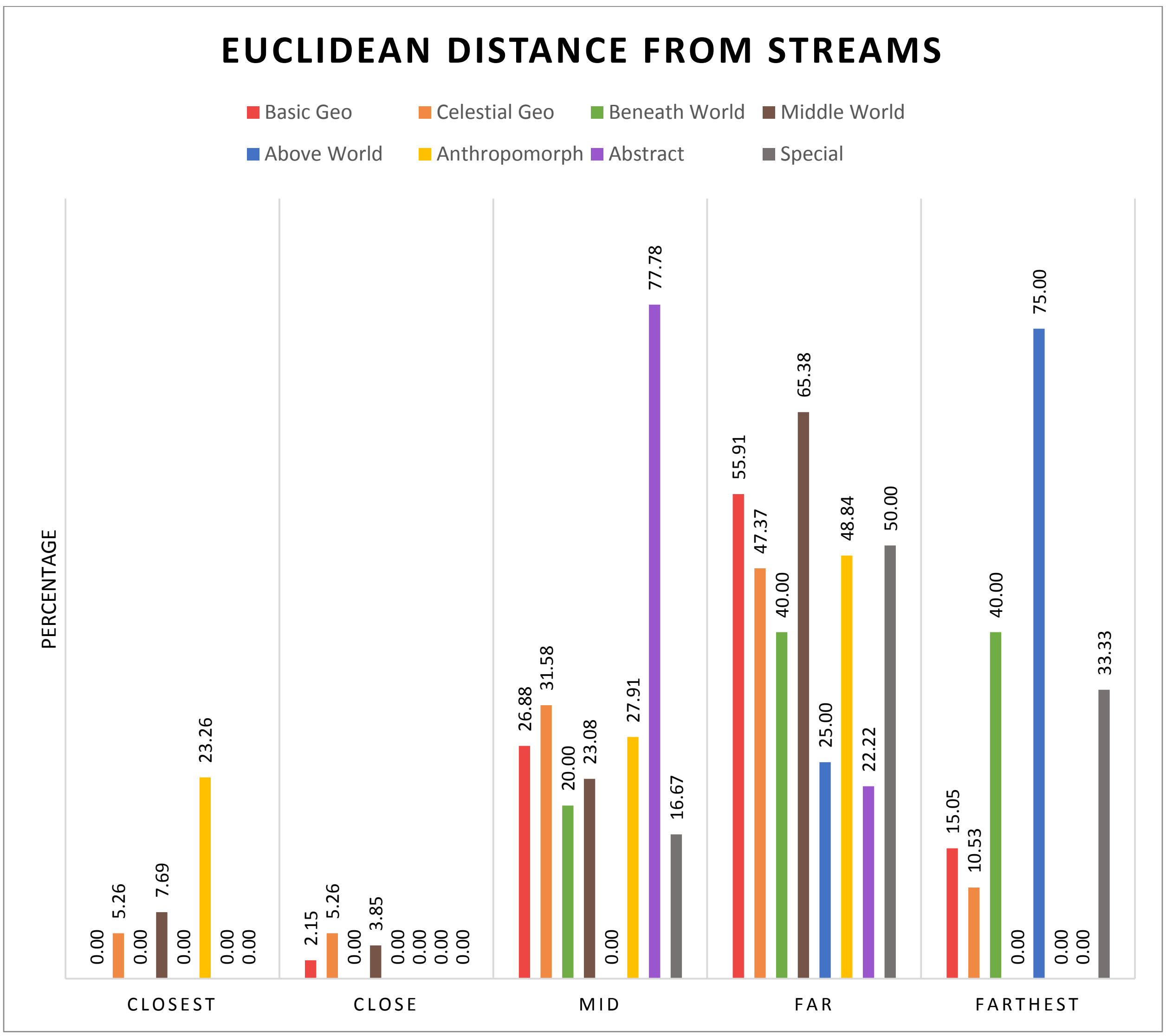



***Figure 4e:*** *Motif percentages relative to their Euclidean distances from streams*

**Table 4.6:** Motif totals relative to their cost distances from mounds

| Motif | Lowest | Low | Mid | High | Highest |
|---|---|---|---|---|---|
| Basic Geo | 5 | 26 | 12 | 17 | 33 |
| Celestial Geo | 0 | 7 | 5 | 2 | 5 |
| Beneath World | 4 | 2 | 0 | 4 | 0 |
| Middle World | 12 | 3 | 1 | 5 | 5 |
| Above World | 0 | 1 | 0 | 3 | 0 |
| Anthropomorph | 23 | 16 | 0 | 2 | 2 |
| Abstract | 0 | 3 | 5 | 0 | 1 |
| Special | 0 | 0 | 1 | 2 | 3 |

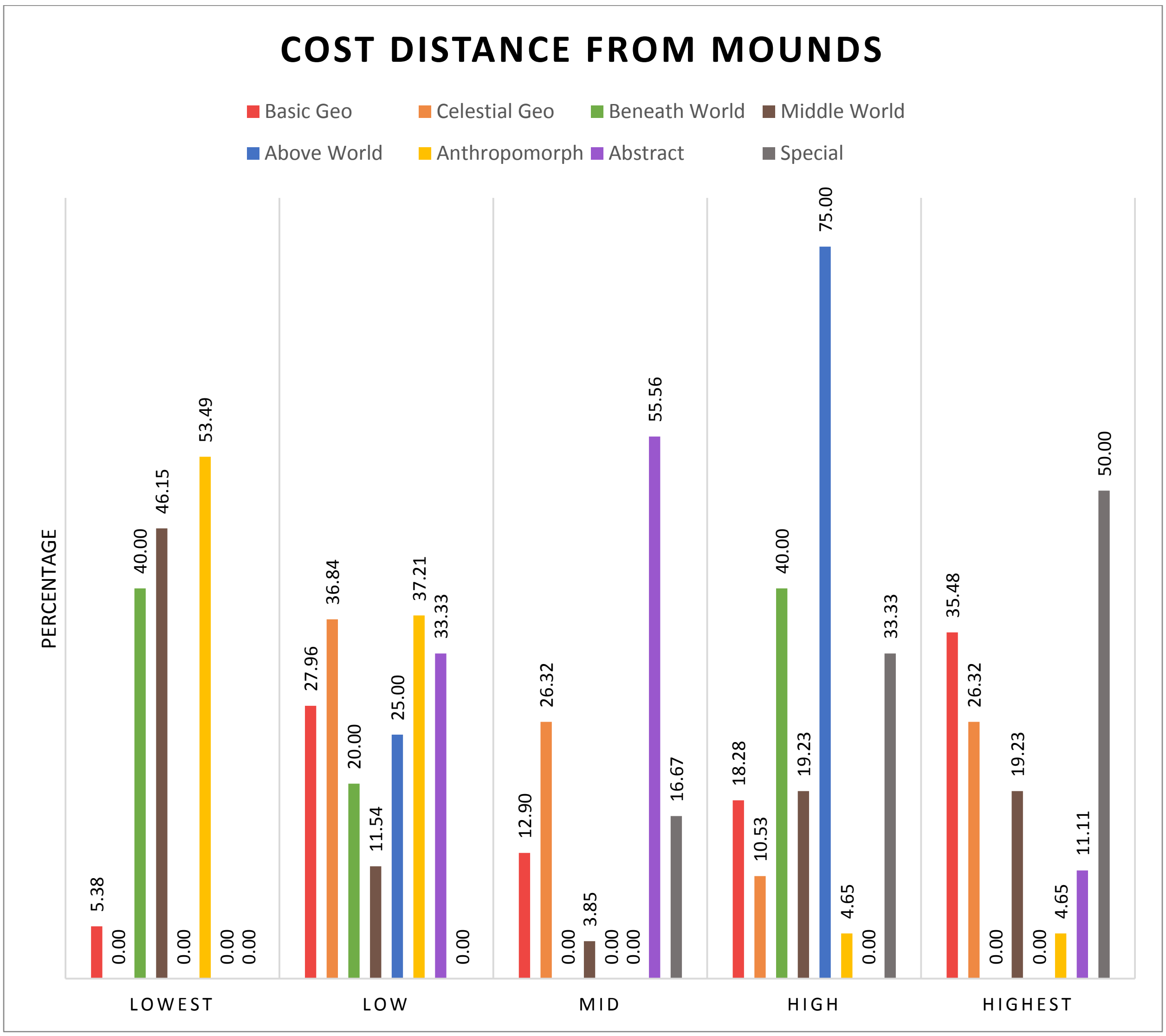



***Figure 4f:** Motif percentages relative to their cost distances from mounds*

**Table 4.7:** Motif totals relative to their Euclidean distances from mounds

| Motif | Closest | Close | Mid | Far | Farthest |
|---|---|---|---|---|---|
| Basic Geo | 18 | 7 | 8 | 40 | 20 |
| Celestial Geo | 6 | 1 | 3 | 7 | 2 |
| Beneath World | 4 | 0 | 0 | 6 | 0 |
| Middle World | 11 | 4 | 6 | 4 | 1 |
| Above World | 0 | 0 | 0 | 4 | 0 |
| Anthropomorph | 22 | 0 | 5 | 16 | 0 |
| Abstract | 5 | 0 | 1 | 3 | 0 |
| Special | 1 | 0 | 0 | 2 | 3 |

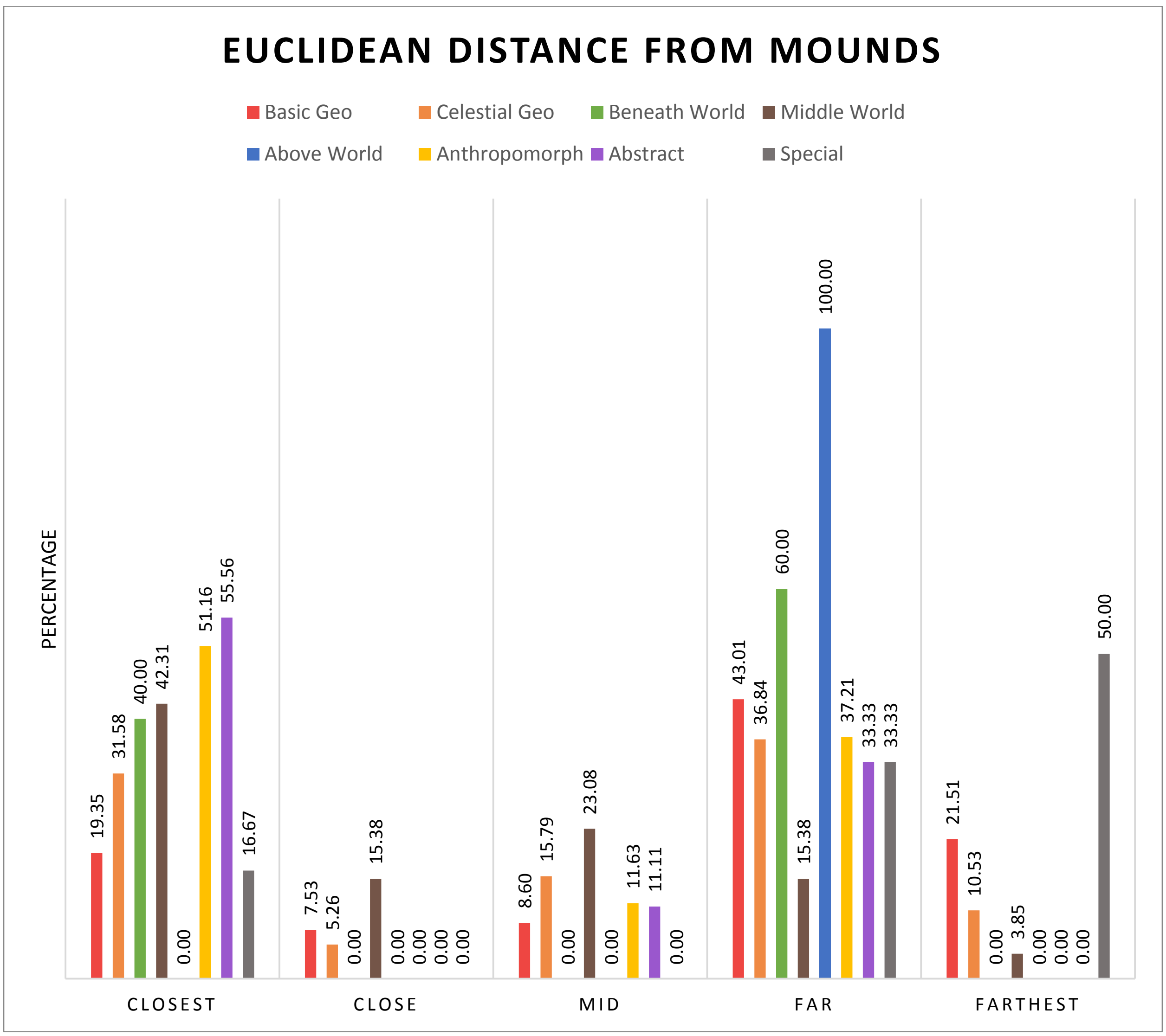



***Figure 4g:*** *Motif percentages relative to their Euclidean distances from mounds*

**Table 4.8a:** Rock art sites with motif types and viewshed results

| Site Number | Basic Geo | Celestial Geo | Beneath World | Middle World | Above World | Anthro. | Abstract | Special | Pixels Observed |
|---|---|---|---|---|---|---|---|---|---|
| 3BA0030 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 26098 |
| 3CE0060 | 2 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1873 |
| 3CE0073 | 3 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 370 |
| 3IZ0143 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 8173 |
| 3IZ0149 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 400 |
| 3MR0094 | 3 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 48346 |
| 3NW0037 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2915 |
| 3NW0076 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 30507 |
| 3NW0079 | 7 | 1 | 0 | 2 | 0 | 1 | 1 | 0 | 8425 |
| 3NW0276 | 0 | 0 | 0 | 0 | 0 | 8 | 0 | 0 | 4127 |
| 3NW0459 | 16 | 0 | 0 | 1 | 0 | 0 | 0 | 3 | 12993 |
| 3NW0626 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 26875 |
| 3NW0681 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 3889 |
| 3NW1054 | 4 | 1 | 0 | 2 | 0 | 0 | 0 | 0 | 37748 |
| 3PP0614 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 29150 |
| 3PP1380 | 0 | 0 | 0 | 1 | 0 | 2 | 0 | 0 | 26484 |
| 3SE0105 | 12 | 5 | 0 | 1 | 0 | 0 | 5 | 1 | 55433 |
| 3SE0321 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 30982 |
| 3SE0406 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 245357 |
| 3SE0605 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 7697 |
| 3ST0018 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 11934 |
| 3ST0054 | 14 | 2 | 4 | 0 | 3 | 0 | 0 | 2 | 7509 |
| 3ST0070 | 3 | 0 | 3 | 9 | 0 | 13 | 0 | 0 | 4016 |
| 3ST0076 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 10050 |
| 3ST0400 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 5709 |
| 3VB0006 | 6 | 0 | 1 | 1 | 0 | 9 | 2 | 0 | 200460 |
| 3VB0019 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 740 |
| 3VB0316 | 18 | 4 | 1 | 1 | 1 | 4 | 1 | 0 | 1996 |
| 3VB0317 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 1685 |

**Table 4.8b:** Motifs and their average viewsheds

| Basic Geo | Celestial Geo | Beneath World | Middle World | Above World | Anthro. | Abstract | Special |
|---|---|---|---|---|---|---|---|
| 31414.33333 | 38239.42105 | 24641.3 | 18866.34615 | 6130.75 | 52294.5814 | 76500.66667 | 18238.33333 |

**Table 4.9:** Motif totals relative to directional prominence

| Motif | Lowest | Low | Mid | High | Highest |
|---|---|---|---|---|---|
| Basic Geo | 24 | 0 | 0 | 22 | 47 |
| Celestial Geo | 4 | 0 | 0 | 2 | 13 |
| Beneath World | 4 | 0 | 0 | 6 | 0 |
| Middle World | 12 | 0 | 2 | 4 | 8 |
| Above World | 1 | 0 | 0 | 3 | 0 |
| Anthropomorph | 17 | 1 | 0 | 21 | 4 |
| Abstract | 1 | 0 | 0 | 2 | 6 |
| Special | 0 | 0 | 0 | 2 | 4 |

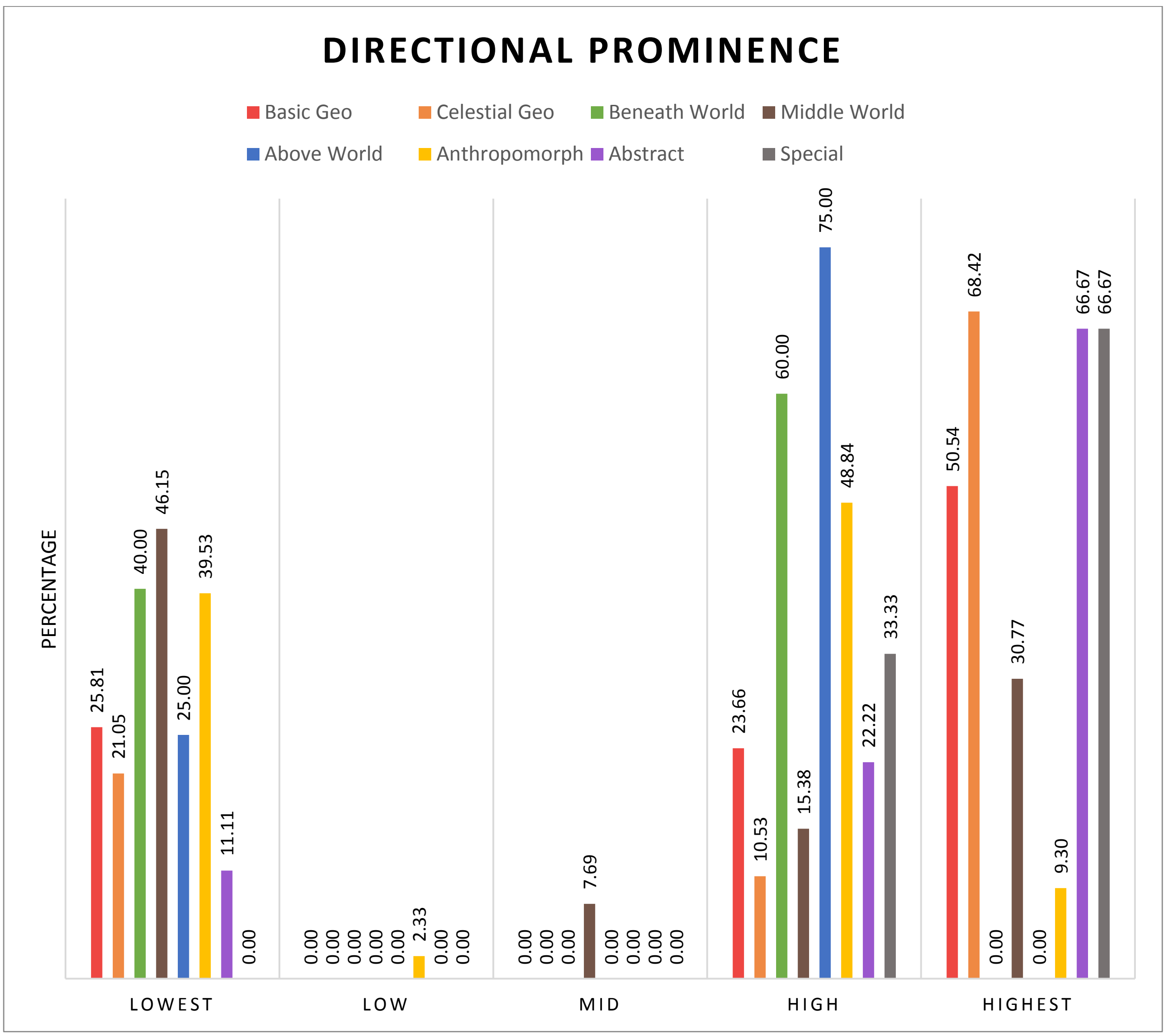



***Figure 4h:*** *Motif percentages relative to directional prominence*

**Table 4.10:** Motif totals relative to light from a winter solstice sunrise

| Motif | Lowest | Low | Mid | High | Highest |
|---|---|---|---|---|---|
| Basic Geo | 4 | 1 | 0 | 6 | 82 |
| Celestial Geo | 3 | 0 | 0 | 1 | 15 |
| Beneath World | 0 | 0 | 0 | 1 | 9 |
| Middle World | 2 | 1 | 3 | 2 | 18 |
| Above World | 0 | 0 | 0 | 0 | 4 |
| Anthropomorph | 1 | 2 | 0 | 0 | 40 |
| Abstract | 0 | 0 | 0 | 0 | 9 |
| Special | 0 | 0 | 0 | 0 | 6 |

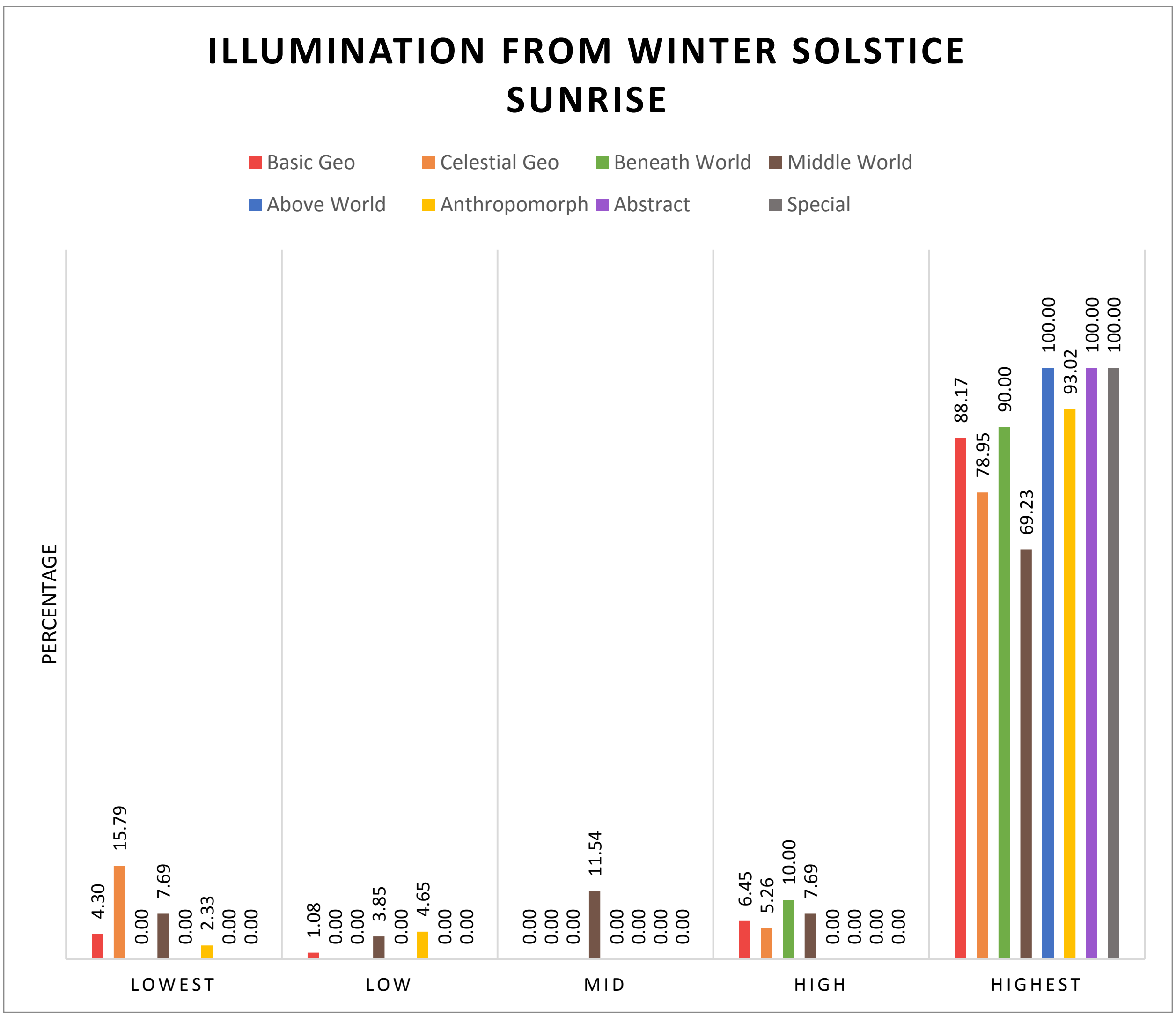



***Figure 4i:*** *Motif percentages relative to light from a winter solstice sunrise*

**Table 4.11:** Motif totals relative to light from a winter solstice sunset

| Motif | Lowest | Low | Mid | High | Highest |
|---|---|---|---|---|---|
| Basic Geo | 27 | 14 | 20 | 0 | 32 |
| Celestial Geo | 2 | 6 | 2 | 0 | 9 |
| Beneath World | 3 | 0 | 5 | 0 | 2 |
| Middle World | 12 | 3 | 1 | 0 | 10 |
| Above World | 0 | 0 | 3 | 0 | 1 |
| Anthropomorph | 23 | 3 | 9 | 0 | 8 |
| Abstract | 1 | 5 | 2 | 0 | 1 |
| Special | 3 | 1 | 2 | 0 | 0 |

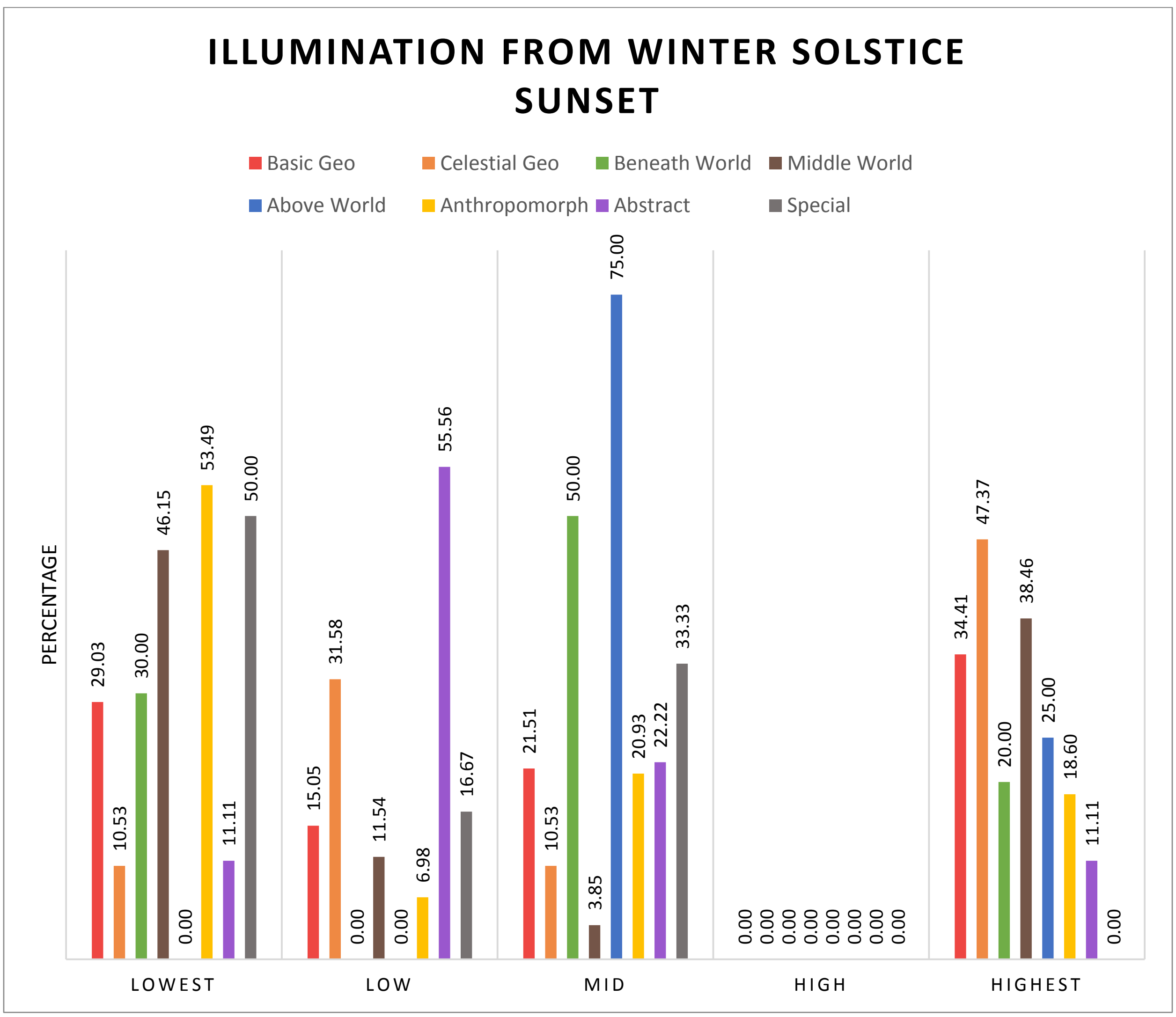



***Figure 4j:*** *Motif percentages relative to light from a winter solstice sunset*