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A Spatial and Temporal Analysis of San Juan Red Ware

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ABSTRACT

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San Juan Red Ware was widely distributed throughout the Four Corners region of the U.S. Southwest between about AD 750 and 1100. Prior research indicates this ware is a marker of identity and was likely associated with feasting and other communal activities. A study of the distribution of this ware indicates that it was traded widely, but with significant variation in relative quantity between sites. This variation is likely caused by unequal access to this ware due either to a lack of access to the necessary exchange networks or by a conscious decision to not participate in the exchange of this ware. San Juan Red Ware became more widely dispersed after the first century of production, which may be indicative of increased integration between social groups. Several methods were used in this analysis, including inverse distance weighting, hexagon binning, fall-off curves, distance diagrams using Typenspektren, and social network analysis. An evaluation of these methods indicates some are more effective than others for this analysis, although the use of several complementary methods is recommended to provide a more comprehensive analysis.

Keywords: Southwest, Ancestral Pueblo, GIS, R, SNA, ceramics, spatial analysis

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1 Introduction

San Juan Red Ware was produced by the Ancestral Pueblo in the Four Corners region of the U.S. Southwest during the Pueblo I and Pueblo II periods. Archaeologists have studied this ware and other ceramics produced in the Southwest for more than a century using numerous methods and theories (see Graves 1998 for a review), although there are no extensive studies of the distribution of San Juan Red Ware. Ceramics are particularly suitable for study, as variation in ceramic technology, form, and style over time and space allow for relative dating. Chemical signatures, abundance, and other factors can often be used to identify the production area of ceramics (e.g., Bishop and Neff 1989; Bishop et al. 1982; Neff 1992).

Understanding ceramic production also requires understanding the related social, economic, and political contexts of the local area or region (Mills and Crown 1995:2). Regional studies have much to offer archaeology and are necessary for answering a variety of questions. Recent large projects in the northern San Juan (also referred to as the Mesa Verde region) and surrounding areas have increased the availability of information thereby facilitating additional, synthetic studies (e.g., Kohler and Varien 2012; Peeples, Mills, et al. 2016; Schwindt et al. 2016; Varien et al. 2007). Gregson Schachner (2015) and Schachner, Throgmorton, and colleagues (2012:12–13) believe that answers to many important questions regarding the Ancestral Pueblo require studies that use the northern Southwest as the scale of the study, and the distribution of objects in this region should yield new insights into the archaeological context of the area. San Juan Red Ware has already been associated with specialized community production

(Hegmon et al. 1995), communal feasting (Blinman 1989), social identity (Allison 2008a), and long-range migration (Allison 2008a, 2008b; Washburn 2006). San Juan Red Ware was widely traded; however, the distribution of this ware is not fully known, and existing studies have used a relative handful of sites to make inferences regarding its distribution. Distribution patterns and neutron activation analysis (NAA) of San Juan Red Ware identify southeastern Utah as the most likely production local for most of this ware (Allison 2008a, 2010; Allison and Ferguson 2015; Hegmon et al. 1995, 1997; Lucius and Breternitz 1981), but it can be found in archaeological contexts hundreds of miles from this area. The social context of San Juan Red Ware makes this ware a particularly suitable subject for a regional analysis.

This thesis is a study of the distribution of San Juan Red Ware across a portion of the northern Southwest (see Figure 1.1), and how the distribution of this ware and prior research into its social context increases our understanding of the people who made, exchanged, used, and discarded these vessels. San Juan Red Ware was produced for at least 300 years, which means the question of when someone had it is equally important to the question of who did or did not have it. Thus, in addition to its spatial distribution, I explore changes in San Juan Red Ware over time by dividing the ceramic assemblages used in this study into fifty-year intervals using a variation of mean ceramic dating (South 1972, 1977). I used several spatial methods to address these questions: inverse distance weighting, hexagon binning, fall-off curves, and distance diagrams using San Juan Red Ware proportions and Typenspektren (spectrum of types; see Nakoinz [2013, 2014] and Cormier et al. [2017]). One non-spatial method, social network analysis (SNA), is also used in this study. SNA is gaining traction in archaeology (see Brughmans 2013 for a review) and has profitably been used to study ceramics and their social context across the Southwest (Mills, Roberts, et al. 2013; Mills, Clark, et al. 2013; Peeples, Mills, Clark, Bellorado, et al. 2016). The use of several methods helps validate the conclusions derived from each method, and this also serves the purpose of testing the utility of each method for this type of study. Therefore,

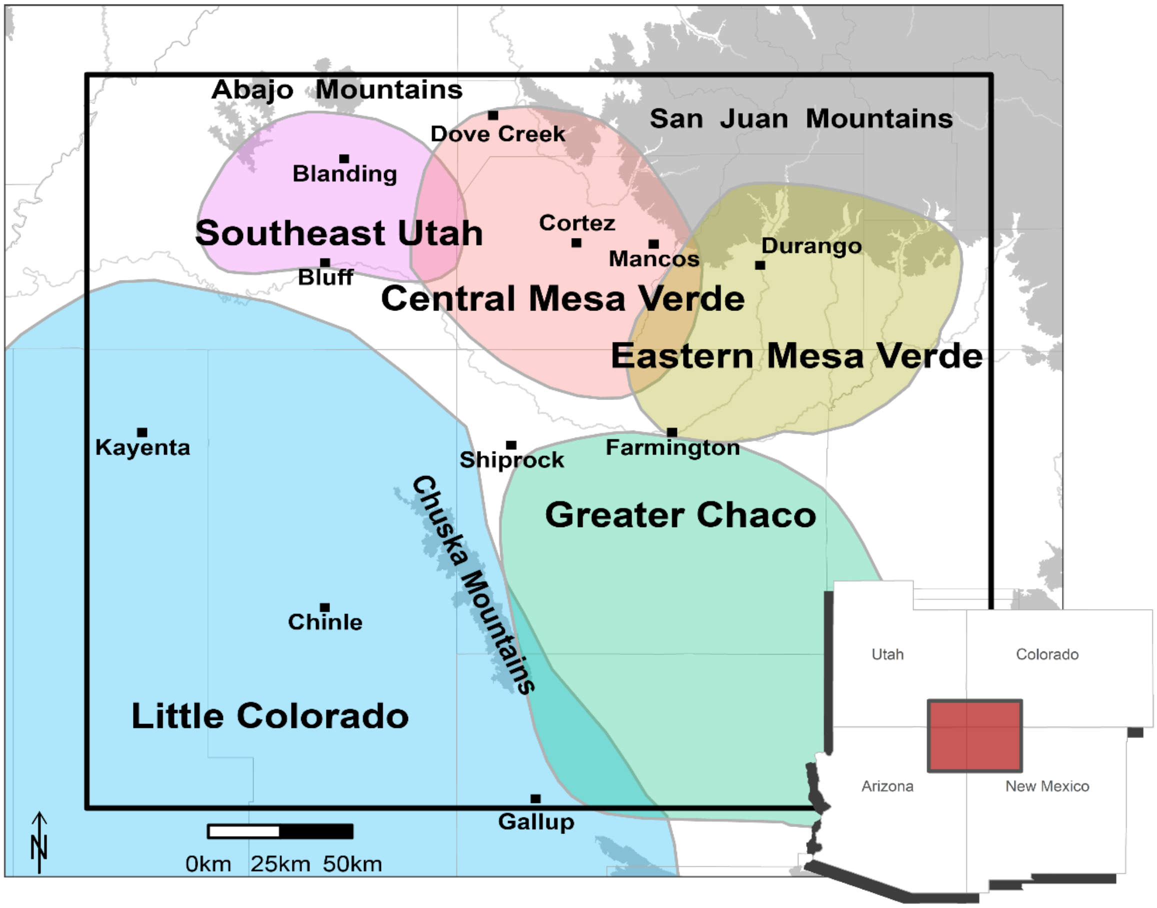


Figure 1.1. Map showing the project boundary and archaeological regions adapted from Wilshusen and colleagues (ed. 2012:Figure 1.1).

the results of this thesis concern the San Juan Red Ware vessels, the people who had them, and the effectiveness of each method used. My distribution analysis indicates that San Juan Red Ware was present throughout much of the study area from even the earliest period of its production, but the distribution is highly variable throughout the area, even where it is most common in southeastern Utah. After AD 850-900, the distribution became more widespread and the variation between sites decreased from preceding periods. This is likely an indication that individuals with San Juan Red Ware vessels became more integrated over time. My analyses and prior research indicate San Juan Red Ware was socially valued, but the variability in access to this ware indicates that either not everyone had access to it or not everyone wanted it. My data suggest that it was not universally valued and is most likely associated with a particular, although widespread, identity based on kinship, a belief system, or a combination of these and other factors. The methods used in this study demonstrate interesting and complementary patterns, but each method has its own advantages and disadvantages. The use of multiple methods is recommended to best identify and validate patterns and interpretations.

THESIS ORGANIZATION

In the remainder of this chapter, I discuss the scope and limitations of my study, as well as a brief review of relevant themes regarding interaction and identity. The subject of Chapter 2 is the Ancestral Pueblo, with a focus on the region and period of this thesis. In Chapter 3, I briefly review the ceramic traditions of the region and provide a more in-depth discussion of San Juan Red Ware. In Chapter 4, I review the sources and methods used to build my dataset and the several methods I used in this thesis. Many adjustments are required to deal with problems relating to sample size and dating, and these adjustments require comparative justification. Thus, in Chapter 5, I provide several examples demonstrating the accuracy and limitations of the methods I used to date sites and account for sample size. In Chapter 6, I present and discuss the results of my analyses and evaluate the effectiveness of the methods I used. In Chapter 7, I demonstrate how the results of this study fit into the broader context of San Juan Red Ware research and provide my conclusions regarding the distribution and social context of San Juan Red Ware.

THESIS SCOPE AND LIMITATIONS

My area of study covers the Ancestral Pueblo sites north of the San Juan River in southeast Utah and southwest Colorado and sites south of this river to just below Chaco Canyon in New Mexico, as well as a portion of northeast Arizona. Trace amounts of San Juan Red Ware are found throughout much of the Southwest, but it is only commonly found in the region of my study until after AD 1000 (Allison 2008c:24). Only in this area is San Juan Red Ware found in enough quantity to allow an in-depth analysis until after AD 1000. Some San Juan Red Ware was produced after this date, but the major trends I intend to examine are best answered by limiting this study to the period prior to AD 1000. Tsegi Orange Ware was produced starting approximately AD 1025 and on occasion has been confused with San Juan Red Ware, which may provide additional complications if I extend my analysis past this date (see Wilson and Blinman 1995:53).

Richard Wilshusen and colleagues (ed. 2012) define several distinct regions in their work on early Pueblo archaeology. Five of these regions fall within my project boundary and are depicted in Figure 1.1: Southeast Utah, Central Mesa Verde, Eastern Mesa Verde, Little Colorado, and Greater Chaco. These regions are used in this study to maintain consistency with prior work.

The primary unit of study is the site or a subunit of the site. I have not identified any ceramics myself and rely on the work reported by other researchers. Differences between ceramic analysts undoubtedly exist, but the nature of this study should limit errors, as for the most part my methods compare San Juan Red Ware to the totals of all ceramics. There are fewer difficulties in separating red ware from other wares, as San Juan Red Ware was the dominant red ware in this area throughout the period of this thesis. Reports that only provide estimates or presence/absence data were not included. I have limited data collection to the site location and the ceramic types and frequencies in order to collect ceramic data from as many sites as possible. One liability of doing this is the absence of absolute chronological data, which is addressed in Chapters 4 and 5, but the resolution of this study is admittedly coarse in order to cover a broader area.

I used several methods in my analysis to best characterize the distribution of San Juan Red Ware. Many spatial analysis methods use some form of interpolation to show likely values in areas without data points. I used inverse distance weighting (IDW) for interpolation in this analysis. Due to limitations with IDW, I used another form of data smoothing called hexagon binning, which involves creating a grid of hexagons across the region of study and using average values per hexagon to show variations in distribution. Distance is usually a major factor in exchange, and I plotted fall-off curves to study this relationship. I am also interested in determining the relationship between San Juan Red Ware and cultural boundaries as derived from ceramic types. The method I used for this involves measuring cultural distance using Typenspektren (Nakoinz 2013, 2014; Cormier et al. 2017). Typenspektren involves interpolating the density of different artifact types across an area and measuring the difference between Typenspektren at different points, although I only used ceramic types in this study (see Chapter 4 for more detail). The final analytical method I used is SNA. I created social networks based on similarities in ceramic assemblages (see Mills, Roberts, et al. 2013; Mills, Clark, et al. 2013; Mills et al. 2015; Peeples, Mills, Clark, Bellorado, et al. 2016), and I computed centrality scores that measure the importance of a node (site) to the shape of the network. The centrality scores were then compared to San Juan Red Ware proportions to determine whether San Juan Red Ware is associated with highly connected sites. IDW and fall-off curves are commonly used in archaeology, but hexagon bins, distance diagrams using Typenspektren, and SNA are less common. As room counts were available in the data used for this thesis, I also compared proportions of San Juan Red Ware to room counts, although the data did not show a relationship between these variables. This thesis also provides a test of these methods to determine their effectiveness for this type of analysis and to see how the various methods complement each other.

I used the proportion of San Juan Red Ware to the total number of ceramics and, in some cases, to the total number of decorated ceramics for most analyses. It is often valuable to compare ratios of artifacts to other artifacts, features, excavation volume, etc., to create a standardized comparison. This is useful for determining whether one site truly has relatively more or less of something than other sites; however, this is not necessary for this study. I am not interested in how much pottery was acquired per site, rather, I am interested in what types of pottery individuals chose to make or acquire.

INTERACTION

Interaction is fundamental to all things social and is thus a fundamental part of archaeology. Interaction involves two or more entities that in some way affect each other. The strength of interaction is usually defined by space, although it is essential to note that space may be measured in different ways. Oliver Nakoinz and Daniel Knitter (2016:8) list four examples of space: social space (measured by social distance), economic space (measured by economic distance), cultural space (measured by cultural distance), and geographic space (measured by geodetic distance). These examples of space can be measured, quantified, and used to analyze interaction. Because space is an intrinsic part of interaction and archaeology in general, the use of GIS has proliferated in archaeology. Archaeological studies focusing on the relationships of features and artifacts to geographic space are often referred to as "landscape archaeology," although there are numerous definitions of landscape archaeology and some differ significantly. My use matches that of Nakoinz and Knitter (2016:13): "Landscape archaeology investigates the interrelationship of animated, inanimated, cultural, social and economic objects on a regional level in space." Essentially this is an attempt to understand how the things within a landscape are connected to and affect each other. Landscape archaeology also refers to a more phenomenological approach that is not considered in this study.

Many useful approaches to quantifying interaction have been successfully adopted from geography. A frequent goal in archaeology is to determine relationships between objects. Waldo Tobler's (1970:236) "first law of geography" states, "everything is related to everything else, but near things are more related than distant things." If this assumption is correct, then space becomes a primary determinant of the relatedness of objects. As previously mentioned, space can be measured in different ways, but these spatial relationships can be quantified and statistically analyzed in archaeology much as they are in geography.

Exchange is a problematic term for archaeologists because it is difficult to be certain that an item was obtained from another person or group, let alone determine how it was exchanged. Joseph Chartkoff (1989:169) asserts that a different definition for exchange is used by archaeologists than is used in common parlance: "In the literature, therefore, the term 'exchange' really is a synonym for the acquisition of exotic goods by any means." Indeed Colin Renfrew (1977:72) uses "exchange" and "trade" to mean simply that an object was acquired from a distance. This is probably a safer interpretation of the word exchange as used by archaeologists; however, this use of the word means that inter-group interaction may not have occurred, even though a foreign object was acquired. Trade and exchange are sometimes used interchangeably, but in some cases the words are used to mean different things, and often the meanings are unclear (see Kohl 1975 for a discussion on the meanings of the terms). Exchange can take many other forms, but the nature of the archaeological record biases our approach towards nonperishable goods often located outside of the procurement or production area. Thus, exchange becomes a principal form of gauging interaction prehistorically. Dean Saitta (2000:151) states,

> Exchange is driven as much by social as by economic necessity. Exchange not only helps to buffer resource stress through various kinds of 'banking' strategies, but it also serves the aims of 'social reproduction.' That is, exchange cements political alliances between interacting groups and provides goods that can be used on a local level to create and signal important status distinctions, as well as meet the requirements of group ritual activities.

Exchange is a highly social phenomena, and exchange in the Southwest is no exception. Richard Ford (1972:22), in his study of ethnographic trade among the Rio Grande Pueblos, argues that exchange is the primary connection between communities. Ford also emphasizes the frequent personal nature of exchange in these societies. For example, the Tewa had personal trading partners with the Jicarilla Apache (Ford 1972:33), although itinerant traders moving from community to community was the most common form of exchange among these Pueblos (Ford 1972). Ford (1983:712) states that early explorers in the Southwest were impressed both with the quantity of exchange and the distances that traders would walk. Exchange is often closely intertwined with kinship connections, meaning exchange often occurs through related family members (Sahlins 1972:123). The nature of this exchange likely depends on the type of kinship connection. Exchange is closer to generalized reciprocity the closer the kinship connection and closer to negative reciprocity the more distant or absent the connection, although Sahlins (1972:196–197) argues that distance itself reduces the closeness of a kinship connection. Thus, individuals are more likely to give items as gifts to close family members living nearby, but are also more likely to expect compensation for the goods from family members living far away or who are more distantly related.

Exchange through personal kinship networks is one possibility for the exchange of San Juan Red Ware, but some of these vessels are exchanged across great distances, which suggests the possibility that these vessels may also have been exchanged outside of kinship networks. Exchange can cross-cut social boundaries (e.g., Ford 1972), and this is more likely the more valuable an object. Katherine Spielmann (2002:198–201) asserts that "socially valued goods," such as objects obtained from great distances, are an essential part of ritual participation in a community. Spielmann (2002:198-199) defines three distinguishing aspects of socially valued goods versus ordinary goods: geographic distance, skilled crafting, and "enchanting" or enhancing an object through time. Additionally, geography itself can be meaningful (Helms 1988, 1993:3). Spielmann (2002:199) cites examples from the Rio Grande area of the Southwest and Neolithic Britain as demonstrations of ceramics that were made in a spatially restricted area and traded widely. Certain locales are argued to be ritually important, and the ceramics produced in these regions take on the social values of the ritually important locale. This is supported by Ford's (1972, 1983) ethnographic studies of Southwestern Pueblo villages who relied on trade for ritual paraphernalia. One type of communal ritual is feasting, which requires the acquisition of large quantities of food, as well as other objects, such as serving bowls. In addition to being an impetus for exchange, communal rituals are also important events in building social identities.

IDENTITY AND MATERIAL OBJECTS

Interaction ties directly to identity. Identity can mean many things, but Allison (2008a:42) provides an all-encompassing definition: "Identity subsumes a wide variety of disparate phenomena, such as self-understanding, reputation, status, gender, linguistic- or ethnic-group membership, genealogy, geographical origin, and location within kinship or other social networks." Each individual has multiple identities that can change over time, but for one school of thought these various identities can be defined as either categorical or relational (see Peeples 2018:6–10). Matthew Peeples (2018:8) provides the following definitions:

> Relational identification refers to a process through which individuals identify with larger groups based on networks of interactions or persistently activated relationships such as kinship or exchange ties. . . Categorical identification refers to the process through which individuals identify with large formal units such as political groups, religious organizations, or states based on perceived similarities with others in these groups.

The nature of relational identity is such that the more individuals interact, the closer the individuals' relational identity will be. Direct interaction is not necessary for shared categorical identities. These identities often involve shared material culture symbolic of group membership

(Peeples 2018:27). Rock art, ceramic designs, and many other symbols may represent affiliation with a clan or other social group (e.g., Bernardini 2005; Peeples 2018). Relational identity is often easier to identify, as evidence of interaction indicates some commonality in relational identity. The presence of similar material culture does not necessarily mean direct interaction between individuals or communities occurred. Relational and categorical identities are not mutually exclusive, and the strength of collective action is greatest among individuals and groups who are highly connected in both types of identity (Peeples 2018:33–39).

Regional studies in archaeology often focus on questions of identity. Peeples (2018:7) identifies three methods used for this purpose: spatial clustering, active expression, and shared practice. Spatial clustering is the search for discrete units often using architecture. Active expression is the use of material culture to express solidarity. Shared practice refers to what is often called “community of practice.” Arguments are strongest when all of these methods are used, but my attempt to interpret identity in this study qualifies as a study of active expression through objects, as well as a search for spatial clustering.

Objects often reflect identity. Barbara Mills (2015:251) argues that researchers should study the role of objects in “constructing and promoting social memory.” Spielmann (2004a:210) adds, “Indeed many communal and personal ritual actions are mediated through objects whose particular attributes contribute to the appropriateness and effectiveness of the ceremony.” A focus on material relationships, often termed “materiality,” is a relatively recent trend in archaeology (Knappett 2012) but is also related to broader trends in the social sciences such as Actor-Network Theory (ANT). The application of ANT to archaeology is termed “symmetrical archaeology” (e.g., Olsen 2012). Symmetrical archaeology is a reaction against “things” becoming “epiphenomenal or residual to the ‘social’ and ‘cultural’” (Olsen 2012:211), meaning that the materiality or physical attributes of objects are ignored in favor of wholly relational or social explanations. This does not mean that social explanations should be ignored, rather the meaning of “symmetrica” is that both the physical and the social are essential and inseparable (see Latour 1993). Bruno Latour (2005:71) writes, “Any thing that does modify a state of affairs by making a difference is an actor.” He does not mean that things have intention (Latour 2005:72), but it is clear that objects and things make a difference in our world and thus are termed actors or agents in the context of ANT. Latour (2005:5) also redefines “social” to refer to a network of interactions, which can be either human or non-human.

To apply this concept to San Juan Red Ware and back to the concept of identity, I emphasize the entanglement of the potter who made the vessel, the individual who acquired and used it, and the vessel itself. If San Juan Red Ware was in fact seen by the inhabitants of this region as a marker of cultural identity, then not only is the vessel imbued with social meaning, but the vessel itself acts as an agent by reinforcing and constructing the identity of the producer and consumer. If Sahlins is correct that kinship connections are reduced by distance, then it may follow that the absence of physical markers of identity also create social distance between individuals, whereas the presence of these objects act to decrease social distance.

Major changes in material culture are often tied to migration. Migration is an important topic in Southwest archaeology due to the frequency it occurs as is evident in the archaeological record. Oral histories further support claims of frequent population movement. Migration is closely linked with identity as movement changes at least the relational identity of individuals, as they usually must form new networks as they move into a new area. Categorical identity can also be affected by migration; individuals may lose connections to prior organizations and seek out new ones. A number of studies demonstrate that Southwestern communities are often composed from individuals with different social backgrounds (e.g., Bernardini 2005; Clark 2004; Duff 2002; Potter and Yoder 2008; Wilshusen and Ortman 1999). The following chapter further discusses the frequency of migration in the region and period covered in this thesis. Bernardini’s (2005) work on Hopi migration using archaeology and oral history demonstrates some of the complications that must be considered when studying migration and identity. Bernardini (2005:14–15) states that European migrations are often a gradual movement and sometimes replacement of peoples, while in the Southwest, areas are often depopulated and migrations are usually small-scale. Furthermore, peoples in the Southwest, and elsewhere, frequently change their categorical identities. Perhaps the most confounding factor regarding Southwestern migration is its small-scale almost stochastic nature:

> Serial migration involved the uncoordinated and unsynchronized movements of relatively small, independent social groups. Although migrating groups frequently came together to form villages . . . each group arrived with a unique migration history that provided it with a distinctive social identity and background. The villages created from the aggregation of these populations were generally short-lived, and when occupations end, their component social groups dispersed and independently selected a number of different destinations. The consequence of this pattern of movement, unfolding over multiple generations, was that the population of any given village contained a heterogeneous mix of groups whose members have different backgrounds and identities. [Bernardini 2005:160–161].

Bernardini's work focused on Hopi migration, but he extends his observations to cover migrations in the Southwest generally. It is likely that many of the ancestors of the Hopi lived in the region discussed here. In this understanding of migration, spatial proximity does not ensure shared ethnicity or identity (Bernardini 2005:42).

The diverse nature of Southwestern communities and the close link between exchange and identity complicate interpretations of ceramic distributions. Ceramics found at a distance from the production area do not necessarily mean they were acquired due to their universal value, rather, they may have been acquired through a personal kinship network (Allison 2008a:43–45).

On the other hand, acquiring a certain type of ceramic vessel or other object may have been an important part of forming an individual's identity and great efforts may be expended to acquire the item. In general, if an object is valued by everyone for its social, ritual, or other value, then I expect the item to be most common where it is produced and to become less common at a relatively consistent rate with little variation (see Renfrew 1977:72). If the distribution diverges from this pattern, then other factors should be explored. Differential access may relate to social or economic phenomena. Economic factors do not appear to have affected the distribution of San Juan Red Ware vessels, and distance had much less of an effect than expected. The variation in the distribution of this ware indicates that not all had access or desired access, although the variation between sites decreases over time, and the relationship between San Juan Red Ware and sites with high network centrality increases over time. This distribution also indicates that individuals with different categorical identities intermingled throughout this area. Throughout the remainder of this thesis, I support these conclusions about San Juan Red Ware and the individuals in this area between AD 750 and 1000 using distribution patterns, their change through time, and prior research.

2 Ancestral Pueblo and the Early Pueblo Period

This chapter briefly covers the Ancestral Pueblo with a focus on the Pueblo I and Pueblo II periods within the project boundaries. These periods roughly correspond to the early Pueblo period defined by Schachner, Throgmorton, and colleagues (2012:3), which lasted from AD 650 to 950. The early Pueblo period covers the advent of large, aggregated villages and the start of the Chaco phenomenon. This chapter is not meant to be an exhaustive review of these subjects; my primary intent is to provide enough background to understand the context of this study. General overviews of the prehistory of the Southwest are provided by Linda Cordell and Maxine McBrinn (2012) and Stephen Lekson (2008); Richard Wilshusen and colleagues (ed. 2012) provide a more detailed review of the early Pueblo period.

PHYSIOGRAPHY

All areas of this study are located on the Colorado Plateau, but elevation and precipitation vary greatly across this region. The lowest area is about 3,700 feet above sea level (1,128 meters; see Figure 2.1 for elevation profiles) along the San Juan River, while the highest area is in the San Juan Mountains at about 14,000 feet (4,267 meters). Precipitation levels fluctuate significantly in this region, but the 30-year average annual precipitation dataset from PRISM (Daly et al. 2000) provides an indication of the amount and location of precipitation. Figure 2.2 shows the aridity of much of the region, but much greater amounts of rainfall in higher elevations. The areas with the highest rainfall correlate with the mountain ranges of the area.

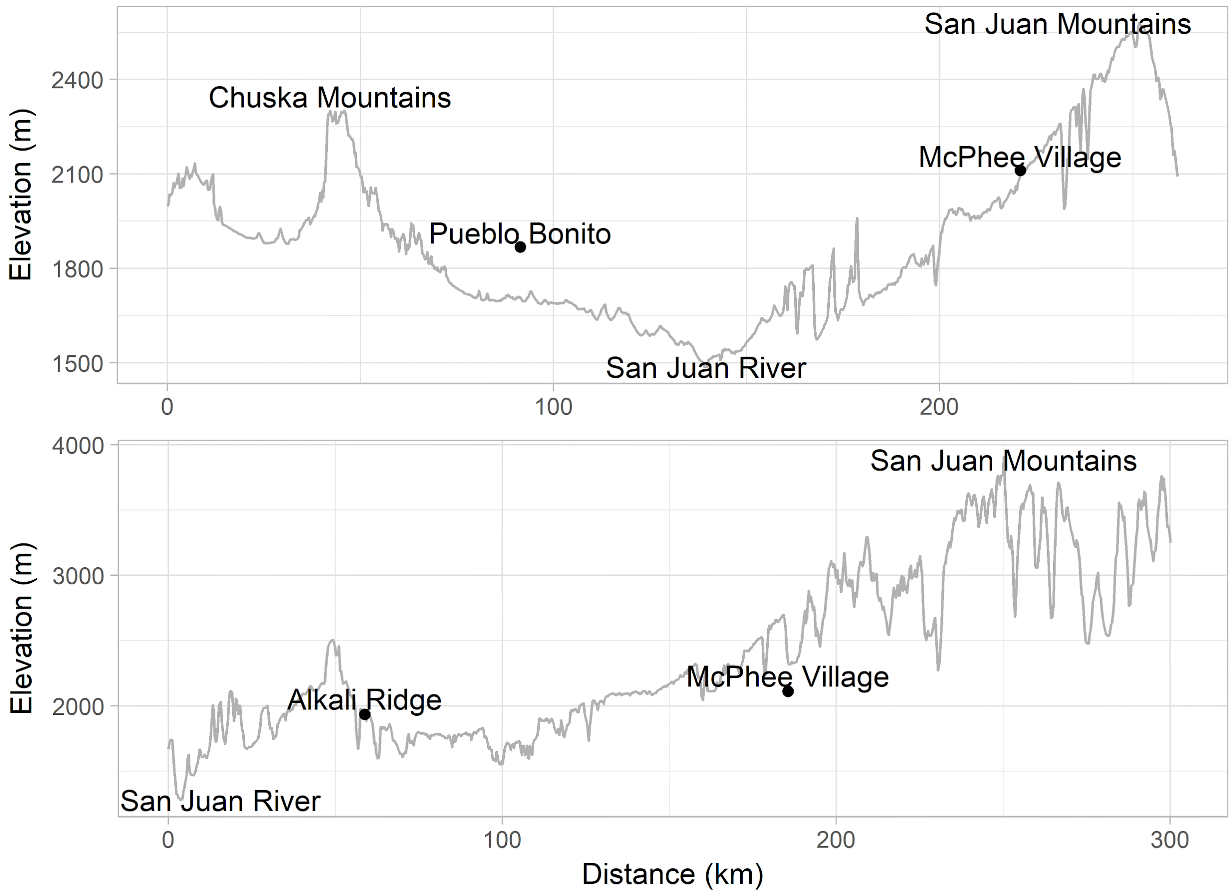


Figure 2.1. Elevation profiles for the region from south to north (top) and from west to east (bottom).

The National Land Cover Database (NLCD; Xian et al. 2011; see Figure 2.3) shows the land cover of the region. Rich vegetation areas, shown in the NLCD, closely correlate with elevation. Generally, Ancestral Puebloan sites are found either in higher elevations where dry farming is sustainable or near drainages and rivers where a steady supply of water is available. Prehistoric patterns differ in some ways from these data, but follow similar patterns. For more detailed information on the geography and past environment of the region see Adams and Petersen (1999).

ANCESTRAL PUEBLO

The Ancestral Pueblo (also known as the Anasazi) are one of the major ancient

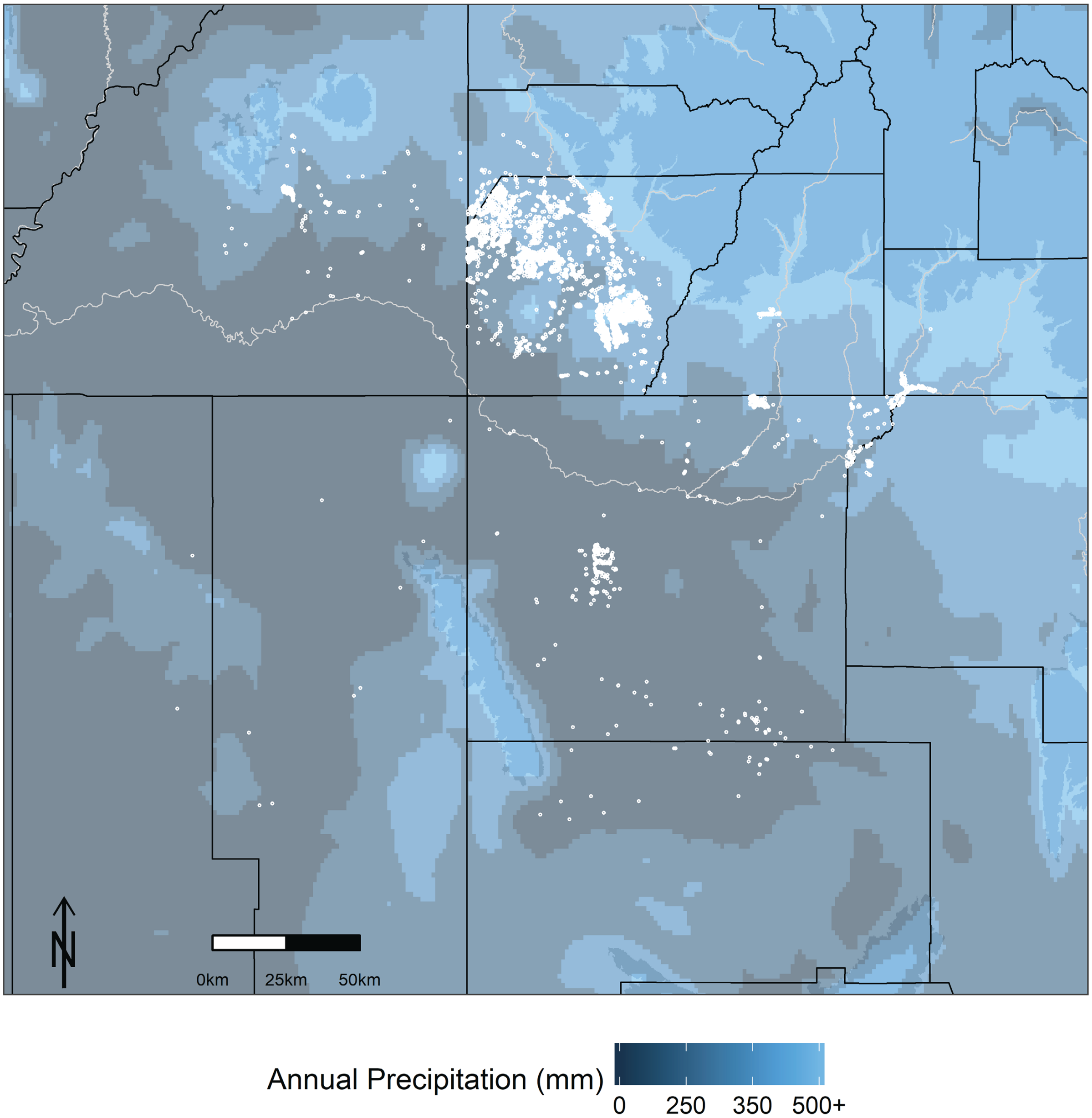


Figure 2.2. PRISM thirty year mean annual precipitation for the region and the locations of sites used in this study (shown in white).

archaeological cultures identified in the Southwest. Ancestral Pueblo territory stretched from southeastern Nevada to the Rio Grande Valley in New Mexico and from southern Utah and southwestern Colorado to central Arizona and New Mexico.

The Pecos Classification (Kidder 1927) is frequently used to describe the chronology of the Ancestral Puebloans of the Southwest. This chronology covers the prehistory of the Southwest

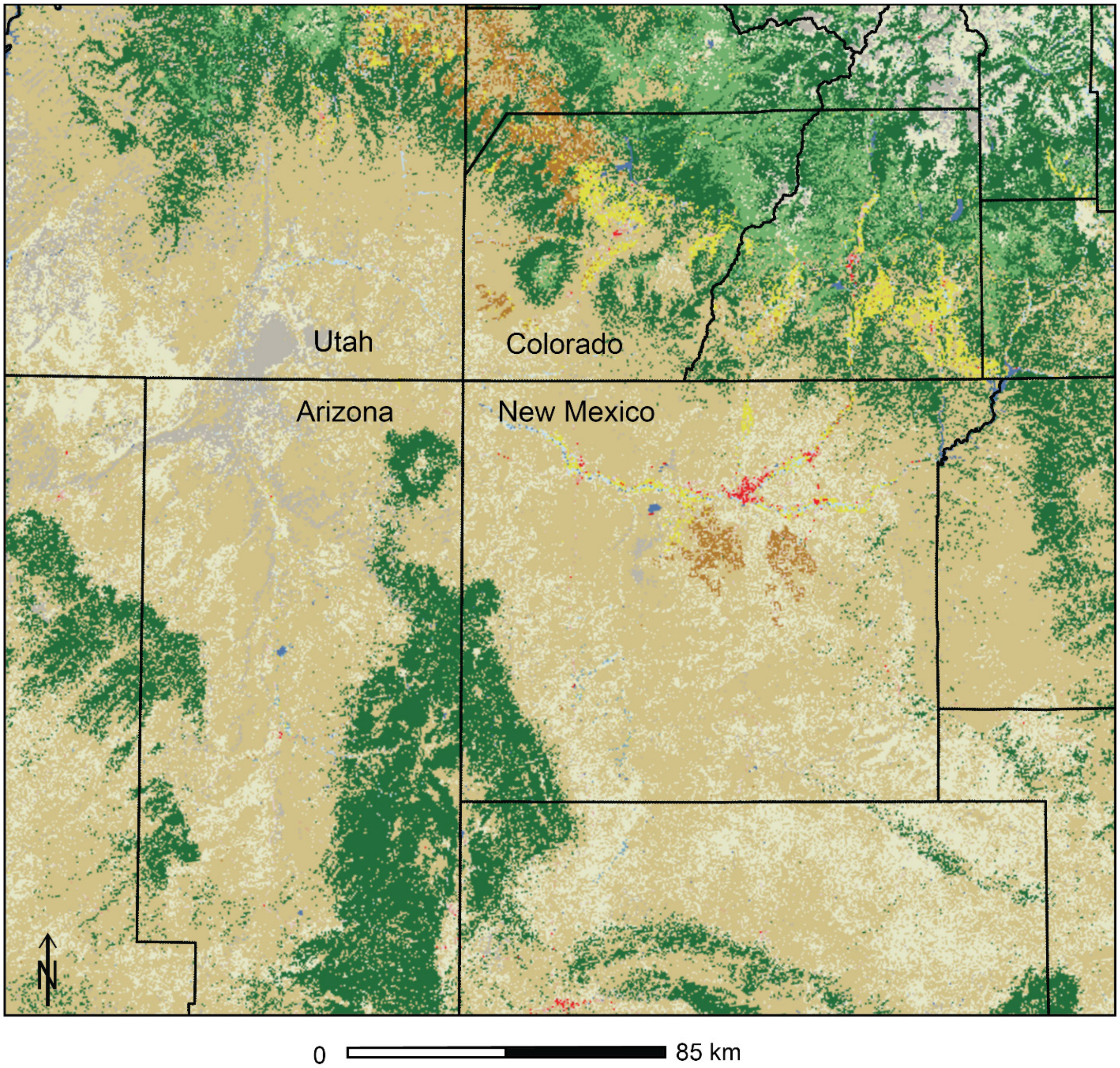


Figure 2.3. National Land Cover Database for the study region.

from 1200 BC to historic times. Originally, the Pecos classification started with Basketmaker I, but this term was dropped in favor of the term Archaic. The largest Ancestral Pueblo populations lived in the Four Corners region until the late AD 1200s, after which the area was largely depopulated for a time. More sparsely populated Ancestral Pueblo regions include the Kayenta of northeast Arizona, the Rio Grande area, and the Virgin branch covering a contiguous portion of Nevada, Utah, and Arizona.

PUEBLO I

The Pueblo I period lasted from AD 750 to 900 and was originally defined by the presence of neck-banded pottery and surface dwellings (Wilshusen and Ortman 1999:369). Large, aggregated villages first developed in this period, but they were usually short-lived and villagers moved frequently. The northern San Juan region was relatively uninhabited at approximately AD 600, but by AD 850 the region supported the largest population in the northern Southwest (Wilshusen et al. 2012:34). This major increase in population can be attributed to two main factors: migration and the "Neolithic demographic transition," which describes a major increase in population caused by sedentarism, among other characteristics (Bandy and Fox 2010; Bocquet-Appel and Bar-Yosef 2008; Kohler et al. 2008; Schlanger and Craig 2012).

Current evidence indicates that multiple distinct social groups inhabited this region. Other than marked differences in pottery between the eastern and western regions, architectural variation is prominent. Four of the eight contemporaneous villages in the Dolores River Valley lie on the eastern side of the river and feature long, curved roomblocks with a plaza and kiva located south of each roomblock. The four villages on the western side of the river feature horseshoe shaped roomblocks enclosing multiple plazas. Wilshusen and Ortman (1999:383) infer from this that at least two social groups occupied the valley. Using three sites from the late AD 700s, Allison (2008a:48) argues that village layouts with long rows of surface rooms are restricted to the western part of the region during the early Pueblo I period, although this architecture later becomes common in other areas. Other studies also indicate multiple social groups were present based on material evidence (e.g., sandals [Webster 2012]).

PUEBLO II

The Pueblo II periods spans AD 900 to 1150. This period is dominated by the presence of the “Chacoan system.” The beginning of Chaco marks the transition point from Pueblo I to Pueblo II. The literature surrounding Chaco is enormous, but a brief overview will suffice. Chaco Canyon is located in the central San Juan Basin, but its influence appears to have spread throughout a broad region, including the northern San Juan. The widespread distribution of Chacoan style architecture, earthworks, and some ceramic wares, among other items, all demonstrate the importance of Chaco to the region.

Construction on great houses is generally well-dated with tree-ring dates. The earliest building period started between AD 850-900, but the biggest construction period was from about 1020 to 1125 (2008:123). Lekson (2008:123) sees the origin of Chaco, and the apparent hierarchy associated with it, in the Basketmaker III period, particularly in the large pit structure villages of Shabik-eschee and 29SJ423, which are located within Chaco Canyon. Others see the beginnings of what would become Chaco in the Pueblo I villages (e.g., Schachner 2010; Van Dyke 2007; Wilshusen and Ortman 1999; Wilshusen and Van Dyke 2006). These villages had great kivas and large pit structures that may have been associated with individuals of an elite status. Lekson (2008:100-102) argues that U-shaped roomblocks in the Pueblo I period were the next step in the evolution of great houses, which culminated with the main structures in Chaco Canyon.

Several large great houses comprise the center of Chaco Canyon. Large earthworks and roads are closely associated with Chacoan great house, and several great kivas are also present in the Canyon and associated with Chacoan great houses. Great houses were likely the residences of powerful elites. A recent DNA study indicates that elites associated with a wealthy burial shared the same matrilineage (Kennett et al. 2017). Chaco was clearly a major influence on the entire northern San Juan. Over 200 of what are called “Chacoan outliers” are found throughout the area centered on Chaco Canyon (Fowler et al. 1987; Kantner 2003; Kantner and Mahoney 2000; Marshall et al. 1979; Marshall and Sofaer 1988; Powers et al. 1983).

ARCHAEOLOGICAL REGIONS

Wilshusen and colleagues (ed. 2012) define several archaeological regions for their study of the early Pueblo period, and five are relevant to this thesis: Central Mesa Verde, Southeast Utah, Eastern Mesa Verde, and Greater Chaco, and the northern part of the Little Colorado (see Figure 11.1). Here I briefly summarize the archaeology of these regions.

Central Mesa Verde

Central Mesa Verde contains the largest concentration of villages and the highest population in the region until AD 900. Wilshusen and colleagues (2012) divide the early Pueblo period into three subperiods for this region. The first subperiod spans AD 650 to 810 and is notable for a major population increase, partially due to migrations from the east and west Mesa Verde regions and from across the San Juan River to the south (see Allison et al. 2012; Potter et al. 2012; Wilshusen and Ortman 1999). This period is associated with household reorganization, with more people and a greater reliance on stored food (Wilshusen et al. 2012:21). Approximately 8,000 individuals lived in this region during the middle subperiod spanning AD 810 to 880, with around half of the population living in villages. Differences in ceramics, village layouts, community architecture, and site abandonment indicate multiple social groups and movement from both the east and the west (Wilshusen et al. 2012:21). The last subperiod spans AD 880 to 920 and is marked by a population exodus to the south and west. Potential reasons for the large population crash are poor environmental conditions and some, likely limited, social conflict (Wilshusen et al. 2012:33).

Southeastern Utah

Allison and colleagues (2012) divide the chronology of the early Pueblo period into four subperiods: late Basketmaker III (AD 500-750), early Pueblo I (AD 750-825), middle Pueblo I (AD 825-880), and late Pueblo I/early Pueblo II (AD 880-950+). The primary trends in this region are rapid population increases and decreases, which often inversely represent demographic trends in the central Mesa Verde region. Populations increased during the beginning of the Pueblo I period (Allison et al. 2012:43), which also coincides with the sudden presence of Abajo Red-on-orange pottery (see Chapter 3). Population declined again during the middle Pueblo I period, although some sites are still present (Allison et al. 2012:48). The late Pueblo I/early Pueblo II period started with another population increase coinciding with a population decrease in the central Mesa Verde region. Architectural features and relationships to nearby communities at several sites may be an indication that these sites are "proto-great houses" (Allison et al. 2012:52). The end of the last period marks another population decrease.

Eastern Mesa Verde

Potter and colleagues (2012) divide the archaeology of the early Pueblo period in the Eastern Mesa Verde region into two periods: AD 750-825 and 825-900. The authors further divide this region into four subregions: the La Plata District, the Durango District, the Piedra District, and the Navajo Reservoir/Fruitland area. The majority of habitation sites in the La Plata District date to the early Pueblo I period, although no sites have been recorded south of the Colorado/New Mexico state line in the La Plata drainage (Potter et al. 2012:56-57). The majority of Pueblo I sites in the Mancos River drainage date after AD 800 (Potter et al. 2012:57). Much of the work in the Durango Archaeological District is a result of the Animas La-Plata project. The project area comprises a large number of Pueblo I sites forming two communities: one at Ridges Basin and the other at Blue Mesa (Potter et al. 2012:57). After 800 the occupations in the region contracted into Ridges Basin and Blue Mesa, and the region was largely depopulated after 825 (Potter et al. 2012:57–58). The Navajo Reservoir/Fruitland District is named after two large projects that comprise much of the Pueblo I research in the area. Occupation in this area began between AD 790 and 800 and lasted until the late AD 800s or early 900s (Potter et al. 2012:62). The lack of early occupation in the area may be indicative of population movement from the south (Wilshusen, Sesler, et al. 2000).

In general, the occupations in these regions represented limited occupations spanning only one or two generations (Potter et al. 2012:62). Wilshusen (2009) and Wilshusen and Scott Ortman (1999) present a possible scenario for population in the region. They suggest that most people in the region came up from New Mexico into the Durango area around AD 750 and then in the early 800s moved west into the Central Mesa Verde region until 875. At this point people moved south into the Fruitland area and the Piedra District and then to Chaco. Tree-ring dates support rapid movement into and out of the region, although populations never approached those of the Central Mesa Verde region (Potter et al. 2012:64–65).

Greater Chaco

The Greater Chaco Basin covers a large area also termed the San Juan Basin. This region had relatively few, dispersed Pueblo I occupations until around AD 875 when more people began moving into the area (Windes and Van Dyke 2012:72). Most of the archaeological work in the area during the early Pueblo period is focused on the area around Chaco Canyon and some of the drainages in the area, but the majority of the region has not been studied (Windes and Van Dyke 2012:72). The northern Greater Chaco region has few early Pueblo I sites. Site numbers increase dramatically in the mid to late AD 800s and 900s (Windes and Van Dyke 2012:76–78). The Chaco Coal Gasification Project (Reher 1977) recorded a number of mostly late Pueblo I/early Pueblo II sites along the Chaco River. The Largo and Gobernador canyons northeast of Chaco were heavily occupied during the Pueblo I period (Windes and Van Dyke 2012:76). Windes and Van Dyke (2012:79) do indicate that dispersed Pueblo I sites are present around the canyon, but significant Pueblo I occupation did not appear until the late 800s when the population grew rapidly at the beginnings of the early Bonito phase (AD 875-925).

Some sites in Chaco Canyon dating to this period indicate ties to the Mesa Verde area in the north based on architecture or ties to the south based on ceramics and tool stone (Windes and Van Dyke 2012:80,83). Lekson (2008:98) states that the majority of the population increase in this region can be attributed to migration from the south. But the increase in sites in Chaco Canyon during this period also corresponds to a major decrease in population in the Mesa Verde region (Wilshusen et al. 2012:31). The origin of the Chaco phenomenon is an ongoing debate, however, there are clearly ties to both the north and the south. The Chuska Valley echoes Chaco Canyon in its early settlement history, with few sites before AD 875 and a number of sites appearing after, although the early sites may be under-identified (Windes and Van Dyke 2012:92). Windes and Van Dyke (2012:92) suggest that migrants may have arrived in the valley by following the Chaco River corridor and a number of sites in this period are located along the potential route. In summary, the early Pueblo Period occupations in the Greater Chaco region are small with the only larger settlements located in the Chuska Valley or in Chaco Canyon (Windes and Van Dyke 2012:100).

Little Colorado

The Little Colorado region is the largest of the regions considered in my study, but it also has the sparsest and least-known archaeology. Of the four subregions discussed by Schachner and colleagues (2012), only the northeastern subregion falls within my study area. Only 3% of this subregion has been investigated, but current information indicates most substantial population growth occurred after AD 1000 (Schachner, Gilpin, et al. 2012:112). Most sites are small hamlets, but were likely occupied year around (Schachner, Gilpin, et al. 2012:112). Villages are known from as early as AD 500 (Schachner, Gilpin, et al. 2012:114). Evidence of public architecture in the area can be seen in both great kivas and dance plazas (Schachner, Gilpin, et al. 2012:119–121). In contrast to the other regions discussed, the Little Colorado region is characterized by slow, steady growth, with more evidence for spatial continuity and less frequent movement.

SUMMARY

The above discussion demonstrates that much of this region was closely connected with ebbs and flows in population inversely corresponding in adjacent regions. Nothing in the early Pueblo period matches the Chaco phenomenon, but large villages and likely some social differentiation can be seen long before Chaco reaches its height. Despite the complementary population movements, each region has distinct characteristics, and the various regions are likely comprised of a number of distinct social groups. Ceramics are often used as markers of social identity, and a number of differences exist in the ceramic traditions of this region. I discuss this further in the next chapter.

3 | San Juan Red Ware

This chapter describes San Juan Red Ware and the types within this ware. It also includes an overview of related research. Some aspects of this study concern the ceramics of this region in general, and I begin with a brief description of the various ceramic traditions found in my study area.

CERAMIC TRADITIONS

The regions used by Wilshusen and colleagues (ed. 2012:Figure 1.1) correspond somewhat to ceramic traditions. A ceramic tradition describes a group of ceramic wares that share some broad characteristics and are usually geographically linked. Ceramic traditions often correspond to archaeologically defined cultures (Wilson and Blinman 1995). Ceramics were exchanged throughout the area discussed here, but the majority of ceramics at a site usually come from the same ceramic tradition. The main ceramic traditions represented in my data are Northern San Juan (or Mesa Verde), Upper San Juan, Chaco-Cibola, Tusayan (or Kayenta), and Chuska. Ambiguities between traditions do not always allow analysts to positively identify a tradition and the usual practice is to assign the sherd to a generic category or to whichever tradition is locally prominent (Wilson and Blinman 1995:34). Each tradition is divided into wares; wares are further subdivided into types. The types within the wares are not individually discussed (other than San Juan Red Ware), but a list of the ceramic types and wares used in this thesis, as well as their dates of production are included in Appendix A.

Most ceramics in my database belong to the Northern San Juan tradition, which primarily encompasses two regions, Southeast Utah and Central Mesa Verde, although this tradition is often found in sites in Eastern Mesa Verde and the other regions. The temper is mostly igneous rock, and ceramics are only occasionally tempered with pot sherds or sand. Ceramic wares in this tradition are divided by color into red, white, and gray. Gray wares are mostly undecorated and often termed "utility ware" (Wilson and Blinman 1995:34). Red wares and white wares are decorated and served similar functions. Decorated ceramics in the northern San Juan region vary from majority red ware in Southeast Utah to mineral painted white ware in Central Mesa Verde and glaze painted white ware in Eastern Mesa Verde (which is part of the Upper San Juan ceramic tradition). Wilshusen and Ortman (1999) and Wilshusen (1999) recognize these three centers of production around AD 840, and Allison (2008a:47) notes these production areas are visible in the late 700s as well. Despite the prominence of San Juan Red Ware in Southeast Utah, various gray wares and painted white wares were produced in this region in similar vessel forms as San Juan Red Ware; however, these wares were not as widely traded (Hegmon et al. 1995; Hegmon et al. 1997:452). This ceramic tradition has been defined and redefined several times, but Wilson and Blinman (1995) provide the most recent overview and description of the wares and types within the tradition.

The Upper San Juan ceramic tradition corresponds with the Eastern Mesa Verde region. Several phases distinct from the Pecos classification were defined for this area based on ceramics from the Navajo Reservoir Project (Wilson and Blinman 1993): the Los Pinos phase (AD 300 to 400), Sambrito phase (AD 400 to 750), Rosa phase (AD 750 to 850), Piedra phase (AD 850 to 950), and Arboles phase (AD 950 to 1050). While many Ancestral Pueblo wares are based on color, Upper San Juan gray ware ceramics can be brown or gray while using the same type of clay, thus brown ceramics are not differentiated (Wilson and Blinman 1993:7). Early ceramics were made from alluvial clays, while later ceramics were made from bedrock clays (Wilson and

Blinman 1993:7). Most temper is igneous rock. Perhaps the most unusual aspect of this ware is the use of glaze paint on some of the white wares. Glaze paints become common in a much later period, but these early glaze wares appear to represent an early experimentation with this technique.

The Chaco-Cibola tradition corresponds to the Greater Chaco Region. It covers much of the San Juan Basin and surrounding areas. Differences between the Chaco and Cibola traditions become more apparent over time but are quite similar prior to AD 1000 (Wilson 2014a). Sand is the most common temper prior to AD 1000 and is replaced with sherd temper by 1050. Gray, white, and red wares were produced; red wares are rare and most closely resemble Mogollon red wares (Wilson 2014a). The Tusayan tradition generally corresponds to the northern part of the Little Colorado Region as used in this thesis. According to Dean Wilson (Wilson 2014b), "Tusayan White Wares are easily distinguished by the long use of organic paint, an unslipped light gray paste, and quartz sand temper." Gray wares are similar to the Cibola tradition. Orange and yellow wares were produced after AD 1050 and 1300 respectively.

The Chuska tradition corresponds to the Chuska Mountains, which are near the eastern border of the Little Colorado Region and western border of the Greater Chaco Region. Gray, white, and red wares were produced. Chuska ceramics were widely consumed in Chaco Canyon and are identified primarily based on the presence of anidine-basalt or trachyte temper and occasionally sand or sherd temper and green, gray, or black angular particles included in the temper (Hayes-Gilpin and Hartesveldt 1998; Windes 1977; Wilson 2013). The paste may be dark gray or bluish. Chuska white wares are similar to Tusayan and Cibola ceramics until late Pueblo II when they resemble northern San Juan white wares (Wilson 2013).

SAN JUAN RED WARE

San Juan Red Ware was first formally described by Harold Colton and Lyndon Hargrave

(1937) and has been described in a number of other sources (Abel 1955; Breternitz et al. 1974; Brew 1946; Morris 1939; Wilson and Blinman 1995; see Figure 3.1 for examples of San Juan Red Ware vessels). Erik Reed (1944) argued that San Juan Red Ware and Tsegi Orange Ware were part of the same series and should be combined and called San Juan Orange Ware. Harold Colton (1956) argues that the separation is valid and provides three criteria to separate the wares: differences in clay refiring color, differences in temper (rock or sand in San Juan Red Ware and white sherds or angular fragments for Tsegi Orange Ware), and the presence of a slip on Tsegi Orange Ware. One problem with Colton's criteria, is his comment that San Juan Red Ware was rarely slipped, but Deadmans Black-on-red is a type within San Juan Red Ware and was frequently slipped.

San Juan Red Ware was the only decorated red ware produced in the northern San Juan region. Production of this ware lasted from approximately AD 750 to 1100. In general, San Juan Red Ware is red to orange in color (unless misfired) and is usually decorated with dark red or black paint. Igneous rock is the most common form of temper. San Juan Red Ware is the only ware in the region that was fired in a well oxidized environment (Shepard 1939:271). Bowls are the most common form, with dippers, half-gourd ladles, jars, seed jars, effigies, feather-boxes, and gourds also present. Vessels were often polished after the painted designs were applied (Morris 1939:182). San Juan Red Ware painted designs often cover a broader area than contemporary white wares and have distinctive elements, although there is occasional crossover (Allison 2008a, 2008b, 2010; Morris 1939:182). Further differences between red wares and white wares are discussed later.

There are three main types within San Juan Red Ware: Abajo Red-on-orange, Bluff Black-on-red, and Deadmans Black-on-red. Various other types have been included and removed from San Juan Red Ware or combined with an existing type. For example, La Plata Black-on-red was used by Abel (1955), but Breternitz and colleagues (1974) combine this type with Deadmans Black-

Figure 3.1. Examples of various San Juan Red Ware vessels (original photographs courtesy James Allison).

on-red, and that is the current standard (see Lucius and Breternitz 1981 for a thorough discussion and history of San Juan Red Ware typology).

Abajo Red-on-orange

Abajo Red-on-orange was first described by J. O. Brew (1946) based on his work at Alkali Ridge, Utah. Wilson and Blinman (1995:55) list the production range as AD 700 or 750 to 850, while Hegmon and colleagues (1997:450) place the start at 750. More recent work argues that the start date cannot be earlier than 750 (Allison 2008a, 2008b). This type is identified by red paint on orange pottery. A washy slip is present in a few, rare examples. Brew (1946:261-267) lists the design elements commonly found on Abajo Red-on-orange vessels at Site 13 on Alkali Ridge in order of popularity: (1) broad, wavy lines, (2) triangles, (3) terrace and half-terrace figures, (4) checks, and (5) straight lines and bands. These observations appear to represent most Abajo Red-on-orange. The design layouts usually cover most of the field. A small percentage of vessels have both black and red paint, which is termed Abajo Polychrome.

Bluff Black-on-red

Bluff Black-on-red was first described by Colton and Hargrave (1937). Wilson and Blinman (1995:56) list the production range as AD 780 to 940 or potentially as late as AD 1000. Hegmon and colleagues (1997:450) place the end date at 950. Early design styles are practically identical to Abajo Red-on-orange, but designs gradually change until they merge with the later Deadmans Black-on-red (Wilson and Blinman 1995:56). Bluff Black-on-red is distinguished from Abajo Red-on-orange by its black paint and the absence of a strong red slip and differing design styles in the case of Deadmans Black-on-red. One variety is recognized: McPhee Black-on-red or Bluff Black-on-red, McPhee variety. It has a sherd temper and was produced between AD 880 and 920 (Wilson and Errickson 1985).

Deadmans Black-on-red

Deadmans Black-on-red was also first described by Colton and Hargrave (1937). Production began around AD 880 (Hegmon and colleagues [(1997:450)] state 900) and lasted until 1100 (Wilson and Blinman 1995:56). The slip is much stronger than the slips occasionally found on the other types, and the linework is finer. A significant difference is that the design styles are more similar to contemporary white ware (although still distinguishable in most cases; James

Allison, personal communication 2018), whereas the other types have few similarities to white ware designs (Wilson and Blinman 1995:56). Deadmans Black-on-red is similar to some Tsegi Orange Ware types and form a common style. One shared design element involves hatchured bands in all-over designs referred to as Dogoszhi style (Wilson and Blinman 1995:57). This design is also present on contemporary white ware vessels.

PRODUCTION AREA AND DISTRIBUTION

The "Criterion of Abundance" (Bishop et al. 1982:301) indicates that San Juan Red Ware was primarily produced in Southeast Utah simply because that is where it is most common (e.g., Hurst 1983; Lucius and Breternitz 1981). Hegmon and colleagues (1995:41) report percentages of misfired San Juan Red Ware sherds at several sites in Utah and at the Duckfoot site in Colorado. Misfired sherds represent mistakes that are likely most common where the pottery was produced. Misfired sherds were least common at the Duckfoot site and most common at Nancy Patterson along Montezuma Creek in Utah. Despite what Hegmon and colleagues (1995:46–52) say is a relatively small production area, they found Bluff Black-on-red was less standardized than contemporary white wares, which suggests a number of potters were producing it. Lucius and Breternitz (1981:106) argue that Abajo Red-on-orange was produced in the Blanding-Bluff area based on clay and temper, and that Bluff Black-on-red was produced along the San Juan, Mancos, and Dolores Rivers, although they note that most of the Mesa Verde region likely obtained Bluff Black-on-red via trade. Deadmans Black-on-red was only placed "somewhere along the western stretches of the San Juan River" (Lucius and Breternitz 1981:107). Allison (2008a:52) reports the ratio of red ware to white ware using a few villages each from the three regions in the northern San Juan. The ratio is largest in Southeast Utah at 12 or 13 sherds to 1. Allison uses sites from the Dolores Archaeological Program in Central Mesa Verde and reports a ratio of 3 to 1 red ware to white ware. Sites from the Animas-La Plata Project in Eastern Mesa

Verde have a ratio of 1 to 12 red ware to white ware.

Anna Shepard (1939:250) notes from refiring that most San Juan Red Ware clay is distinct from white ware clay, although there is some overlap. Shepard (1939:271) compared San Juan Red Ware found in the La Plata region by Morris to San Juan Red Ware obtained by Brew at Alkali Ridge and found differences in the paint type, but it appears that she was comparing Bluff to Abajo. She notes that the one black painted sherd found by Brew was the same as the La Plata paint. Shepard (1939:271) originally suspected that red painted pottery came from the Alkali Ridge area and black painted pottery came from the La Plata region based on various analyses including petrography. Shepard's work is supported somewhat by a more recent study by Norman Oppelt (2001). He used petrography to compare Bluff Black-on-red sherds and rock samples from a number of sites and locales in the northern San Juan (see Oppelt 2001:Figure 1). Oppelt lists Montezuma Creek, Cottonwood Wash, and the San Juan River as the production locations in Utah. He argues that Bluff Black-on-red and particularly the sherd tempered McPhee variety (Wilson and Errickson 1985) was produced in the Montezuma Valley based on its common occurrence there. He also states that the eastern drainages of the Animas and La Plata rivers were the source of Bluff Black-on-red that was traded to the Mesa Verde area, based on the presence of andesite in the temper. None of the rock samples he collected west of theses rivers contained andesite, but he does note that andesite is common in sherds from the Edge of the Cedars site in Utah and the andesite temper lacks titanate, which Shepard (1939) found in the andesite of the Animas and La Plata area. Also, Allison (2010) concluded that the San Juan Red Ware found in the Animas-La Plata Project was nonlocal based on chemical sourcing and other means (see below). It seems unlikely that San Juan Red Ware was produced inthe La Plata region and particularly that it was the source of San Juan Red Ware for the Mesa Verde area, as it is simply not as common in this region, as is shown in detail in Chapter 6 of this thesis.

Neutron activation analysis (NAA) studies have contributed more to the sourcing of San Juan

Red Ware and support Southeast Utah and likely parts of western Colorado near the Utah border as the production areas. Glowacki and Neff (2002:6), in their discussion on NAA, advise against relying too much on the criterion of abundance. An initial NAA study by Hegmon and colleagues (1995) analyzed sherds from Edge of the Cedars and one sherd from Black Mesa. They found that all but one sherd formed a close chemical group. Hegmon and colleagues (1997:459) used NAA to identify three compositional groups with distinct signatures for San Juan Red Ware. One group may have been made along McElmo Creek in Colorado, but only a few samples fit this group. The other two groups were almost certainly made in southeastern Utah, and comparisons with local clays and temper indicate at least one compositional group closely matches clay from Montezuma Creek at the eastern edge of Utah. Glowacki and colleagues (2002) used NAA for a number of different ceramic types and clay sources and combined their data with earlier NAA results. The purpose of their study was to match sherds to specific clay formations or sources. They tentatively suggest that some San Juan Red Ware sherds were made in southwestern Colorado from clays along McElmo Creek (Glowacki et al. 2002:71). NAA conducted as part of the Animas-La Plata Project (ALP; Allison 2010) found that the San Juan Red Ware sherds in the area were nonlocal and matched groups identified to the Montezuma Creek area of Southeast Utah, and areas to the west of Montezuma Creek, as well as to the group previously identified that matches clays from McElmo Creek. A number of sherds in this study were placed in a group without an identified production area. NAA of San Juan Red Ware sherds by Allison and Ferguson (2015) also indicates the production of San Juan Red Ware was likely located primarily in southeastern Utah, although there was little exchange between production sites, and most San Juan Red Ware found in Colorado was sourced to the easternmost production area along Montezuma Creek. The production locus of one group has not been determined, but Allison and Ferguson (2015) believe it is located along the Utah and Colorado border based on its distribution pattern. Altogether these NAA studies consist of 483 San Juan Red Ware sherds.

Most sherds are from southeastern Utah, 20 are from the Duckfoot site, and 159 come from the ALP. Allison and Ferguson (2015) combined the data and found eight chemical groups, but 64% were assigned to one group, and 29% were left unassigned. The largest unassigned proportion is found in the ALP. Allison and Ferguson note that unassigned sherds potentially belong to one of the groups, but a conservative approach to group membership was taken. The NAA studies do not preclude the possibility of San Juan Red Ware production in the Central Mesa Verde or Eastern Mesa Verde regions, particularly with the location of one chemical group unknown; however, the most likely location for production outside of Utah is in southwestern Colorado (Glowacki et al. 2002; Allison 2008a, Allison 2010). Despite, the uncertainty for some areas of production, these studies suggest that most San Juan Red Ware was produced in Southeast Utah. Regardless of the location of production, the wide distribution of San Juan Red Ware distinguishes it from other wares of the period in the northern San Juan region. Contemporary white wares were produced throughout the northern San Juan, but were not traded as widely as San Juan Red Ware (Hegmon et al. 1995:36). As there is no functional reason to acquire San Juan Red Ware over locally produced and available pottery, the reason for this distribution must be understood within a social context (Hegmon et al. 1997:452).

SOCIAL CONTEXT

Several studies address the social context of San Juan Red Ware. The high ratio of bowls to other vessel forms suggests that San Juan Red Ware vessels are often meant to be visible. Eating is often a communal activity and bowls are usually used for serving and eating (e.g., Parsons 1933:96), which makes these bowls quite visible to others. A San Juan Red Ware vessel immediately stands out from contemporary vessels due to its color, but Allison (2008a:53) notes that the painted designs are also quite distinctive and probably represent active signals indicating a distinct identity from groups to the east. He states “Many of the designs use complex, two-dimensional symmetry, while contemporary white wares have rotational symmetry and much sparser designs” (Allison 2008a:53).

San Juan Red Ware may have originated from migrant groups moving into the area from the south based on similarities to wares and designs in the southern Southwest (Allison 2008a, 2008b; Allison et al. 2012; Washburn 2006). Archaeologists have long noted a possible origin outside of the northern San Juan. Morris (1939:179) felt San Juan Red Ware was foreign based on his observation that it was the finest pottery found in the La Plata region. Although, at this time Morris was not able to identify where what he calls black-on-red pottery came from, and he later states that white wares may have had the same foreign origin as red wares (Morris 1939:184). Colton (1956) believed the ware originated south of the Rio Puerco, as that was the closest area where pottery was fired in an oxidized environment. Lucius and Breternitz (1981:105) argue that Colton’s interpretation is incorrect as San Juan Red Ware was only fully oxidized at the end of the firing process, while Mogollon ceramics were oxidized throughout the firing process. They argue for a local origination for San Juan Red Ware through experimentation (Lucius and Breternitz 1981:105). Wilson and Blinman (1995:55) provide some support for Colton and state that Abajo Red-on-orange is similar to the earliest painted types in the Mogollon region. More recent analysis by Dorothy Washburn (2006) using design symmetry concluded that Abajo Red-on-orange designs are non-local and represent a group of immigrants moving into the area. Allison (2008b:6) concurs with Washburn and notes that a number of Abajo designs never appear on white ware designs. In general, Abajo bowls have two-dimensional patterns and designs are dense; white ware designs are usually sparse and never have two-dimensional patterns (Allison 2008b:6). He also notes that the presence of non-bowl vessels is unusual for decorated vessels, as non-bowl forms are rare in contemporary white wares (Allison 2008b:5). Abajo bowls are also different from contemporary white ware bowls in several ways: they are generally wider, shorter relative to the diameter, have walls that are less steep, and are more symmetrical (Allison 2008b:5–6).

Several studies associate San Juan Red Ware with communal gatherings or feasting and possibly with ritual activity. Spielmann (2004a) found that San Juan Red Ware vessels are most frequently found in rooms associated with oversized pit structures at Alkali Ridge in the 700s. She argues this association and other evidence relates to communal feasting (Spielmann 2004a:222). Spielmann (2004a:224) believes San Juan Red Ware may represent a new ceremonial system, and that the acquisition of San Juan Red Ware, specifically from southeast Utah where the ware and presumably the ceremonial system originated, is an important part of participating in this system. Blinman's (1989) study at McPhee Village in the Dolores area found that San Juan Red Ware was more abundant in the three roomblocks associated with large pit structures that had the most complex ritual features in the village, and the evidence is indicative of potluck style feasting involving individuals from throughout the village. These roomblocks also had a higher ratio of bowls to jars of both white wares and red wares, which is indicative of feasting (Blinman 1989:120; see Potter 1997 for additional evidence of feasting at this site). Thus, San Juan Red Ware appears to be related to at least feasting and possibly ritual activity at McPhee Village. Stephen Plog (1986:304) also found that sites with ritual structures on the Black Mesa have more San Juan Red Ware than at other sites. Hegmon and colleagues (1997:452) use these data to infer that San Juan Red Ware is important in various contexts, including ritual, mobility, and exchange. They also believe that San Juan Red Ware was produced by part-time specialists composed of interhousehold work groups. An important caveat to these studies is that San Juan Red Ware does not appear to be associated with feasting in the same area in the 700s in Colorado (Allison 2008a:61–62). Most studies of San Juan Red Ware focus on the period after AD 850. Allison's study focuses on AD 7606 to 820. He found no evidence for a connection between San Juan Red Ware and communal activity at sites in the Dolores area or Sacred Ridge area during this period. Burial practices usually entail ritual procedures, and five burials in

Ridges Basin have reconstructible San Juan Red Ware vessels. Allison (2008a:61–62) notes that each of these burials came from sites with unusually high San Juan Red Ware proportions. Furthermore, all but one of the vessels were jars or seed jars, which are rarely found in other contexts, as most San Juan Red Ware sherds in the area come from bowls. Allison (2008a:61–62) suggests these jars may have been procured specifically for burial and represent individuals with greater access to San Juan Red Ware through their personal exchange networks.

In summary, San Juan Red Ware was most likely produced in southeastern Utah based on a variety of evidence. In addition to its color, its unique design patterns and other characteristics clearly stand out from local white wares. San Juan Red Ware also has some association with communal activity, at least in some areas and time periods. Ceramics, particularly decorated wares, often reflect social identity, and San Juan Red Ware certainly appears to be a marker of categorical identity. The wide range of its distribution emphasizes the importance of possessing these vessels to some individuals for expressing and reinforcing part of their identity.

4 Database and Methods

In this chapter, I cover the methods I used to collect and analyze my dataset. There are numerous factors that must be considered for a study of this nature, and these choices can create bias and change interpretations. Therefore, I describe the processes and decisions I made in selecting, cleaning, and processing the data used in my thesis with enough detail that my analysis should be reproducible. An important part of conducting reproducible research is documenting the steps taken in analysis. Fortunately, the statistical programming language and software R (R Core Team 2017) promotes the use of scripts, which document each step taken and can easily be rerun producing the same results. R was also chosen for its ability to handle large datasets and aid in cleaning and combining data, as well as for its flexibility in performing numerous types of analysis. R is free and open source software, and it is primarily updated by the use of separate packages that can be downloaded and used within R. Geospatial and graphical packages provide nearly all of the functions found in geographic information systems (GIS) software, as well as the typical statistical functions and a multitude of other functionality. I also review the basics of the various methods I used in my analysis. This chapter covers data collection, date estimates, Bayesian empirical estimation, distribution maps, distance diagrams, fall-off curves, and social network analysis. Because of the significant possibility of distortion and error when dealing with this type of data and assigning dates, the following chapter provides greater detail on how the methods to date sites and to account for sampling error compare to published interpretations of selected sites.

DATA COLLECTION

The first step in collecting the data for this thesis was to decide the boundaries. As discussed in Chapter 1, data collection was limited to southeast Utah, southwest Colorado, and northern New Mexico between AD 750-1000 (see Figure 1.1). A few sites from northeastern Arizona are included as part of the Chaco Social Networks Project (CSNP), but overall this area was sparsely occupied during the early Pueblo period (Lekson 2008:96; Schachner, Gilpin, et al. 2012).

Once the area and time frame was decided, I utilized two existing databases containing several thousand assemblages. The largest database is from the Village Ecodynamics Project (VEP) and its expansion, the VEP II project (Schwindt et al. 2016). This study began in 2002 and models environmental, demographic, and other data for a 4,600 km^2 portion of Southwest Colorado (Schwindt et al. 2016; an additional section in the northern Rio Grande area of New Mexico was not used as it is outside the boundaries of this thesis). Access to this database was granted by the project directors through a personal inquiry. The VEP region of study encompasses the boundaries of Mesa Verde National Park, which places additional restrictions on the use of data from the park. Access to these data required an application for a research permit. Once this was obtained I was granted access to the full dataset needed for my analysis. The second major database I used in this study was created as part of the recent Chaco Social Networks Project (Peeples, Mills, Clark, Bellorado, et al. 2016; Peeples, Mills, Clark, Aragon, et al. 2016). This database requires an application and an explicit boundary for the desired data. Both datasets contain a range of data besides ceramic tallies, including estimated room counts and other architectural data.

Ceramic Data

After removing any evident duplicates from my various sources of data, my database contained 8,989 ceramic assemblages (due to the presence of multiple, separate assemblages for many sites, I often refer to assemblages rather than sites). This number was further reduced to 7,220 assemblages by removing assemblages with fewer than 10 sherds. A number of site reports provide ceramic counts by provenience, and these were kept separate where possible. The largest portion of my reduced database, 6,087 assemblages, came from the VEP and 295 assemblages came from the CSNP. Data for the remaining 838 assemblages were collected from project reports, tallies reported from site visits, site forms, and other publications where ceramic tallies were available. Only full tallies were used, as some reported data contain only estimates or a mix of tallies and estimates. Data collected on site forms filled out during surveys is often inaccurate (e.g., Potter et al. 2012:60), and represent enough uncertainty that these forms were not searched for ceramic data if not already included in an existing database.

Much of the ceramic data available included the use of common, formal ceramic types that are easily comparable from site to site. Caution should be noted that differences do exist between ceramic analysts, and ceramic identifications will vary somewhat between analysts. Most ceramic types with the most ambiguities between types cover a chronologically similar period, which tends to reduce the chronological errors that may result from disparities in analysis. The VEP ceramic data contained 36 different formal and informal ceramic types. It appears that ceramic types that did not fit these categories were placed into an "unknown" category. The CSNP contains 821 formal and informal ceramic types, which covers a far greater range both spatially and temporally than present in my study. Ceramic types (both formal and informal) often have variations in spelling, etc., and were relabeled for consistency. The ceramic types from the CSNP were generally used. The greatest disparity between reported ceramic types is a result of a near complete revision of the Mesa Verde ceramic typology by Donald Forsyth (1977) for work conducted by Brigham Young University in the Montezuma Canyon area of southeast Utah. Forsyth listed the corresponding type from the traditional typology for each type he defined. For comparative purposes, the corresponding traditional type was used in this study, rather than the type defined by Forsyth.

The greatest difficulty in combining ceramic data involves the use of informal types. Many sherds are ambiguous in that they cannot be assigned to a formal ceramic type with reasonable certainty, usually due to the small size of the sherd or to the location on the vessel body where the sherd came from. Some ceramic types require the neck or rim of the vessel in order to properly identify it. Ceramic types that rely on painted design styles require enough of the design to properly identify it. These informal types often carry some form of chronological designation (e.g., Pueblo I White Ware or Early White Ware), but the specificity is variable and many informal types cannot be easily correlated. A new category was added in situations where the ceramic types could not be clearly matched to an already identified ceramic type. The number of ceramic types in the database grew to 360 ceramic types, as a result of the relatively large size of this study area covering multiple regions with different ceramic traditions. The large number of ceramic types (many informal) results in large ceramic tables and significantly slowed computation. For this reason, 126 ceramic types with fewer than 20 sherds in the complete database were eliminated and the counts were moved to an unidentified category. The ceramic types used along with the date range of production (if used in ceramic dating) are included in Appendix A.

Location Data

Site location data was included in the VEP and CSNP databases (the protection of this sensitive information is one of the reasons for an application process) and in some other sources of data not available to the public. Many of the sites containing ceramic data used in this study did not have published location data. The site coordinates were acquired in one of two ways.

First, I completed applications to the state databases maintained by the respective State Historic Preservation Officers for Utah, Colorado, and New Mexico. Each state offers fee waivers for academic research purposes. Once access was acquired, the site numbers were used to obtain the geographic coordinates of the site. Location data consisting only of Public Lands Survey System township and range were converted to the center point of the section or quarter-section given. The second method of acquiring site location data mostly involves sites reported in the Chaco Gasification Project (Reher 1977). Official state site numbers were not given for the 128 sites with reported ceramic tallies, which prevented me from using the New Mexico site database. In order to obtain location data, a map of the project boundary was georeferenced and maps containing site locations was aligned with the georeferenced project map. Site locations were then digitized. It is not possible to assess the accuracy of this location data, but it is more than sufficient for a regional study. All location data was converted to the North American Datum of 1983, if necessary, and stored as Universal Transverse Mercator coordinates with the appropriate zone.

DATE ESTIMATION

Determining chronology proved to be the most challenging aspect of this study, in addition to likely being the greatest source of inaccuracy. Establishing the chronology of a site always involves attempting to account for numerous factors and biases that can distort the true chronology of a site. It is almost always a simplification to assign a single year to a site as "the date" it was occupied, but in many cases it can be a useful simplification. The availability of absolute dates from tree-ring, radiocarbon, and archaeomagnetic dating greatly aids the interpretation of site chronology, but there are many other factors to account for when dating a site including occupation length, demographic history, and stratigraphy. As is demonstrated in Chapter 5, even the availability of absolute dates does not necessarily mean the entire ceramic assemblage was deposited near that date. Many sites lack the data to thoroughly analyze the site using all of the above criteria, and it is not feasible or within the scope of this project. Also, the number of sites provides a challenge in that each site cannot be considered separately. To briefly characterize the magnitude of the task to individually consider the sites, and estimating that it would only take 10 minutes to review all of this information per site, it would take more than half a year working 8 hours a day to complete this task for all sites in my database. A single method for each site was devised for practical purposes.

There are two primary questions to consider when determining the associated chronology of the ceramic assemblages in my database: (1) what portion of the ceramic assemblage from each sites was deposited within the time period of my study, and (2) what year was each sherd deposited? Definitive answers to these questions are impossible, but it is possible to provide reasonable estimates using the same criteria for each site. I used two methods to answer these questions: mean ceramic dating and the proportional assignment of ceramic assemblages.

Mean ceramic dating (MCD) was first used by (South 1972, 1977) for historical ceramic assemblages. The technique is simple; the weighted mean is calculated for each ceramic type by multiplying the number of sherds by the median date in the ceramic type's production range and then dividing the product by the total number of sherds in the assemblage. The result is a single date representing the mean date for the ceramic assemblage. Generally, it is assumed that the popularity of a ware starts and ends low with the greatest popularity occurring in the center of the range when the ceramic was produced. This type of distribution forms the well-known "battleship curve" often used in seriation. The date derived from MCD does not reflect the length of time a site was occupied, but does provide an estimate of the date in the middle of the occupation

Several sources of error can affect the accuracy of MCD. One of the most significant sources of error is that sites dating near the beginning or end of ceramic sequences cannot be accurately dated. A case study of MCD in the Kayenta region, which is adjacent to my study area, found that sites could not be dated earlier than AD 750 or later than 1300 (Christenson 1994:308). Other major sources of error are the accuracy of the analysis, the accuracy of the date ranges used, the actual popularity distribution of the ceramic type, and multicomponent sites. Surprisingly, sample size appears to have limited impact on the results (Carlson 1983:9; Christenson 1994:309). It is plausible that some situations will be significantly affected by sample size (likely only for multicomponent sites). Of these sources of error, multicomponent sites are of the greatest concern and my method to account for this is discussed following my discussion of MCD. Though MCD was originally developed for historical archaeology, it was quickly adopted for use in the Southwest (see Christenson 1994:298–299 for examples). Andrew Christenson (1994) compared sites dated using MCD and tree-rings in the Kayenta region and found MCD correlated well with the tree-ring data, and this method has been used within my area of study (e.g., Allison 2004). Despite its limitations, MCD is a useful heuristic for understanding chronology using only the number and types of ceramics present at a site.

Often multicomponent sites are excluded when attempting ceramic dating or seriation to avoid the major complications inherent in using mixed assemblages (e.g., Steponaitis and Kintigh 1993:360). The potential for multicomponent sites in my database was too great to use MCD without specifically accounting for them. Chapter 5 further discusses the effects of using MCD without adjustments and demonstrates that I would lose too much data to consider throwing out these sites. Some methods exist for untangling ceramic assemblages into specific components (e.g., Kohler and Blinman 1987), but the method I used was inspired by John Roberts and colleagues (2012) and also discussed by Ortman (2016).

Roberts and colleagues (2012) developed their method as part of the Southwest Social Networks Project (Mills, Clark, et al. 2013; Mills, Roberts, et al. 2013; Mills et al. 2015) in order to apportion ceramic assemblages into specific intervals while accounting for multicomponent sites and/or long occupation spans. This method relies upon a distribution curve representing the popularity of a ceramic type and the occupation span of the site. The distribution curve represents the probability that a sherd of a given type was present in a given year along the time span that the ceramic type was in use. This means that if a standard normal curve is used, then a sherd has a greater probability of belonging to the central portion of the curve (the mean date) than to dates on either end of the curve. The ceramic assemblage is apportioned by overlapping the site occupation span with the ceramic popularity curve and using the corresponding probabilities to determine which percentage of the ceramic types present at a site belong to which period. Roberts and colleagues (2012:1514–1516) list two ways this method can be adjusted: choosing a different distribution curve and adjusting for demographic history. I do not consider the effects of demographic change in this study due to lack of data, but the choice of the distribution curve is a significant one, as the probability that a sherd was deposited in a given year is directly related to the chosen distribution curve. Various distribution curves are available, including a uniform distribution where every year is assigned the same probability. Carlson (1983) discusses the effects of a uniform distribution, and Ortman (2016) uses this curve for what he calls "uniform probability density analysis." The most appropriate starting point for this method without prior knowledge of the true distribution curve is the standard normal distribution (Roberts et al. 2012:1515). An important note about this curve is that the tails on either end of the curve extend to infinity. In this work, I follow the solution recommended by Carlson (1983) and used by Roberts and colleagues (2012:1515) by truncating the curve at two standard deviations from the mean. This required slightly scaling the probabilities to keep the total sum at one. The use of distribution curves as used by Roberts and colleagues bears similarities to the techniques used by Steponaitis and Kintigh (1993) and Ortman (2016) and discussed by Christenson (1994) for dealing with multicomponent sites. An attempt was made in this study to find a better estimation of the popularity curves for each ware, but I found I lacked sufficient control sites with well-dated ceramic assemblages in much of my study region, and the use of the standard normal curve represents the best approximation when more informed data is absent.

Some differences exist in how I apply the method discussed by Roberts and colleagues (2012), although Ortman (2016:121) discusses using this method to handle multicomponent sites as I have done in this study. I do not have prior knowledge regarding the occupation spans of the sites in my database, and I do not intend to divide the assemblage of a site into multiple periods, rather, my purpose is to determine which portion of a mixed ceramic assemblage does not belong to my total period of study. Thus, I assigned a probability to each year within the range a ceramic type was produced using probabilities from the truncated normal curve. I then multiplied the total number of sherds in each ceramic type by the probability for each year in its ceramic range. After this step, I removed the ceramics that fell outside of my study range resulting in a reduced ceramic assemblage, but one that has a greater probability of being deposited during my period of interest. This does result in non-integer values. After removing portions of each assemblage, the mean ceramic date was calculated from the remaining data. Some dates fell earlier or later than my study period due to the number of sherds that remained with production periods partially falling outside of my study period. This is an indication that the sites lack a strong component representing my period of interest and were excluded. My data could be refined if the occupation span of each site was known, and some attempts have been made to estimate occupation length using variations of MCD (Carlson 1983; Christenson 1994; Steponaitis and Kintigh 1993); however, choosing empirically appropriate parameters to estimate the site occupation span would require accurate calibration data that are not available for portions of the study area. Figure 4.1 shows a distribution curve representing a likely single component site that is unproblematic for MCD, and a likely multicomponent site where the later component would bias the date obtained using MCD.

Early sites in southeast Utah proved problematic after the initial dating run due to the

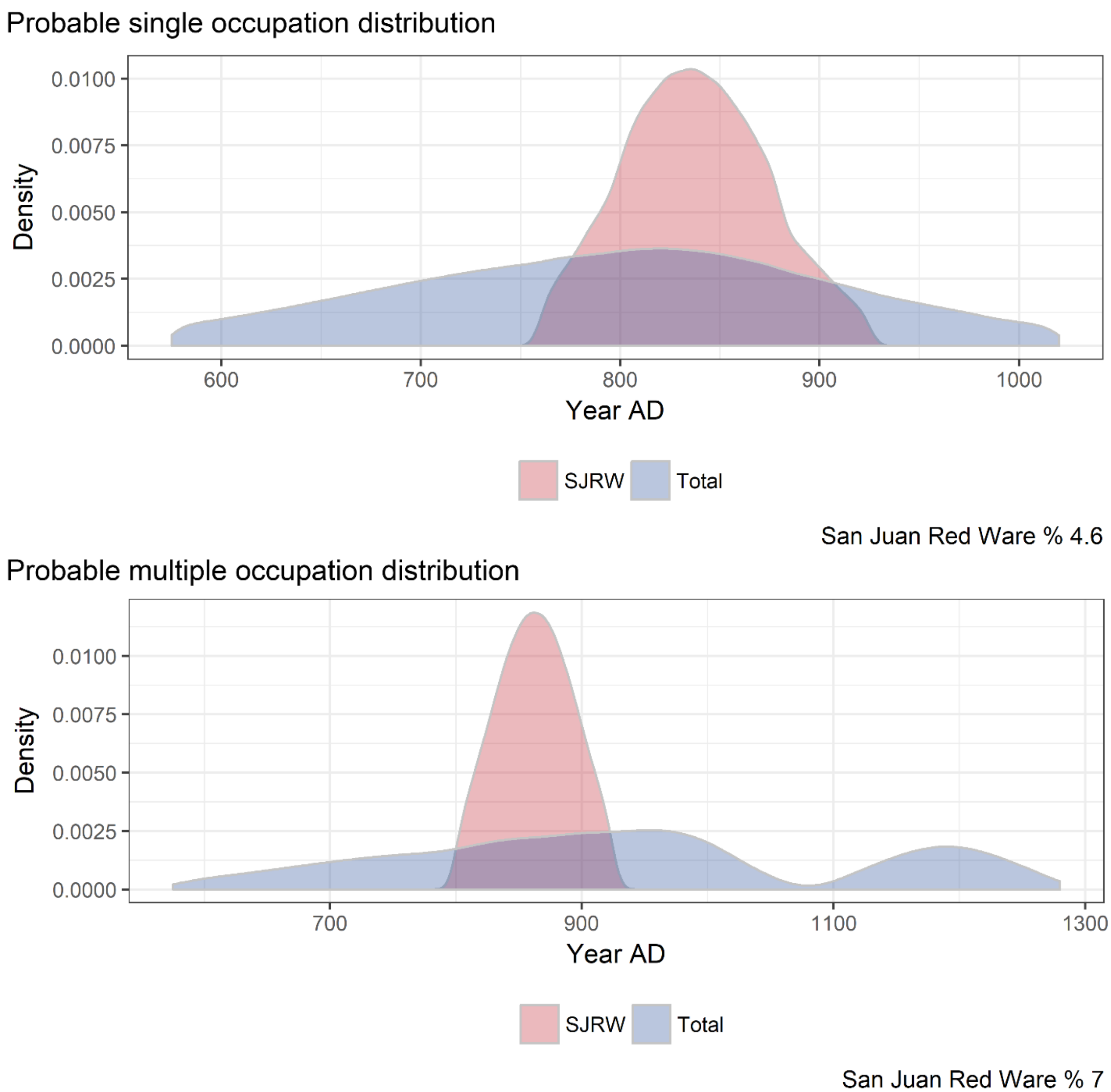


Figure 4.1. Density distribution showing the probability that each sherd was deposited in the corresponding year for all ceramics and for San Juan Red Ware (SJRW).

problems discussed earlier when using MCD on sites that date near the beginning or end of a ceramic sequence. Only two sites dated to the AD 750-800 period in the initial run, while several known sites that date to this period were dated to the 800-850 period. For example, Site 13 (42SA13) dates to the late AD 700s, but was dated initially to 821. The problem in these cases was the high proportion of Abajo Red-on-orange and infrequency of other dateable ceramic types. The median date for this type is AD 820, but it appears to have a right-tailed distribution that places the greatest popularity in the late 700s (James Allison, personal communication 2018). A date of AD 790 was used and the MCD was recalculated. This resulted in a date of AD 791 for Site 13, which matches well enough with reported dates (James Allison, personal communication 2018). Eleven sites date to Southeast Utah during the AD 750-800 period after the adjustment, and this better matches expected results (see Allison et al. 2012).

I considered the possibility of using the ceramic assemblages as divided into the various years within the production range of the ceramic type, but the results would only show the rises and falls in the popularity of a ware as modeled by the standard normal curve. The strength of MCD is to use multiple criteria for estimating the mean site date, and I believe the distribution of ceramics is more accurately reflected by using MCD to obtain one date for each site. There is still the possibility of multiple occupations creating a mean date that is somewhere between the occupations, and the occupation length of some sites may be very long; however, the majority of multicomponent sites that can be separated using ceramic types appear to have the later occupation sometime after AD 1000, which places these assemblages outside of the period of my study and reduces the potential for error. For clarity, I term the method I used of removing portions of the assemblage not likely to date to my period of interest and then obtaining the mean ceramic date as adjusted MCD, and the typical method as described by South (1972, 1977) standard MCD. Figure 4.2 shows the distribution of sites by period following this method. The following chapter discusses specific sites and how the methods I have discussed compare to published site dates.

BAYESIAN EMPIRICAL ESTIMATION

After removing assemblages that did not fall between AD 750-1000, I was left with 3,367 assemblages. The next step in this analysis was to account for sample sizes. Small samples may

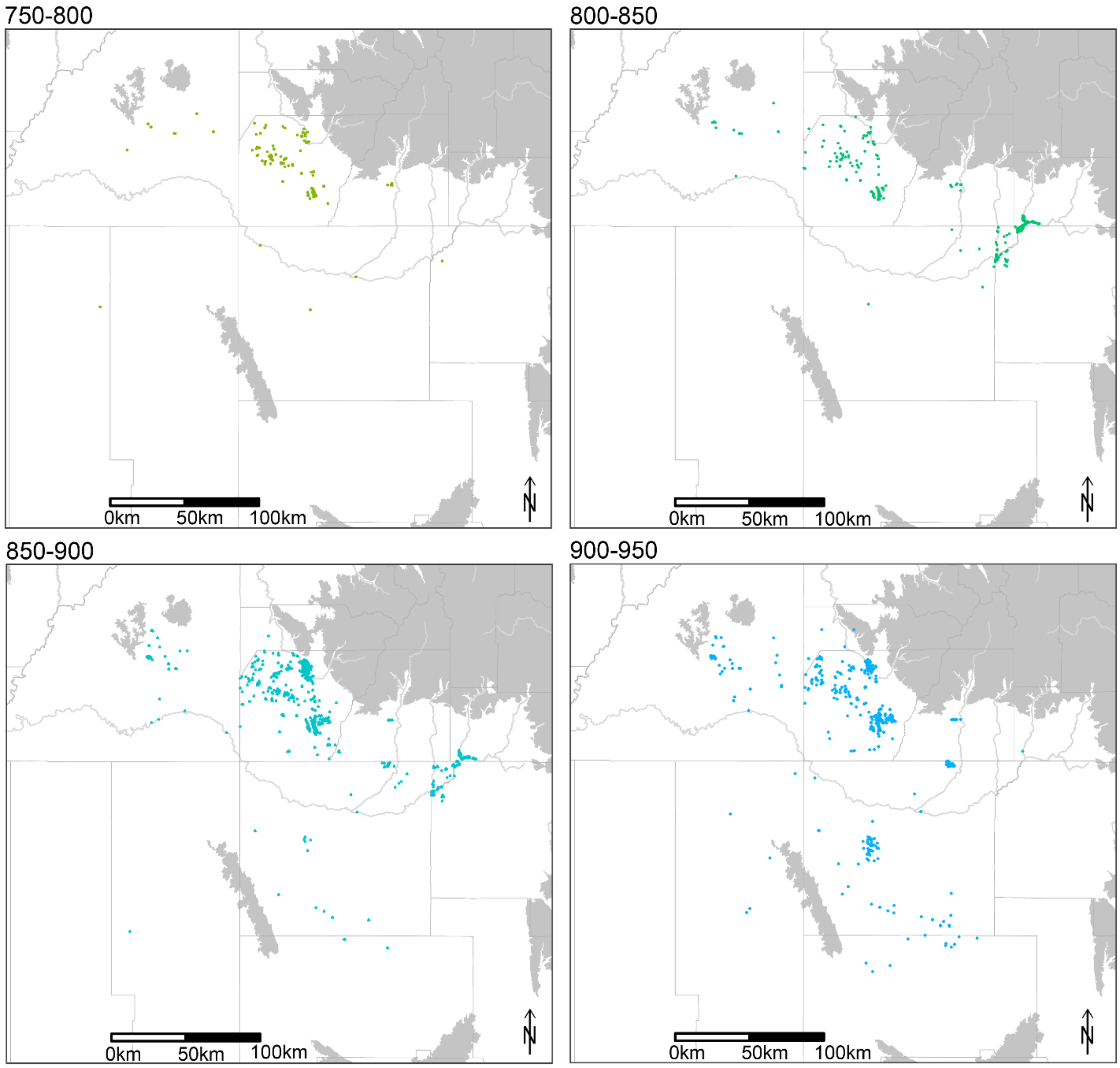


Figure 4.2. Site locations by period.

have proportions that vary significantly from actual population values, and I exacerbated this problem by removing portions of the ceramic assemblage in the previous step. After adjusting the assemblages, the mean ceramic assemblage size for my remaining assemblages is 252.5, while the median is only 22.1 sherds. Abnormal results caused by small sample sizes would negatively affect many of the methods I used. One option is to throw out problematic assemblages; however, Bayesian empirical estimation has provided excellent results in reducing the error inherent in

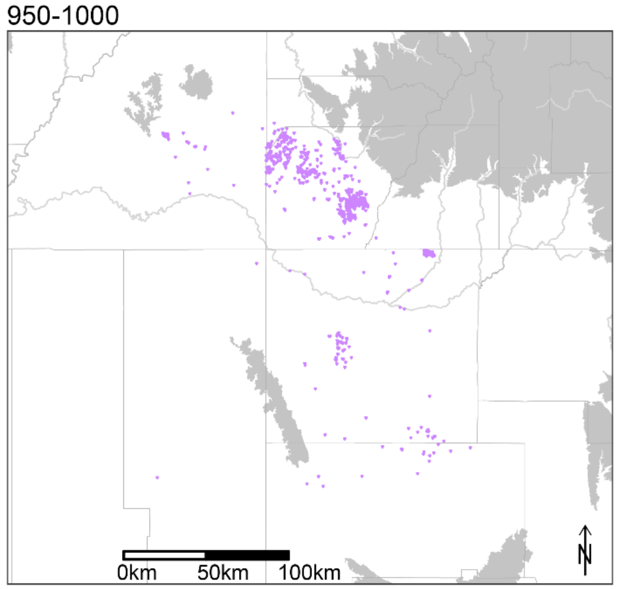


Figure 4.2 continued.

small assemblages.

Bayes Theorem combines prior knowledge with observed data to create what is called a posterior probability (see Iversen 1984). Often archaeologists have additional data that is relevant to the data in question. Bayes Theorem allows this additional data to influence the results thereby decreasing the random effects of small samples. In this thesis, I have a number of sites existing in relative proximity to each other. Following Tobler's principle (see Chapter 1) that things in close proximity are more related than distant things, it is most likely that if San Juan Red Ware is abundant at one site, then it is likely abundant at a site nearby. The prior knowledge that a ceramic type is usually found in a certain percentage in a region can be combined with the known assemblage from a site to create a more reasonable and justifiable ceramic proportion. The effects of the prior probability on the observed data decreases the larger the assemblage is, thus a site with a few thousand sherds will be relatively unaffected by a significantly different prior probability. Bayes Theorem has been applied to archaeology in a number of ways, including estimating ceramic proportions (e.g., Ortman et al. 2007; Robertson 1999). Bayesian

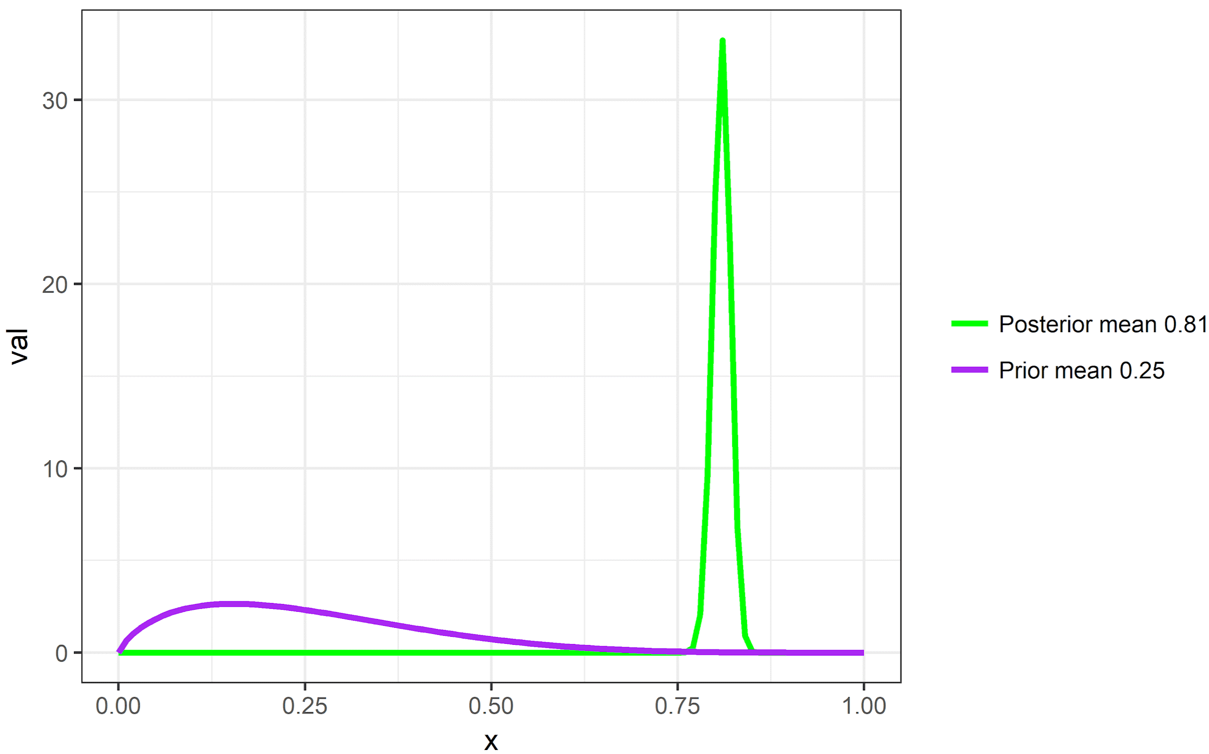


Figure 4.3. Beta distribution showing the prior and posterior estimates of the San Juan Red Ware proportion for an example assemblage where the posterior estimate is higher than the prior estimate.

empirical estimation relies on the beta distribution to produce a beta density function that describes the shape of the data using the mean and standard deviation (Robertson 1999:140–141). Examples of this density function are shown in Figures 4.3 and 4.4, which compare the prior and posterior beta curves for assemblages with high and low proportions of San Juan Red Ware.

The most important consideration in using this method is to estimate a reasonable prior probability. Two parameters are required: the prior mean and the prior standard deviation. These are calculated by taking the mean and standard deviation of the mean for each site used in generating the prior probability. The two factors considered for estimating this parameter were spatial and temporal relationships. Robertson (1999) used one prior probability distribution for all assemblages for the site of Teotihuacan, but Ortman and colleagues (2007) used varying prior

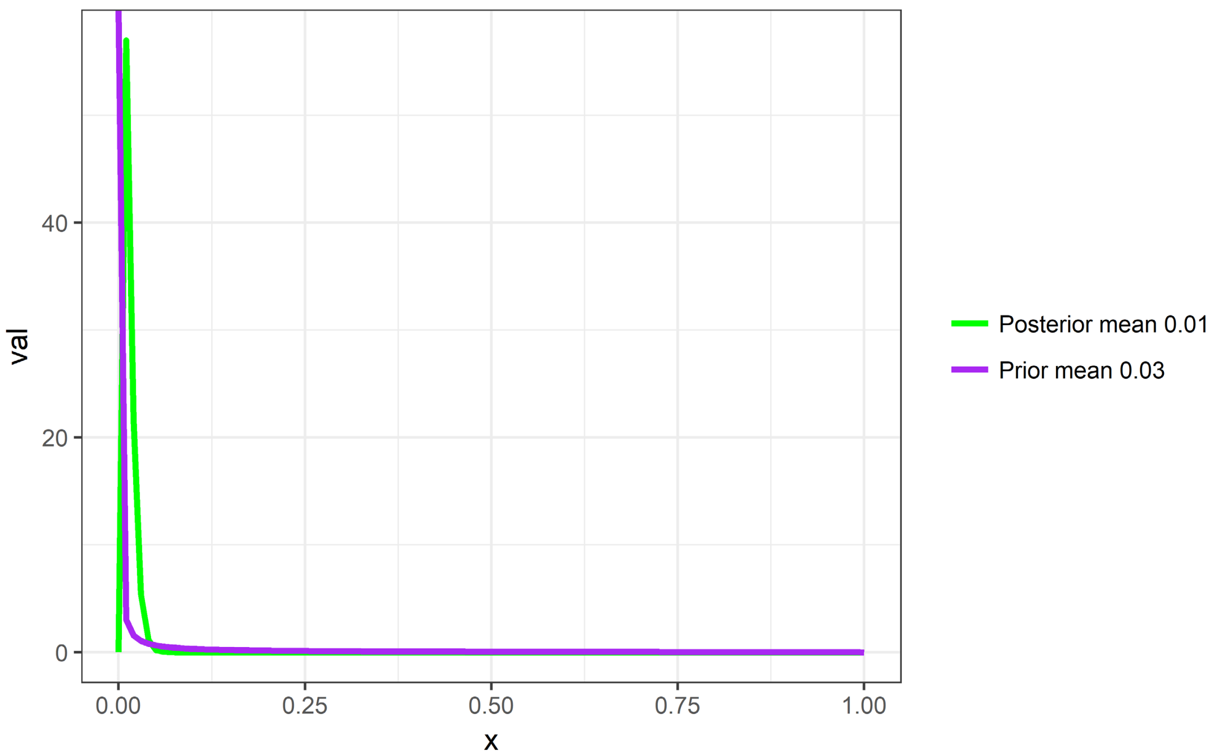


Figure 4.4. Beta distribution showing the prior and posterior estimates of the San Juan Red Ware proportion for an example assemblage where the posterior estimate is similar to the prior estimate.

distributions to account for both spatial and temporal relationships. The proportion of San Juan Red Ware varies significantly across the study area both in space and time, and the use of one prior probability for all assemblages would be inappropriate. Initially, the intent was to use a method of interpolating values from known points called inverse distance weighting to estimate the proportion of red ware for each area within the study area using large ceramic samples (100 or more sherds); however, for essentially all areas outside the Central Mesa Verde region there are too few sites to reliably interpolate values for the surrounding areas. An alternate method is to divide the project area into smaller regions and use a single prior probability for each site dating to the same period within the region. Due to the low numbers of large assemblages in many areas, I used this method for this thesis.

The regions are based on those described by Wilshusen and colleagues (ed. 2012:Figure

1.1). These regions have both overlap and gaps between them. In order to definitively assign a site to a single region, some modification of the region boundaries was necessary. Figure 4.5 is a topologically correct version of the regions made by expanding or contracting each boundary to cover all areas and avoid overlap. Figure 4.6 shows the number of assemblages larger than 100 sherds for each region and period. While this solves the problem of having too few sites, some regions had too few or no assemblages with more than 100 sherds and were treated separately. No period in the Little Colorado region and two periods in the Greater Chaco region had no more than two assemblages with more than 100 sherds. The assemblages used for the priors in these cases were determined by calculating the distance from the center of each region to all sites and then selecting the 20 closest assemblages.

After calculating the prior mean separately for each period and region, Bayesian empirical estimation was used to generate a posterior estimate of San Juan Red Ware for each site. Sites with fewer than ten sherds were removed from consideration in a prior step; however, the adjusted MCD involved apportioning the assemblages between periods which further reduced some assemblages. Of the 3,367 assemblages dating to the period of my study, 933 assemblages had fewer than ten sherds after removing sherds likely to date to other periods (see Figure 5.6 and discussion in Chapter 5 for the effects of samples with fewer than ten sherds). Figure 4.7 shows a comparison between the posterior estimate of the proportion of San Juan Red Ware for each site and the observed proportion for each site.

Proportions of San Juan Red Ware were calculated in two ways: the total ceramic proportion and the proportion of decorated ceramics. The proportion of decorated ceramics is a meaningful way to compare the proportion of San Juan Red Ware across assemblages, particularly because most San Juan Red Ware vessels were bowls, which were most often decorated regardless of the ware. Decorated ceramic proportions were used in the Southwest Social Networks Project (Mills, Clark, et al. 2013), which worked well in the study, but their study covered a much larger

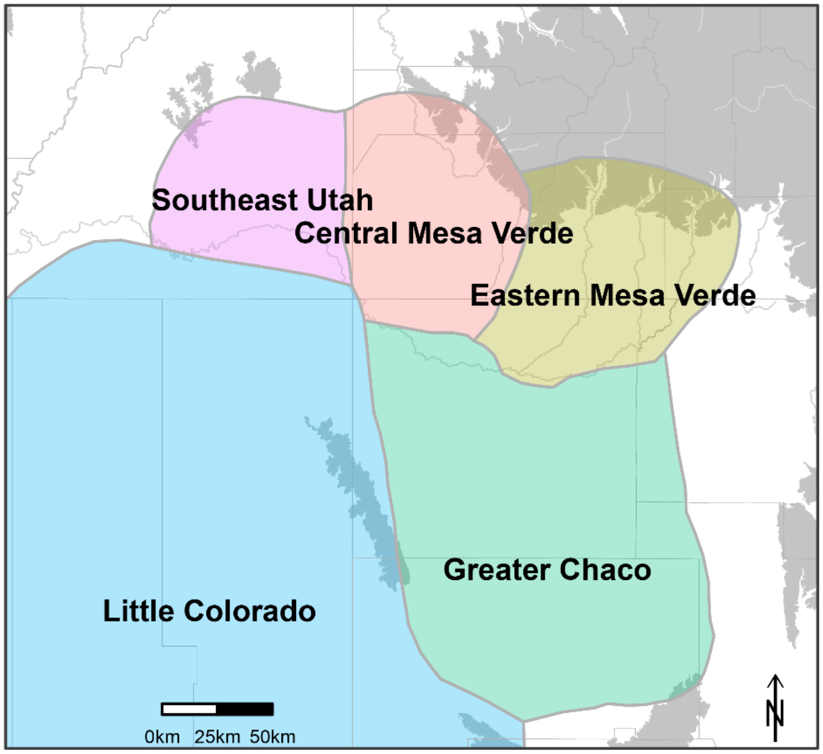


Figure 4.5. Adjusted, topologically correct regions from Wilshusen et al. (ed. 2012:Figure 1.1).

area. Unfortunately, most assemblages in my data have fewer than 10 decorated ceramics. Of the 3,061 assemblages that remained after dating the assemblages and removing assemblages with fewer than 10 total sherds, only 880 assemblages had 10 or more decorated ceramics. The size of the region covered in this study necessitates as many data points as can reasonably be included for proper interpolation. Using the decorated percentage of San Juan Red Ware likely does not add enough value to warrant excluding so many assemblages; however, I have also conducted the same analyses using decorated ceramics. Typically, the results are similar, other than the effects of using fewer assemblages.

ANALYTICAL METHODS

This study is principally concerned with identifying interaction through the medium of San

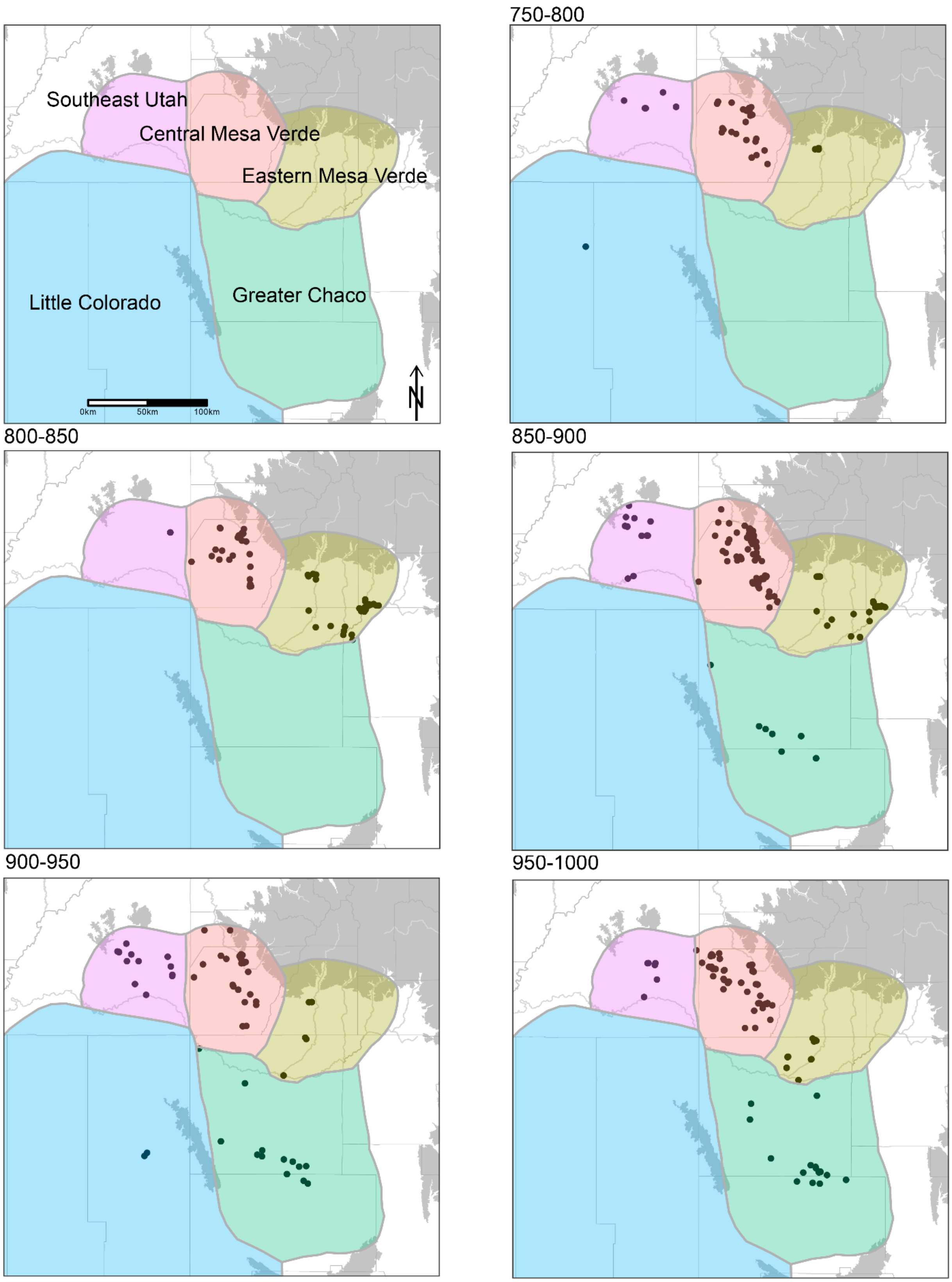


Figure 4.6. Assemblages with more than 100 ceramics by period.

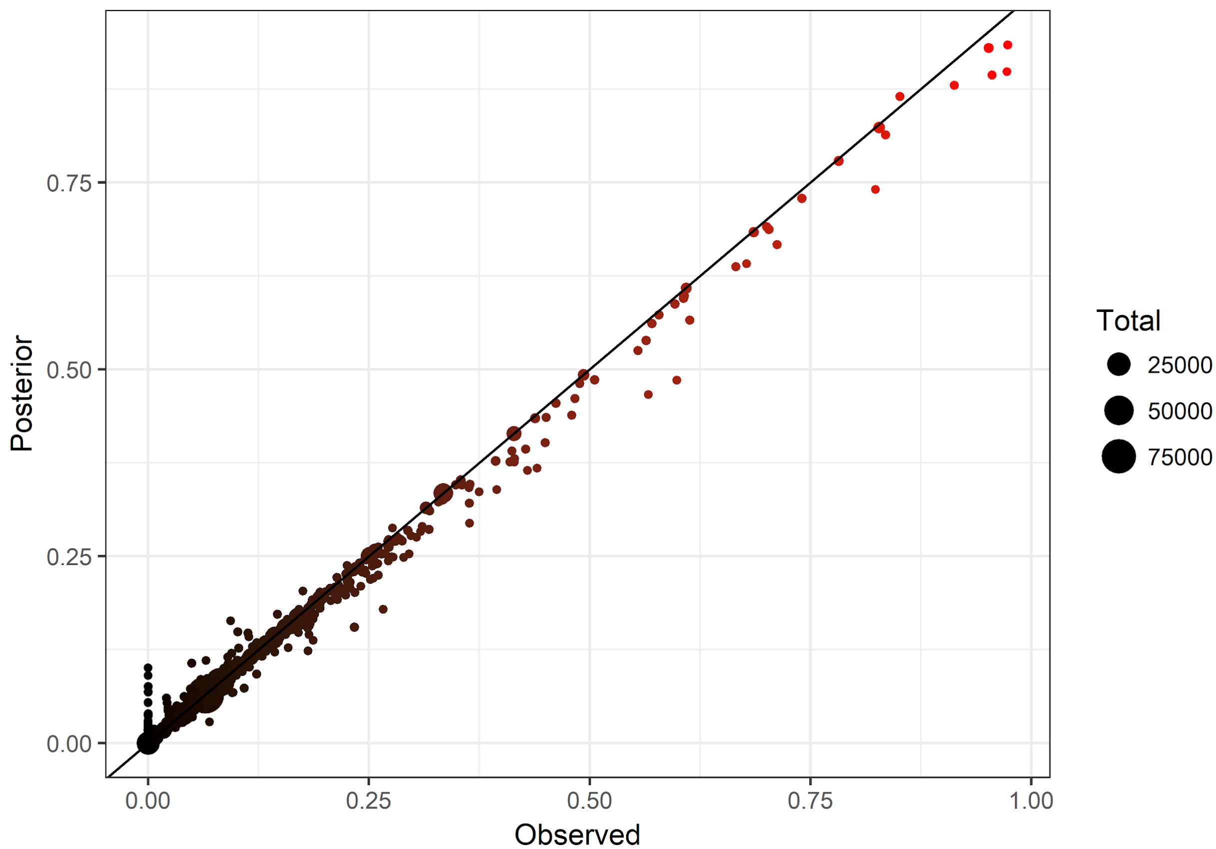


Figure 4.7. Posterior San Juan Red Ware estimates vs the observed San Juan Red Ware for each assemblage with more than 10 total ceramics (red points indicate higher proportions of San Juan Red Ware).

Juan Red Ware exchange. As discussed in Chapter 1, interaction is measured in space, which can be measured in different ways. The majority of methods I used to study interaction are concerned with geographic space. The exceptions are social network analysis, which attempts to measure social distance, and while one axis of the distance diagrams measures geographic space, the other axis is an attempt to measure material cultural distance, although only ceramics are used. A variety of methods were chosen to identify patterns and trends evident across multiple methods to reduce the chance of erroneous interpretations and to evaluate the utility of each method.

Distribution Maps

Distribution maps are commonly used in archaeology to study trade, diffusion, and cultural connections (Hodder and Orton 1976:1). Often analyzing the density or frequency of artifacts is the objective. Density can be calculated in multiple ways; the most frequently used are total counts, the artifact proportion, or the ratio of the artifact to some other variable. Inverse distance weighting (IDW) is a form of interpolation that can be used to interpolate known values throughout an area. The power in IDW determines the influence or weight that points have on nearby areas. The strength of influence declines inversely to distance raised to the power parameter. Higher powers will increase the influence of near points and create a more detailed distribution, while lower powers will increase the influence of more distance points and create a smoother distribution. Areas with few or no points can be problematic for IDW, but artificial zero points can correct this problem (e.g., Janetski et al. 2011:34).

In this study, I created a buffer around existing points of 18 km, which roughly represents the distance that can be traveled to and back in a day (Varien 1999:153–155). Five thousand zero points were created and spaced with equal distances throughout an area somewhat larger than the study area. All points that fell outside of the 18 km buffer zone for existing assemblages were retained with a San Juan Red Ware proportion of zero. The result of an IDW analysis is a raster layer where each cell contains an interpolated value (in this case the proportion of San Juan Red Ware). A power of three was used in this study. Other powers were experimented with, but three appears to represent the best compromise between points not completely dominating their local area, but also showing “hot” spots where San Juan Red Ware values are much higher than average. Separate IDW rasters were created for each period within my study. Contour lines were overlaid on the raster to better represent changes in values.

Originally, IDW was the only distribution map planned for this study, but the scale of this study and the large variation between assemblages (demonstrated in Chapter 6), makes interpretation difficult in many areas. For example, a small area may have several assemblages with high and low proportions of San Juan Red Ware. In this situation the interpolated values for the area may show little or no San Juan Red Ware and hide the assemblages containing high proportions of this ware. This reduces the effectiveness of interpolated values. For these reasons, I also used another form of distribution mapping, which does not rely on interpolation. The distribution I used is a variation of "hexagon binning." It is related to histograms, as values are tallied inside bins. Hexagons are an ideal shape for three-dimensional bins, as circles cannot cover an area without overlapping, and the diagonal neighboring center points of squares are not equidistant to other neighboring squares, as they are with hexagons. Rather than using an average of the San Juan Red Ware proportions within the hexagon I used a weighted average. The weighted average was used as large assemblages should count more than small assemblages. Several sizes of hexagons were experimented with and a hexagon length of 9 km was chosen with a total area of 81 km^2. This size covers a relatively large area, in some cases a few hundred assemblages, but is not large enough to eliminate all variation and is consistent with other distances used in this study.

The use of hexagon bins also allows easy visualization of hexagons with weighted means significantly above or below the region mean used as the prior in Bayesian empirical estimation. A 99.9% confidence interval was calculated for each region and period using the binomial distribution, and each hexagon was plotted as either within the confidence level, above, or below. A high confidence interval was chosen to emphasize the large variability in San Juan Red Ware proportions found across the region. This provides a mean of statistically evaluating the possibility of achieving this distribution using randomly distributed values.

Distance Diagrams

Distance diagrams are a simple and effective method for studying interaction (Nakoinz and Knitter 2016:198–203), and are similar to fall-off curves. The main difference for this study is that values from each assemblage are plotted for fall-off curves, whereas the interpolated data and arbitrarily spaced points are used for distance diagrams. The diagram involves plotting a measurement of distance against a measurement of interaction. I used distance diagrams to further explore the results of IDW and compare these values to the Typenspektren (see below for more detail). Sample points along a straight line are used to extract the values from the rasters, and these values are plotted against the Euclidean distance from a certain point. Distance diagrams can be made in several ways, but in this study they represent a cross-section of an area. Because all points along the line are only compared to the starting point, areas that are different from the starting point may not be similar to each other.

This method is an attempt to measure variation in material culture using Typenspektren. Culture in general is a problematic term for archaeologists and has a complicated history, particularly as it relates to defining culture in geographic space (see Nakoinz 2014; Cormier et al. 2017); however, it is still a useful term for examining interaction if explicitly defined. Nakoinz (2014) uses a modified definition of culture originally supplied by Klaus Hansen (2003:39), which essentially states that culture is comprised of standardizations held in common by groups of individuals and created through spheres of interaction. Borders may be "fuzzy," meaning that boundaries between cultures are not always sharply defined and individuals may participate in more than one "culture" (Nakoinz 2014:187–188). The emphasis on interaction in this definition is key to spatially defining cultures and cultural distance. One must be careful when using this method to not take the archaeological concept of culture too far. This method distinguishes zones of interaction with similar material culture and does not necessarily correlated to linguistic or social boundaries. One of the main purposes of this technique is to attempt to identify whether clear boundaries exist, and, for this study, only ceramics were used to define these boundaries. Using more artifacts would be better, but the data are not available in this study.

The term "Typenspektren," or spectrum of types, is a comparative tool for analyzing cultural distance (Nakoinz 2014:193). This concept is "based on systems theory that assumes interaction between material culture, culture and ethnic units" (Nakoinz 2014:188). Typenspektren uses kernel density estimation to interpolate the density of each material type for each point in a grid across the region of study. The combined density estimates can then be compared with other points using a Euclidean distance formula. One of the principal analytical decisions is to determine the bandwidth used. This controls the kernel density smoothing. Several values were experimented with. Values lower than about 6 km caused sharp differences between areas, and values much above about 11 km resulted in too much smoothing of the data. Results were fairly similar within that range, and I chose a value of 9 km to be consistent with other distance values I have chosen. While Typenspektren was developed to consider a wide range of artifacts, I used only the different ceramic types. The point of using this method is to determine how areas with high proportions of San Juan Red Ware correlate with variation in ceramic types in general. The area of my study incorporates multiple regions with separate ceramic sequences. While there are valid archaeological reasons for separating the wares, some of the ceramics are at least visually similar to ceramics in other regions that are given a different name (usually for plain ceramics), which may sharpen the differences between regions artificially. Informal ceramic types were removed for this analysis to minimize differences. The result of the Typenspektren analysis is a series of densities for each ceramic type used associated with 3,000 points overlaid in a grid over the study area. The results can be visualized in several ways; one method, which I used, was to create a geographic cross-section by picking a starting point and calculating the difference between the starting point and each point along the line. The result of this cross-section is called a distance diagram.

Fall-off Curves

Fall-off curves (also known as exponential models) have long been a useful method for archaeologists studying interaction (Hodder 1974; Renfrew 1975, 1977). In its simplest form this method plots the frequency of an object (either total count or relative proportion) against the distance of the object from its source. Typically, the frequency of objects declines with distance from the source. Colin Renfrew (1977:72) calls this "the law of monotonic decrement," which states:

> In circumstances of uniform loss or deposition, and in the absence of highly organized directional (i.e., preferential, nonhomogeneous) exchange, the curve of frequency or abundance of occurrence of an exchanged commodity against effective distance from a localised source will be a monotonic decreasing one.

The decline in the frequency of an object over distance is related to the cost of moving the object among other variables. It follows from Renfrew's law that if fall-off curves deviate from the expected curve, then there is some other factor affecting the distribution of the object. Distances can be also be calculated using least cost path (LCP) analysis, which can include many variables to generate a more likely travel path than a straight line; however, a study found little difference in correlation between fall-off curves with distance measured using LCP or Euclidean distance (Bischoff 2017). Fall-off curves are easiest when a single known point comprises the production zone. In the case of San Juan Red Ware, multiple sites were involved in production, and there is the possibility that San Juan Red Ware was produced outside the considered production zone. The solution, in this case, is to choose a middle point between the area with the highest density of San Juan Red Ware and use this as the point from which all other data is plotted. This is a typical procedure for this type of study, but one must be careful not to interpret the distance in this fall-off curve as measuring to the edge of the production zone. Sites closest to zero and for roughly 30 km are likely still in the production area.

Social Network Analysis

A recent trend in archaeology is social network analysis (SNA; Brughmans 2013). Network analysis in archaeology can be traced back to Clarke (1972, 1977) but did not widely catch on (Knappett 2013:4). A network is defined as a system of nodes connected via edges. SNA seeks to determine the relationships between nodes and determine the general shape of the network. Although SNA is related to graph theory, it is useful for more than just visualizing relationships. Network statistics can provide information on the network as a whole, but measures can also be obtained for each edge or node. The centrality score is an indication of how connected a node is in the network. There are numerous methods of calculating centrality scores, and each measures connectedness in a different way. Because people and interaction are usually not directly visible in archaeology, material remains are used as a substitute.

Carl Knappett (2013:6) critiques many studies of interaction for only focusing on points and radii for the study of interaction. While GIS is well-suited for studying interaction in space, Knappett (2013:6) argues that network analysis overcomes problems inherent in relying principally on spatial measures:

> Network approaches can avoid many of these problems. They do not bring necessary directionalities. They do not oblige the drawing of boundaries, zones, or territories based on limited information. They can be relational and/or spatial, so they do not succumb necessarily to the criticism of either spatial or social

> determinism. And most importantly, they can cross scales. Anything from a household to the state can be thought of in terms of a network.

SNA allows archaeologists to draw connections irrespective of geographic distance. This may help archaeologists see relationships that are otherwise hidden.

SNA has great potential for studying interaction, but it is not without its caveats. Social networks constructed by archaeologists may be very different from social networks in other disciplines. A sociologist, for example, may be reasonably certain that all of the nodes and edges in a network are present. Archaeologists must be able to estimate how much of the network is missing, how missing nodes may affect the structure of the network, and whether or not the network statistics obtained from the analysis are significantly affected by the missing data. Peeples (2017) provides statistical techniques to assess the robustness of a network. Essentially, these techniques use random resampling to assess the variability of network statistics, and the centrality measure I used in this study has shown to be robust using this test.

The Southwest Social Networks Project (SWSNP) conducted by Mills and colleagues (2013; 2013; 2015) is a well-known archaeological application of SNA. This project uses a database containing site and ceramic data between AD 1200-1450 to examine interaction and investigate how networks based on ceramic exchange changed through time using 50-year intervals. Several methods and concepts used in my study derive from the SWSNP. The centrality scores mentioned earlier may be calculated in a number of ways, but I have chosen to use eigenvector centrality as used in the SWSNP (Mills, Clark, et al. 2013:5786). This measure was chosen above others for its robustness and ability to measure the relationships not only between the immediate connections of a node but also nodes connected throughout the network.

The most important criteria for developing a network archaeologically is determining the criteria to link nodes (each site forms a node). These links are usually called edges in network terms and can be binary or weighted. Binary ties between nodes are defined either as present or absent. Edges can also be weighted using continuous data. Peeples and Roberts (2013) discuss the advantages and disadvantages of using binary or weighted efforts and conclude that weighted networks often are better for analysis, although visualization is easier with binary networks. Mills and colleagues (2013:5786) use binary networks for visualization, using 75% similarity between assemblages as the cutoff, and weighted networks for most analyses. Birch and Hart (2018) found that weighted and binary networks were both useful for different types of analysis and use a cutoff of 57.5% similarity for representing binary connections. Both Mills and colleagues (2013) and Birch and Hart (2018) use the Brainerd-Robinson (Brainerd 1951) index of similarity for comparing assemblages, and this was the method I used in my study. The index returns a number between 0 and 200, but can be scaled to 0 to 1 for easier interpretation.

I used SNA on all formal types found at each site. Mills and colleagues (2013) used wares rather than types, as many sherds are identified only to a ware; however, within my study area the use of specific types is likely to show greater resolution of the level of interaction between sites, despite the greater risk for error. I used weighted networks to calculate eigenvector centrality for each assemblage, which are then be compared to the proportion of San Juan Red Ware for the assemblage in an attempt to determine whether correlation exists and how this changes over time. Some areas have high concentrations of contemporaneous assemblages in a small area. This can result in assemblages showing high centrality overall for the network, but these same assemblages may show few connections to other areas. To control for this effect, I also calculate another eigenvector centrality score for each assemblage after removing all other assemblages within 18 kilometers. This method is computationally intensive but is useful for gauging the importance of San Juan Red Ware to long distance exchange.

5 Method Comparison

Archaeological data are inherently messy, and the combination of archaeological data from numerous sites and projects over a number of years compounds the problem. In order to conduct my analysis on as many sites as possible, I chose not to collect more detailed information about every site, including data from various dating techniques as well as architectural data and other artifact data. This chapter is an examination of the methods I used to date sites and account for sample size and contains a comparison with the more detailed information discussed in site reports. Undoubtedly the methods I used simplify and in some cases distort the phenomena I am trying to represent, but this chapter demonstrates that the methods and approximations used are reasonable and do not invalidate the conclusions made in this study. There are two main questions regarding the validity of the data that I attempt to answer in this chapter: when were the sites occupied, and relatively how much San Juan Red Ware is actually present at a site?

SITE DATING

As discussed in Chapter 4, dating the sites proved to be the most challenging aspect of this thesis. Tree-ring, radiocarbon, or archaeometric dates are available for many sites, and many other sites have relative dating using additional criteria other than the ceramic dating that I used in this study. Even for sites with good dates, multiple occupations can be difficult to untangle, and small early occupations can easily be obscured by later occupations. This section discusses mean ceramic dating in general, within a specific region, and for individual sites.

Table 5.1. Distribution of Assemblages by Period Using Mean Ceramic Dating (MCD) and Adjusted MCD.

	Pre 750	750-800	800-850	850-900	900-950	950-1000	Post 1000
MCD	240	88	168	465	289	314	5340
Adjusted MCD	372	142	288	900	694	1343	2270

Mean Ceramic Dating Comparison

The first comparison I make compares standard mean ceramic dating (MCD) with the adjusted MCD that I used in this study. The difference between these methods is that I removed parts of the assemblage prior to applying MCD as discussed in Chapter 4. This section is a further exploration of the effects of this method compared, where possible, to other reported data. As only ceramic types with well-defined, and usually not overly long, date ranges are used for MCD, some assemblages cannot be dated. The inclusion of all ceramic types likely would not help, as the uncertainty would be too great to make reasonable interpretations based on these data.

The first point regarding the difference between the standard MCD and the adjusted MCD is the number of assemblages that cannot be dated, as ceramics reported for these assemblages did not include the ceramic types I used for MCD. Only 834 of the 7,140 assemblages in the database (9.3%; see Table 5.1 for numbers by period) could not be dated using standard MCD, while 2,149 of the assemblages (24%) could not be dated using the adjusted method. The difference is due to the removal of all sherds that fell outside of the AD 750-1000 range. These missing sherds prevented the site from being dated, and may mean that the assemblage does not represent occupation within this range. The standard MCD range for the 1,315 assemblages that could not be dated using the adjusted MCD is AD 1095-1658.

The second point in my comparison is when assemblages actually correspond with a date.

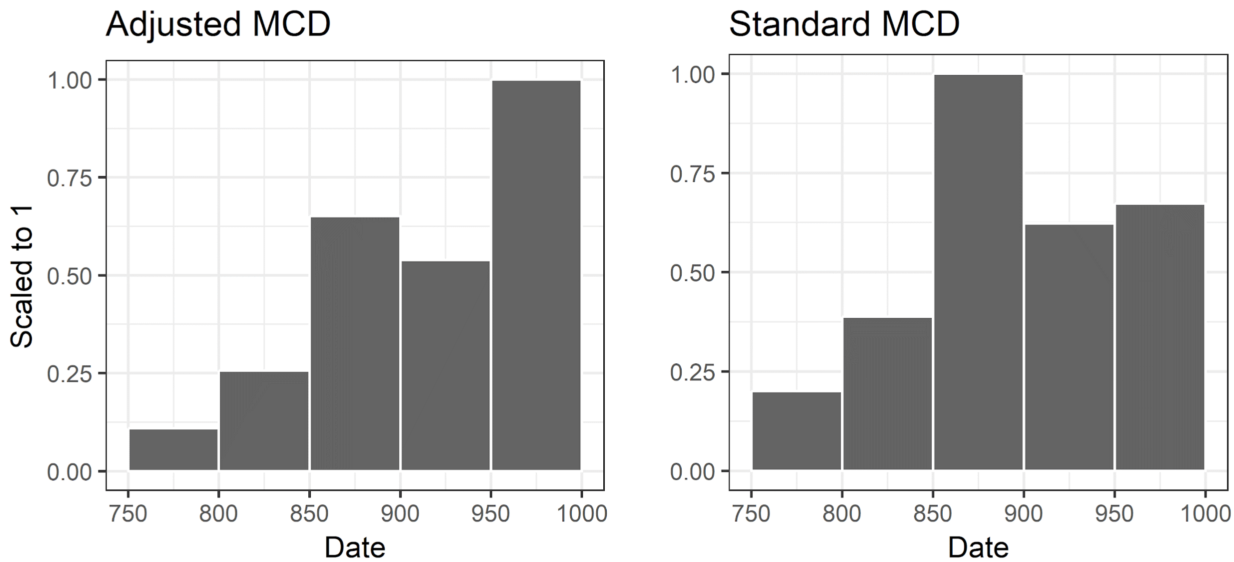


Figure 5.1. Comparison of standard mean ceramic dating (MCD) to the adjusted MCD used in this study.

Figure 5.1 compares the distribution of assemblages between AD 750-1000 for standard and adjusted MCD. The histograms are scaled to a maximum of one to focus on the differences in the distribution of assemblages rather than the difference in the number of assemblages. The histograms both show an increase in assemblages over time, as should be expected, but with a drop in the AD 900-950 period. The main difference is that most assemblages in the standard MCD appear in the AD 850-900 period, while the majority of assemblages in the adjusted MCD appear in the 950-1000 period. This problem is likely due to the issue of multiple occupations, which pulls many of the AD 950-1000 assemblages into the 1000 or later period when using standard MCD.

Another advantage of this method is the number of assemblages that are retained when using the adjusted MCD. Only 16.4% of the assemblages in my database fall within the time period of my study using standard MCD, while 40.2% of assemblages fall within my study period using adjusted MCD, a difference of 2,143 assemblages. This study is an attempt to collect as much data as possible to study San Juan Red Ware, and the adjusted MCD is clearly a superior method for achieving this goal and does so in a justifiable manner. Still, MCD is not perfect, and the rest of this section further examines its accuracy.

Eastern Mesa Verde Region

Tree rings generally provide the most secure dates for sites and a comparison of the regional trends in tree-ring dates described by Potter and colleagues (2012) for the Eastern Mesa Verde region provides a good test of the dating methods I used. While the site dates match expectations overall, the Eastern Mesa region has the most dramatic changes in site density and location throughout the period of my study. The sites used by Potter and colleagues for three of the districts they describe in this region appear to correspond closely to the sites in my database, with the exception of the La Plata District, where I have few data. This district is not discussed in this section (see Figure 5.2).

Most of the occupation in the Eastern Mesa Verde region prior to AD 800 occurs in the Durango District. The tree-ring cutting and near-cutting dates provided by Potter and colleagues (2012:Figure 4.4) for the Durango District show that most of the tree ring dates for this area fall between the early AD 700s and the early 800s. The AD 750-800 period matches this description and shows a tapering off of occupation resulting in only a few sites dating to this region in the 900-950 period and no assemblages in the 950-1000 period. The apparently late date I obtained for the assemblages is probably caused by assemblages with few datable ceramics. Tree-ring dates in the Piedra district range primarily from the early AD 800s to the late 900s (Potter et al. 2012:Figure 4.5), which matches the distribution of sites in the 800-850 and 850-900 periods. The Navajo Reservoir/Fruitland District tree-ring dates have the greatest range spanning from close to AD 800 until nearly 900 (Potter et al. 2012:Figure 4.5). The dates I obtained for assemblages in the Navajo Reservoir/Fruitland District are also similar to the tree-ring dates

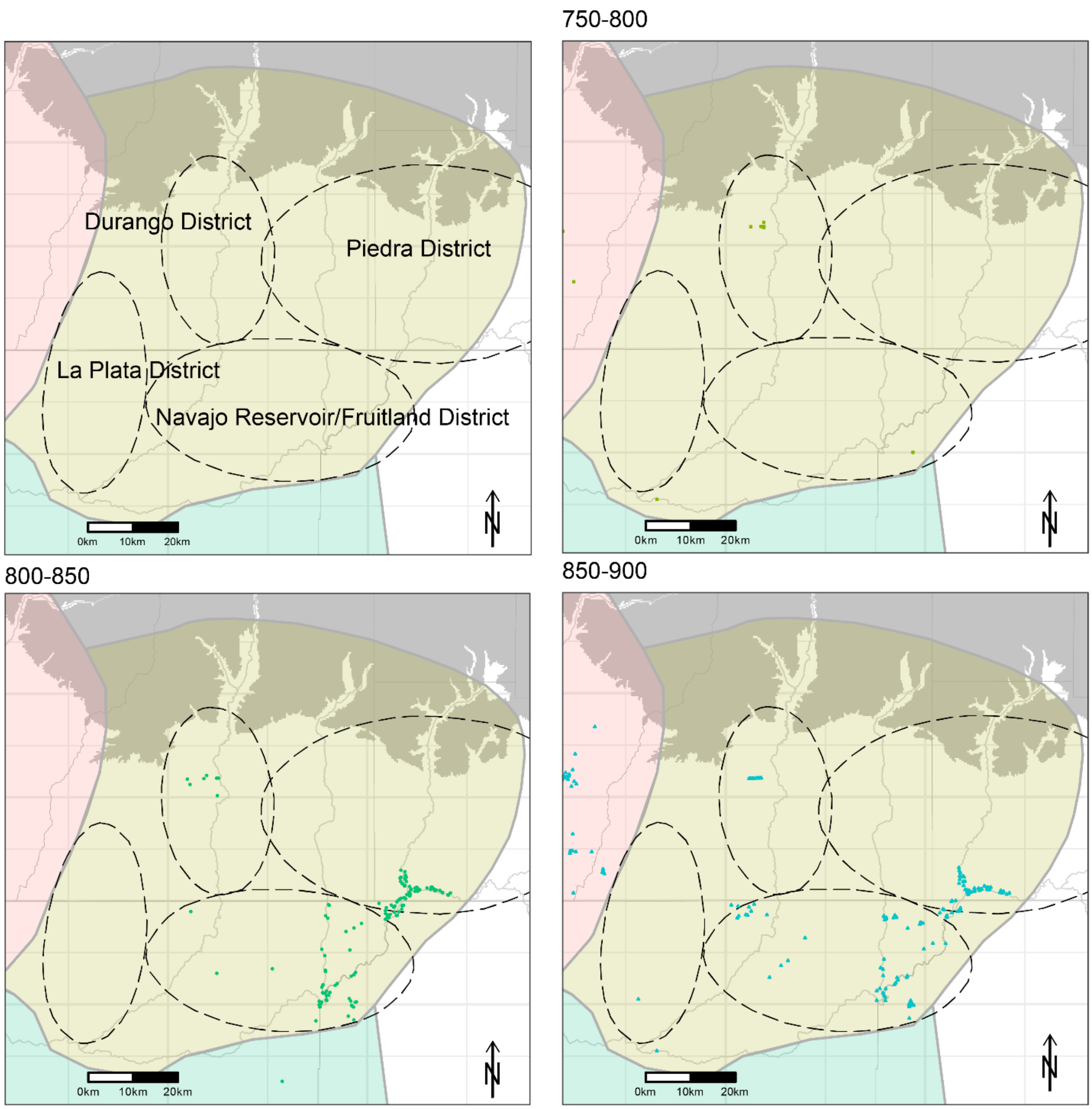


Figure 5.2. Distribution of assemblages by period for the Eastern Mesa Verde region.

and the adjusted MCD dates with only one site in this area during the AD 750-800 period. The remainder of the assemblages fall in the AD 800-850 and 850-900 periods (note that the cluster of sites in the northwest part of this district were excavated as part of the Cedar Hills project and are not included in the data used by Potter and colleagues).

While the above comparisons show a fair match, there are certainly important differences

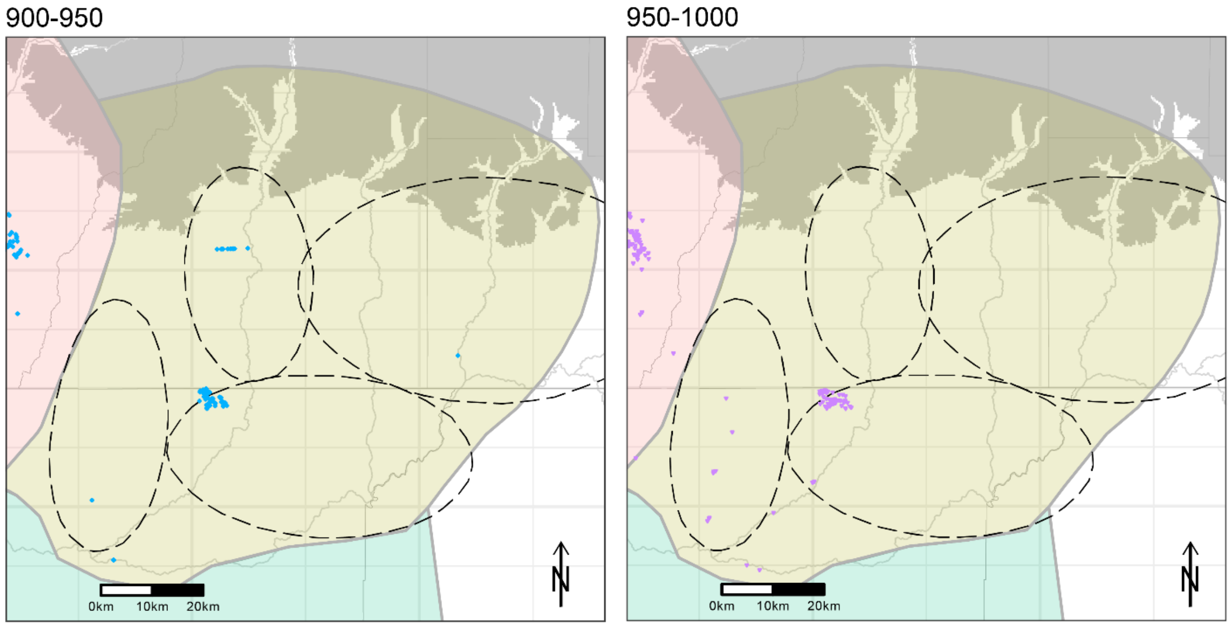


Figure 5.2. Continued.

in dating using tree-rings and ceramics. Potter and colleagues (2012:Figure 4.8) also provide the aggregated tree-ring dates for the region, which shows a sharp cutoff at AD 900. While this corresponds to the complete absence of sites in most sub-regions after AD 900, a more detailed comparison illustrates the differences. Figure 5.3 compares the tree-ring dates drawn from the data used by Potter and colleagues with the dates obtained using adjusted MCD. The data are not equivalent as many sites included in the ceramic dates histogram are not in the tree-ring histogram (the sites where tree-rings were obtained are not provided by the authors). These histograms demonstrate the tendency of mean ceramic dates for similar assemblages to cluster tightly around the mean of the ceramic ranges. This imprecision is one reason why my data is split into fifty-year intervals to avoid making unrealistically precise date estimates.

Individual Sites

The following site-specific comparisons were chosen haphazardly, but no attempt was made

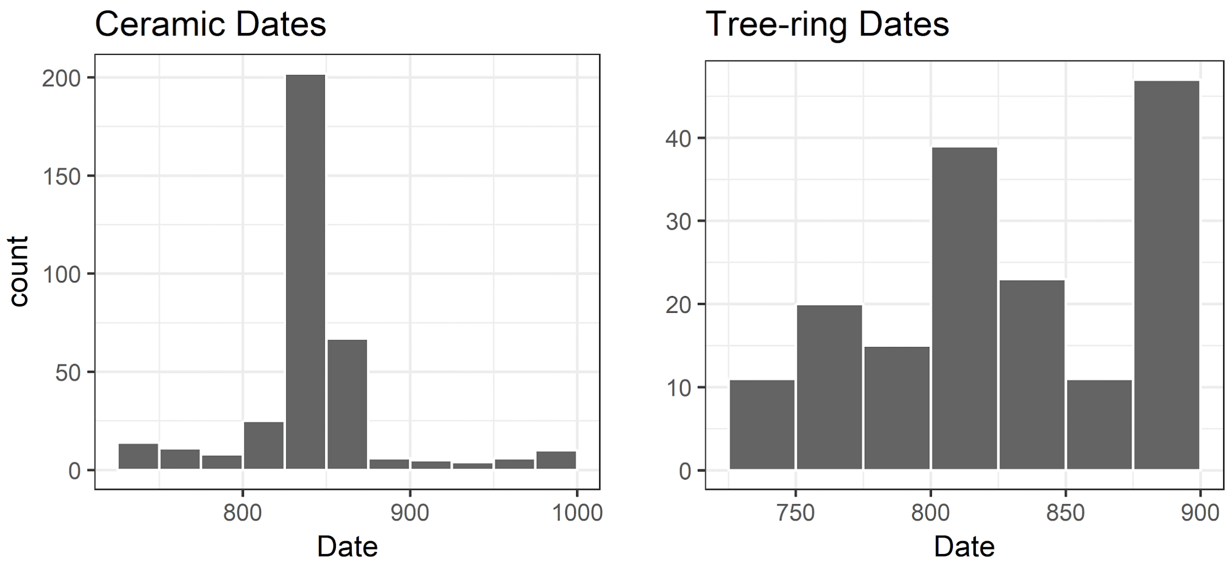


Figure 5.3. Comparison of the adjusted mean ceramic dates used in this study to the tree-ring dates reported by Potter and colleagues (2012:Figure 4.8).

to deliberately pick sites that support my methods or exclude sites that contradict my methods.

The Red Knobs site (42SA259) is one of the largest Ancestral Pueblo sites in southeast Utah (Allison 2004) and contains multiple components. The site has not been excavated and has no absolute dates, thus ceramics are used to date the site. Based on the surface ceramics collected, the site contains an occupation from around AD 900 and a later occupation in the 1100s (Allison 2004:341). These dates also match the architecture found at the site. Allison (Allison 2004:348) states "The site probably was not occupied, or only very lightly used, from about AD 950 to 1050 or 1100." Only Mancos Corrugated and Deadmans Black-on-red were produced during this period and found at the site, and they most likely belong to either the early occupation or a small intermediate occupation. Other ceramics produced during this time span were not found at the site. The mean date for the early ceramics is AD 905, but the presence of Abajo Red-on-orange indicates earlier use of the site of probably around 825; the mean date for the late ceramics is 1148 (Allison 2004:350–351). The standard MCD I obtained for this site is AD 1118, which is close to, but earlier than the date provided by Allison; this reflects the incorporation of the early ceramics in the MCD. The adjusted MCD for this site is AD 941, which is later than the date

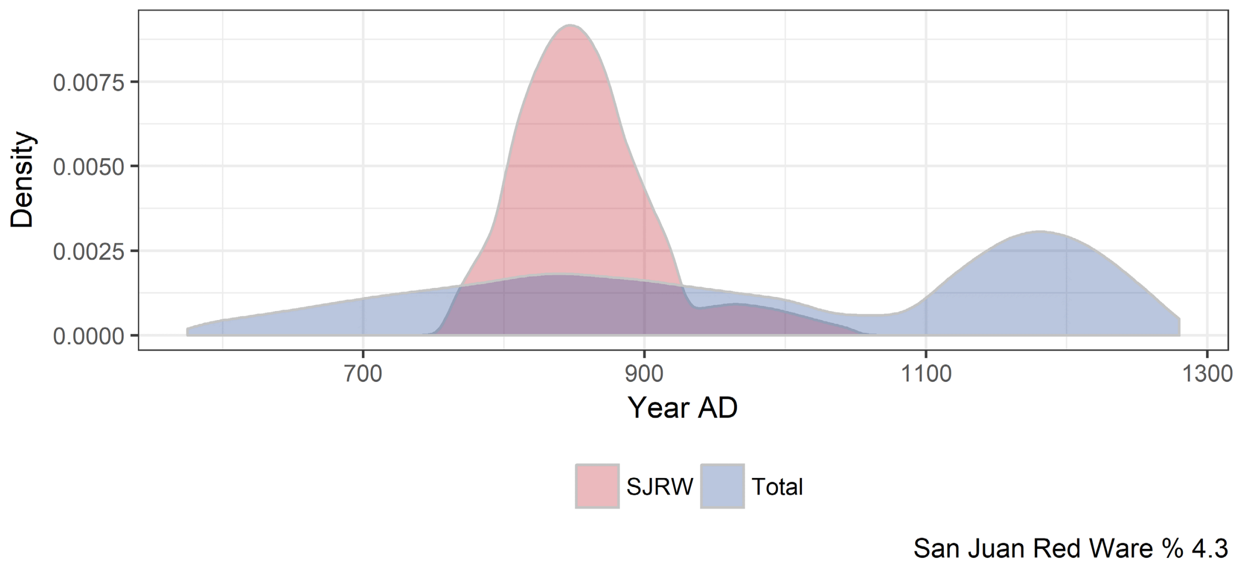


Figure 5.4. Density distribution for the Red Knobs site showing the probability of each sherd being deposited in each period for all ceramics and for San Juan Red Ware.

provided by Allison and is probably a result of including a greater percentage of the ceramics with production ranges that span the two occupations. Nevertheless, the date is still within the same fifty-year interval as the date suggested by Allison.

Figure 5.4 shows a density plot of the ceramics from Red Knobs. This figure represents the summed likelihood that a sherd from this assemblage was deposited in any given year that the pottery was produced for all ceramic types and for San Juan Red Ware. The density curves suggest two occupations, which is clearly supported by the data available for Red Knobs. The fact that the density curve does not drop to zero in between occupations is representative of the long production spans of some of these wares, particularly those that could not be typed specifically, but still need to be portioned into a specific year. A portion of the San Juan Red Ware falls outside of the AD 1000 cutoff used in this study, and thus is not included in the analysis, which reflects the uncertainty mentioned earlier about whether Deadmans Black-on-red belonged to the early or late occupation. The methods I used are certainly not a perfect representation of reality and, while all of the ceramics used in the adjusted MCD are allocated to the AD 900-950 period, a portion of these ceramics likely were deposited at an earlier or possibly later date. Still, even with the detailed treatise provided by Allison it is impossible to precisely place the ceramic assemblage into specific dates or periods, and the above comparison indicates that the dating I used is sufficient for my purposes.

The Badger House Community reported by Hayes and Lancaster (1975) represents a more complex comparison. This is a collection of closely related sites on Wetherill Mesa within the boundaries of Mesa Verde National Park. Fortunately, the ceramic data are subsetted into the specific site or architectural feature where it was excavated. Hayes and Lancaster (1975) used tree-ring dates (when available), architecture, ceramics, and other chronologically sensitive artifacts to date the sites. The close association of the buildings and the tendency for abandoned structures to fill with trash from later occupations provided some challenges to the excavators for assigning accurate dates. Many of the ceramic sherds came from fill that was not directly associated with the structure. While this is a problem for dating the site, this is not an issue for my study, as I am concerned with the dates associated with the ceramics not the architectural features.

Table 5.2 shows the MCD and adjusted MCD for each subunit that corresponds to the ceramic data in my study, as well as the date assigned by the excavator and the ceramic totals. While the ceramics are reported by feature, much of the data comes from the fill of structures. There are a handful of late Pueblo II or Pueblo III ceramic types that were not included in the adjusted MCD. Dates from standard and adjusted MCD were similar, but all date to the same mid to late 800 date range. This matches the latest reported dates for these structures and the similar dates are a result of the fill from all of the occupations mixing together and clouding the data. Many of the Basketmaker III ceramics were removed from the assemblage for the adjusted MCD date, which is appropriate due to the occupations that clearly did originate in the Basketmaker III period. This comparison indicates that, for the purposes of this study, the dating I used closely

Table 5.2. Dating Comparison for the Badger House Communities to Mean Ceramic Dating (MCD) and Adjusted MCD.

Subunit	MCD	Adjusted MCD	Reported Date*	Total Ceramics	Total Used**	% Used
Great Kiva***	846	857		4743	3026	64
House 1	865	870	860	2343	1521	65
Protokiva D	868	871	860	1211	811	67
House 5	868	873	860	2547	1677	66
Protokiva E	863	865	860	4912	3165	64
House 4 and Pitroom F	868	868	860	7432	4745	64
House 7	868	871	800	1720	1117	65
House 6	868	873	800	756	500	66
House 2	869	874	775	209	138	66
House 3 and Protokiva C	869	852	725	6867	4274	62
Pithouse G	849	856	620	1340	839	63

Note: *Data from Hayes and Lancaster (1975).
**"Total Used" refers to the ceramics dated between AD 750-1000 and used in the adjusted MCD.
*** Hayes and Lancaster (1975:60-63) do not specifically date the kiva, but they do state it was likely used in early Pueblo I and the fill was deposited prior to AD 853.

matches the interpretations proffered by the excavators.

LA 66704 is a small site with one pithouse that was likely occupied for about 10 years (Wilshusen, Hovezak, et al. 2000). It was excavated as part of the Frances Mesa project and yielded tree ring dates in the AD 870s (Wilshusen, Hovezak, et al. 2000:140); the tree-ring dates were near cutting dates and the site likely dates to about AD 880. This site is advantageous as a comparison due to its short occupation and distance from other sites, which prevents contamination of this assemblage. The standard MCD and adjusted MCD for this site is AD 805. The tree-ring dates and the contextual data demonstrate the limitations of MCD for this site. The site dates to the later end of Rosa Black-on-white and Piedra Black-on-white pottery, which causes the date to fall earlier than the actual date (see Figure 5.5).

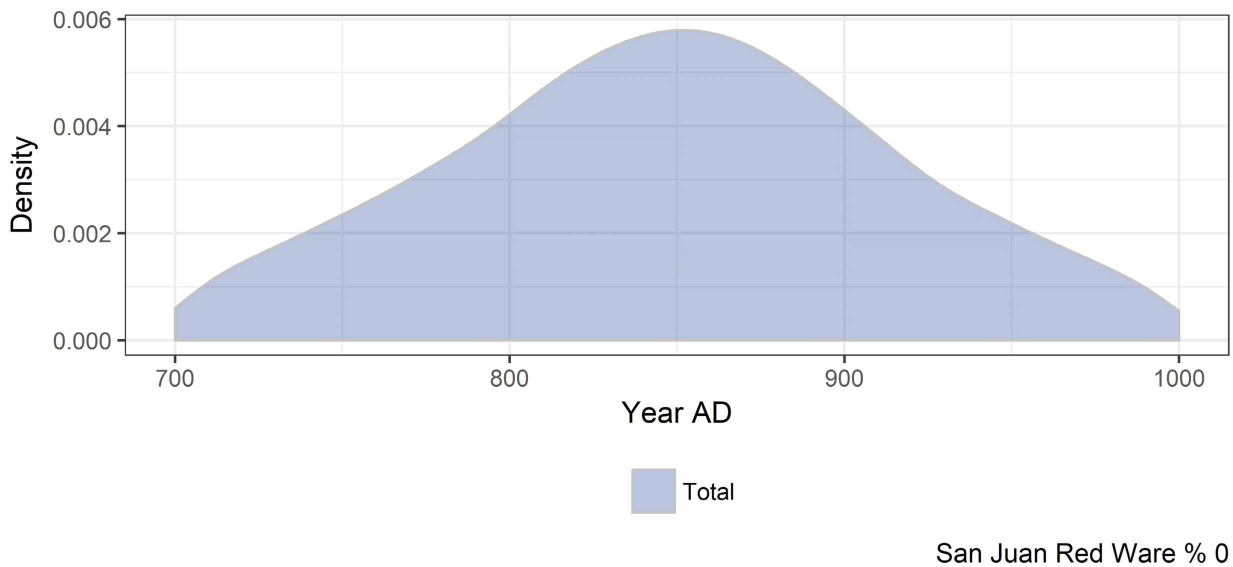


Figure 5.5. Density distribution for LA 66704 showing the probability of each sherd being deposited in each period for all ceramics.

Conclusion

This comparison demonstrates some of the strengths and weakness of both MCD and the adjustments to the ceramic assemblages I made prior to MCD. An ideal solution, if time and funds were not an issue, would be to carefully review each assemblage for absolute and relative dates, control for population increases and decreases, determine the site occupation range, and portion the ceramic assemblage based on these data. As discussed in Chapter 4, this is not practical. If archaeologists are going to move forward with regional scale analysis with the data currently available, then some assumptions, generalities, and even some inaccuracies (though these should be minimized as much as possible) must be tolerated; however, I believe I have shown that these methods for dating the sites and apportioning ceramic assemblages reasonably represent the historical trends in this region.

BAYESIAN MODIFICATION OF SAN JUAN RED WARE PROPORTIONS

This section reviews general trends and several specific sites to demonstrate the effects of

Bayesian empirical estimation on the proportion of San Juan Red Ware. I have attempted to choose individual sites that represent some of the variability in my data. As discussed in Chapter 5, sites within each period and region were treated separately. Sites with San Juan Red Ware proportions that differ significantly from the mean for the period and region are most affected by this method. Differences are small for sites with small assemblages and a San Juan Red Ware proportion close to the mean. The San Juan Red Ware proportion derived from the reported counts (as modified using adjusted MCD) are called the observed value, and the estimate after applying Bayesian empirical estimation is the posterior value. When discussing individual sites, I also discuss how the adjusted MCD affected the ceramic assemblages, as these were modified from the reported values when adjusting for multicomponent sites.

All Sites

Differences in San Juan Red Ware for all assemblages ranges from 0 to 35.7% with a mean change of 1.4% and a median change of only 0.7%. Four assemblages with larger than 1,000 sherds saw a change in the observed value of 0.1%. Table 5.3 shows the mean difference and the standard deviation of the difference between the observed and posterior values in relation to sample size. As mentioned in the prior chapter, assemblage sizes with fewer than 10 sherds have too much variability and were thrown out. Figure 5.6 shows the absolute difference between the observed percentage and the posterior percentage of San Juan Red Ware for assemblages with fewer than 50 sherds. Assemblages with fewer than 10 sherds were included for demonstration. Variation increases as the assemblage size decreases, but the variation increases significantly for assemblages with fewer than 10 sherds. Overall, only small assemblages and assemblages differing significantly from the prior mean were largely affected by Bayesian empirical estimation.

Table 5.3. Comparison of the Differences between Observed San Juan Red Ware Percentages and the Bayesian Empirical Estimation Percentages.

	10-25	25-50	50-100	100-500	500-1000	1000+
Mean	2.73	1.32	0.71	0.26	0.07	0.01
Standard Deviation	3.32	1.85	0.88	0.32	0.08	0.04
Number of assemblages	863	537	462	387	60	124

Individual Sites

5MT993 has the greatest variation from observed to posterior values, and is either multicomponent or has an occupation lasting from the late AD 900s or early 1000s to the 1100s based on the ceramic dates of sherds found at the site. It is located in the Central Mesa Verde region and originally contained 54 sherds. After adjusting for sherds that were likely deposited after AD 1000 the total is about 13 sherds. The San Juan Red Ware proportion is 24.1%, but with the later sherds removed the proportion increases to 82.4 %. The prior mean estimate for the period and region is 6.1%, which results in a 46.6% posterior estimate. The true proportion of San Juan Red Ware is unknowable, but due to the empirical estimation I can be reasonably certain that the true proportion of San Juan Red Ware during the period of my study is close to 46.6%, if the removal of the other sherds is appropriate, which is significantly higher than the average for the time and region.

The ceramic assemblage for site 5LP0536 originally contained 1,490 sherds for this site located in the Eastern Mesa Verde region with a San Juan Red Ware proportion of .05%. Most of these sherds are either completely untyped or undifferentiated gray ware with long production spans that resulted in the removal of a number of these sherds from consideration. Of the about 495 remaining sherds, the San Juan Red Ware proportion is 1.5%. The prior estimate for the period and region is 1.7% and the posterior mean is 1.5%. It is quite possible all of the sherds

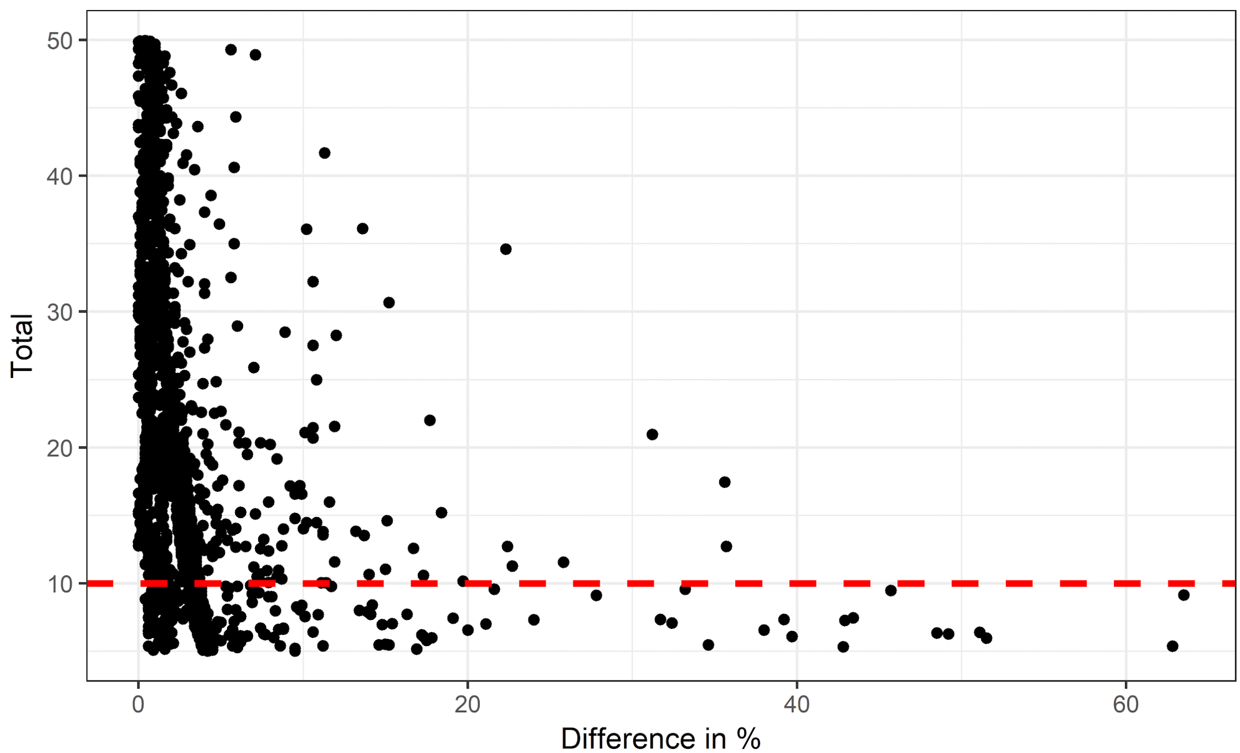


Figure 5.6. This plot compares the total number of ceramics from assemblages with fewer than 50 sherds compared to the absolute differences between San Juan Red Ware proportions prior to and after applying Bayesian empirical estimation.

belonged to the same occupation, which means the San Juan Red Ware percentage is too high, but it is not significantly different than the unadjusted mean. The large size of this assemblage and similar observed and prior values demonstrate that large assemblages are only slightly affected by Bayesian empirical estimation.

42SA6396 is located in Southeast Utah and has 28 assemblages comprising the total site data. After adjustments, 20 assemblages remain with mean ceramic dates between AD 757 and 996. The San Juan Red Ware proportion after adjustments ranges from 0 to 9.9%, and the posterior mean ranges from 0.2% to 12.4%. The change in proportion ranges from 0.1% to 4.5%. The subunit with the greatest change has only about 12 sherds and no San Juan Red Ware. The prior for the area is 16.3%, which demonstrates that even for a small assemblage with a much larger prior mean the posterior is only 4.5%, and thus the low San Juan Red Ware proportion is likely correct.

Conclusion

There are two main benefits for using Bayesian empirical estimation. The first benefit is that San Juan Red Ware proportions from small assemblages are adjusted to a more reasonable estimate of population proportions based on the period and region. The second benefit is that the use of this method increases confidence in assemblages that significantly differ from expected values. Some of the sites discussed above have results that are unexpected for the time and region, but this method demonstrates that sampling error is not a major source of error. It is important to note that sampling error is the only type of error accounted for by using this method. Mistakes in data collection, reporting, removal of surface sherds by collectors, or any other source of error can still cause erroneous data.

This chapter has demonstrated that the methods used in this study provide reasonable methods for accounting for difficulties with multicomponent sites, lack of absolute dating, and small sample sizes despite the disparate sources of data and the lack of chronological resolution. The remainder of this thesis discusses my analysis and conclusions.

6 Analysis

This chapter covers the results of the analyses specified in Chapter 4 with some interpretations. I begin with a brief overview of San Juan Red Ware by region and then discuss distribution maps, as these maps help familiarize the reader with the area and demonstrate many of the trends observed in this analysis. Fall-off curves are discussed next as they are the most direct way to deal with the relationship between San Juan Red Ware and distance. The Typenspektren analysis is examined using distance diagrams and compares differences in general ceramic types along with distance diagrams of the inverse distance weighting. The social network analysis is discussed to demonstrate the relationship between San Juan Red Ware proportions and network centrality using ceramic similarity networks. This chapter focuses on descriptive analyses of the various methods used to examine San Juan Red Ware. I also discuss the effectiveness of the various methods used. The concluding chapter discusses these results in the context of prior research.

RESULTS

Tables 6.1 and 6.2 show the mean proportions of San Juan Red Ware for each region and period. The first table shows the percentage of San Juan Red Ware to all ceramics and the second shows the percentage San Juan Red Ware of all decorated ceramics. San Juan Red Ware is clearly most abundant in Southeast Utah throughout all periods. Several periods in Greater Chaco and Little Colorado have few assemblages and show higher percentages of San Juan Red Ware in

Table 6.1. Mean San Juan Red Ware Percentages for all Assemblages by Region and Period.

Region	750-800	800-850	850-900	900-950	950-1000
Central Mesa Verde	3.2	4.7	5.1	5.3	5.2
Eastern Mesa Verde	1.5	1.2	1.9	1.7	1.4
Greater Chaco	15.2	0.8	1.3	2.4	1
Little Colorado	3.9			20.5	6.4
Southeast Utah	26.3	11.9	25.8	16.7	14.4

these periods (see Table 6.3 for the number of assemblages in each region and period). These assemblages are all near the San Juan River not far from the Southeast Utah region. San Juan Red Ware proportions are also more variable between decorated and total ceramics for periods and regions with few assemblages. For example, Greater Chaco becomes more consistent after AD 850 when the total number of assemblages increases. Generally, San Juan Red Ware proportions of total ceramics correlate well to San Juan Red Ware proportions of decorated ceramics, but there are some anomalies. The largest difference is Eastern Mesa Verde in the 750-800 period, with 1.5% total San Juan Red Ware and 14.4% decorated San Juan Red Ware. There are only eight assemblages in this period, and most of these assemblages have between 10 and 25% decorated San Juan Red Ware proportions. This result is likely due to small sample size, but would require further research to determine its reliability. Decorated ceramics become more common through time, which further decreases the variation between decorated and total proportions.

Distribution Maps

I started my analysis with inverse distance weighting (IDW; see Figure 6.1), as it is one of the best methods for visually identifying where San Juan Red Ware is most common; however, the application of this method proved more problematic than anticipated. As is shown later, the

Table 6.2. Mean San Juan Red Ware Decorated Ceramics Percentages for all Assemblages by Region and Period.

Region	750-800	800-850	850-900	900-950	950-1000
Central Mesa Verde	5.9	11.5	15.4	11.4	6
East Mesa Verde	14.4	3.5	5.4	3.6	1.6
Greater Chaco	24		4.3	4.1	1.5
Little Colorado	67.8			26.8	13.7
Southeast Utah	57.5	34.7	55.6	46.4	3.5

Table 6.3. Total Number of Assemblages by Region and Period.

Region	750-800	800-850	850-900	900-950	950-1000
Central Mesa Verde	102	117	550	305	624
East Mesa Verde	8	133	117	54	48
Greater Chaco	3	3	23	84	74
Little Colorado	1			5	2
Southeast Utah	11	15	54	72	28

variation within San Juan Red Ware is extreme, and the large number of assemblages in Central Mesa Verde make it difficult to see some trends. For these reasons a variation of hexagon binning was also used. Hexagon bins have no predictive element, but the predictive value of IDW in this thesis is of minimal value.

IDW for the AD 750-800 period shows three areas with high concentrations of San Juan Red Ware, but two of these areas only represent one site and the third has only two assemblages. San Juan Red Ware is clearly most prominent in Southeast Utah, but not universally. The distribution maps for this period all show a gap in the San Juan Red Ware distribution in the center of this region (see Figure 6.2 for hexagon distribution maps), and the hexagon confidence intervals show that the central region has significantly less than the expected value for the region and period (see Figure 6.3 for hexagon confidence interval maps). The westernmost hexagons in Central Mesa Verde all have more San Juan Red Ware than expected. The only other hexagon

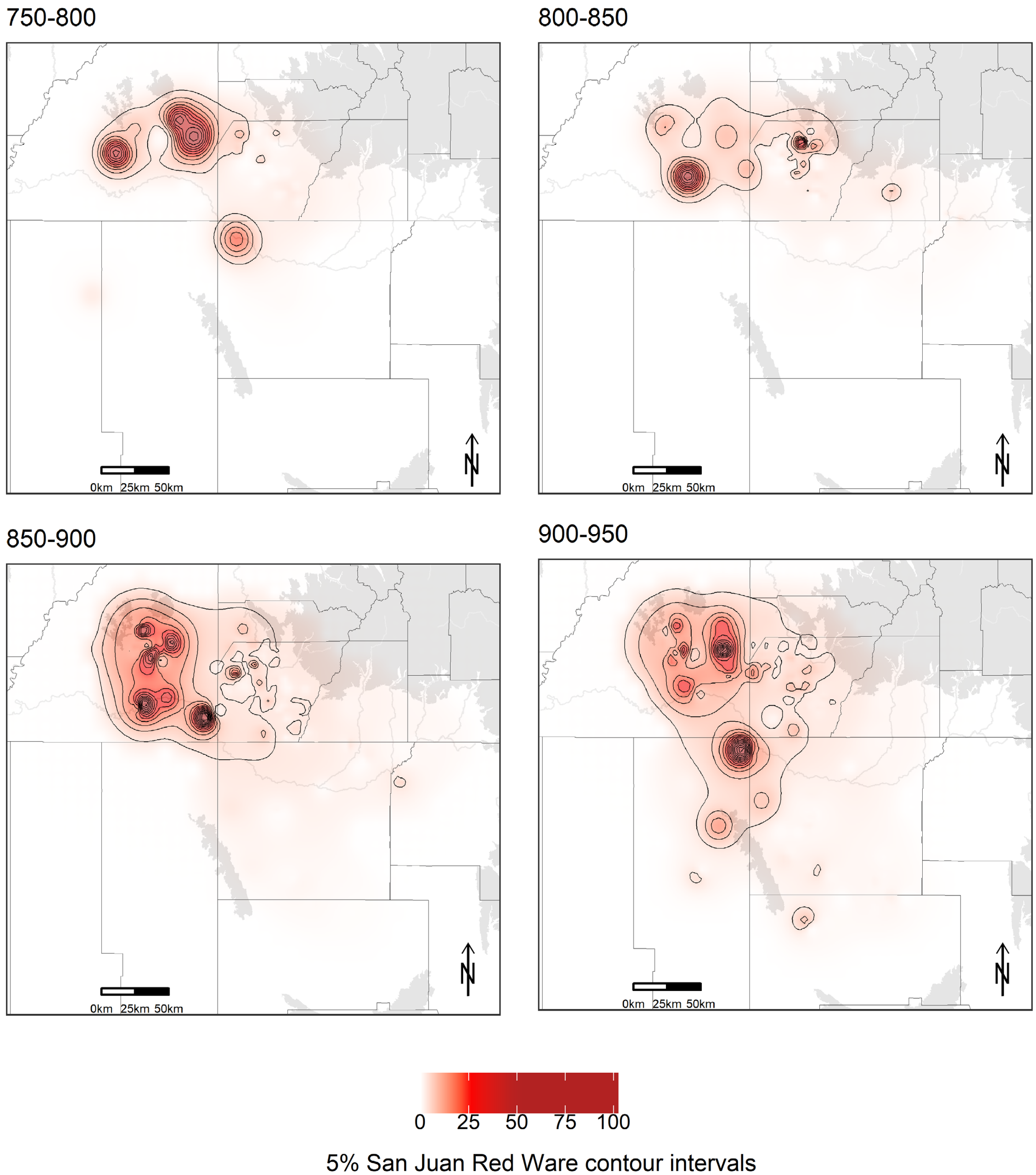


Figure 6.1. Distribution maps of San Juan Red Ware by periods, using inverse distance weighting with contours.

with more San Juan Red Ware than expected is located in Mesa Verde. The sites representing the highest concentrations are the Fred Site (42SA6179), 42SA971, Site 13 at Alkali Ridge (42SA13), and the San Juan Biwall site (LA 69891). The San Juan Biwall site has a surprising San Juan Red Ware percentage for its location in northwestern New Mexico, and this area also

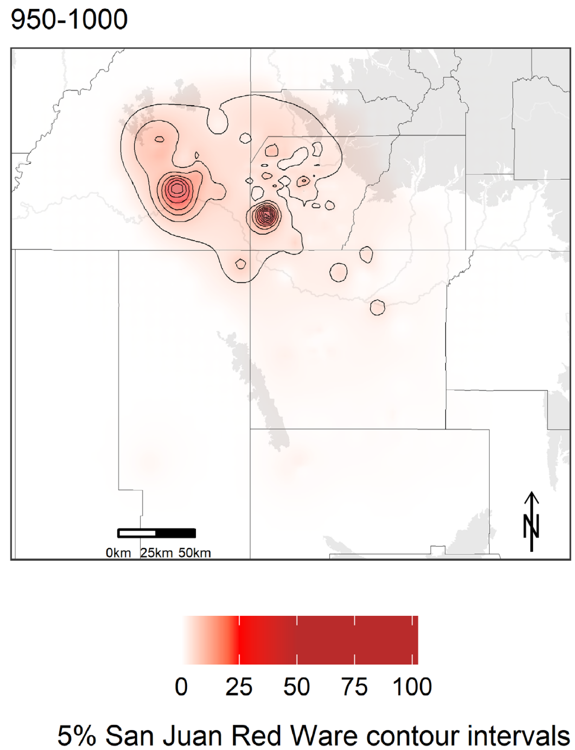


Figure 6.1 (continued).

shows a high concentration of San Juan Red Ware in the 900-950 period. No other clusters of sites with high San Juan Red Ware proportions are found in this period, but it is worth noting that small amounts of San Juan Red Ware are present in most assemblages, including the Dolores and Durango areas.

The AD 800-850 period shows a wider distribution of San Juan Red Ware, but this period has fewer large concentrations and surprisingly small San Juan Red Ware proportions in Southeast Utah. This may be an indication that some of the producing sites are not included in this study or that some sites producing San Juan Red Ware are dated to other periods using my methods, but in general few large sites date to this period (Allison et al. 2012). The highest concentration in Utah is site 42SA8308 located near Bluff, Utah, which correlates with Oppelt's (2001) suggestion that San Juan Red Ware was likely produced along the San Juan River. The highest San Juan Red Ware percentage is not in Utah, rather it is found at site 5MT13470 in Central

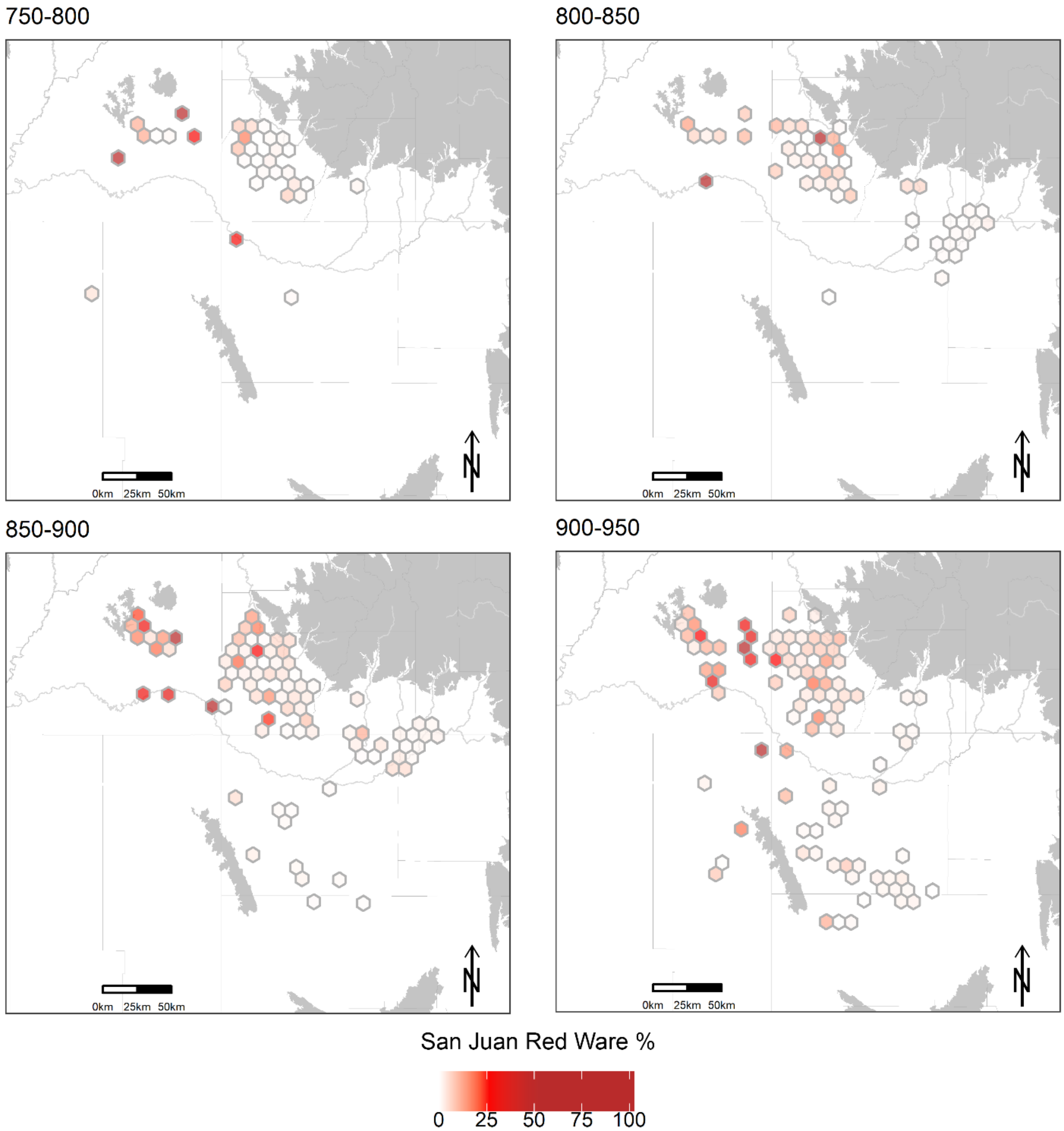


Figure 6.2. Hexagon bins showing weighted averages of San Juan Red Ware proportions by period.

Mesa Verde near Dolores, Colorado. This appears to be a small habitation site and most of the surrounding sites have little or no red ware, although three larger sites located within 10 km have between 14 and 39% San Juan Red Ware: Windy Wheat Hamlet (5MT4644), 5MT4609 and the Bedrock site (5MT4611). Together these sites represent the highest concentration of San Juan

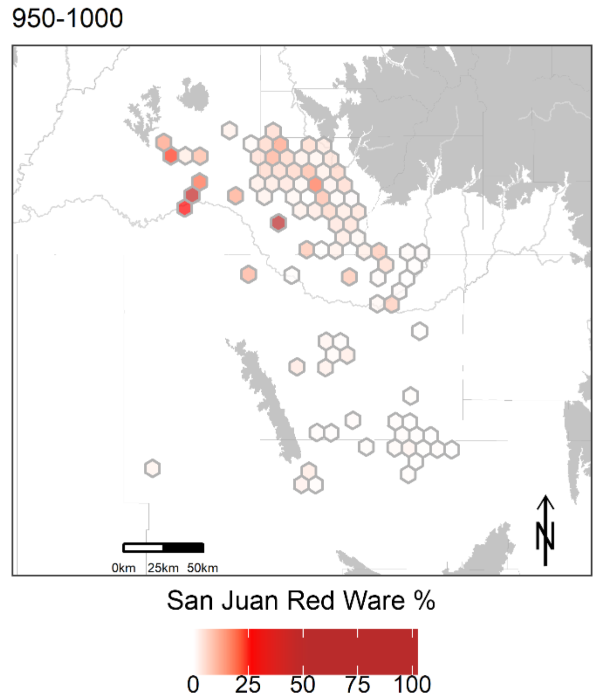


Figure 6.2 (continued).

Red Ware in this period. Three of the four hexagons with significantly high values of San Juan Red Ware represent sites within the Dolores Archaeological Program. A number of assemblages in Central Mesa Verde have high proportions of San Juan Red Ware but are mostly scattered around the area. Overall, the hexagons covering Mesa Verde have significantly less San Juan Red Ware than expected. Three assemblages in Mesa Verde National Park and several assemblages along and just north of McElmo Creek have between 10-22% San Juan Red Ware and represent small clusters of San Juan Red Ware. The addition of a number of assemblages in the Navajo Reservoir/Fruitland District of Eastern Mesa Verde provides more comparative data for this region. Assemblages in the Durango area show more San Juan Red Ware than other parts of this region. The Blue Mesa site has the highest San Juan Red Ware proportion in this area at 14.4%. The highest San Juan Red Ware proportion in Eastern Mesa Verde is at site LA4140, excavated as part of the Navajo Reservoir Project, with 18.3% San Juan Red Ware. This site is over 200 km from where most San Juan Red Ware was likely produced in Southeast Utah and demonstrates

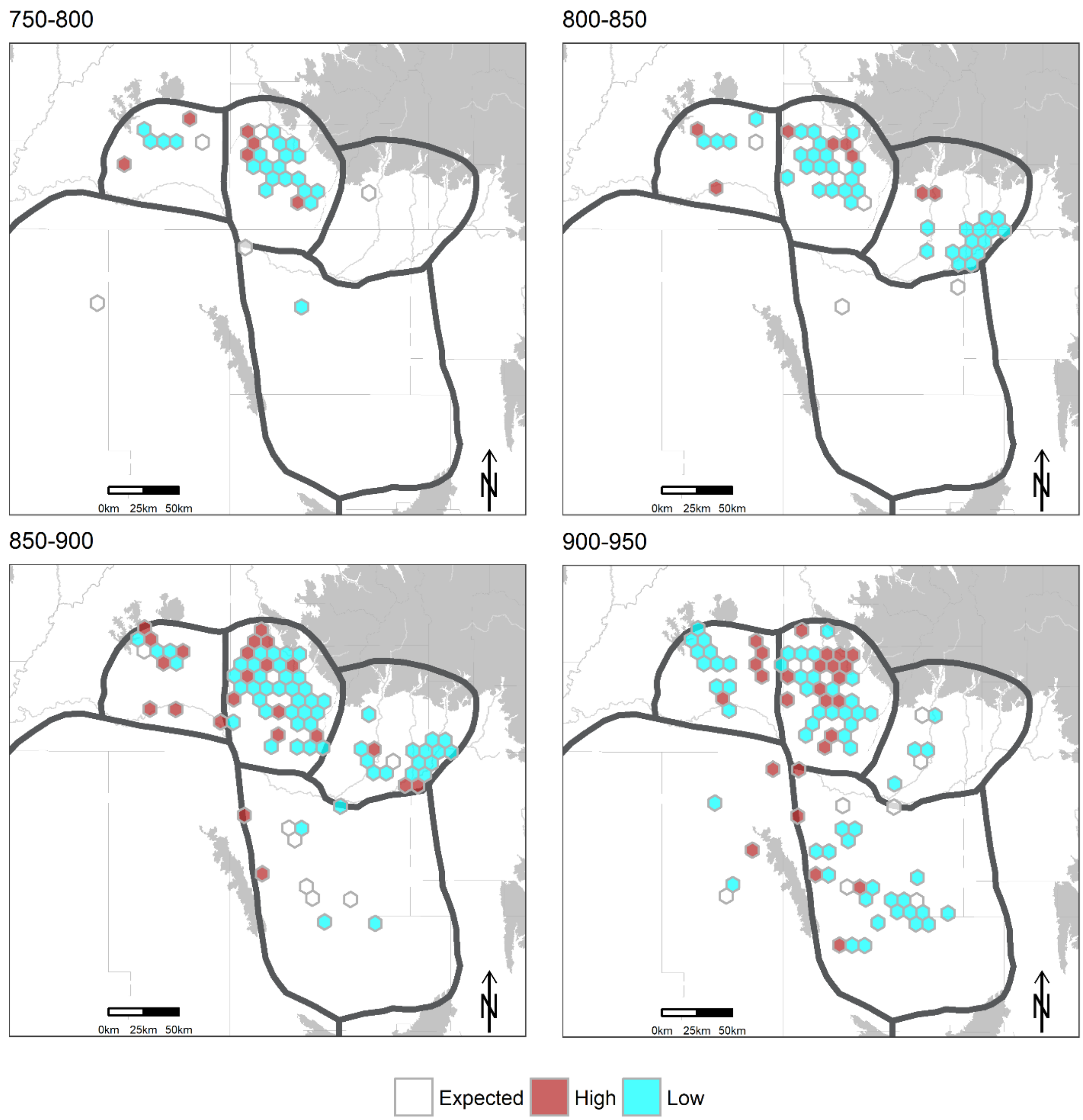


Figure 6.3. Hexagon bins indicating whether weighted averages are within, above, or below a 99.9% confidence interval from the mean San Juan Red Ware proportion for the period and region.

how far San Juan Red Ware was traded early in its production history.

San Juan Red Ware in the AD 850-900 period is more dominant in Utah than the preceding periods. A number of assemblages have greater than 50% San Juan Red Ware, and only two of these assemblages fall outside Southeast Utah. The Cross Roads/Radio Tower Site (5MT6) and

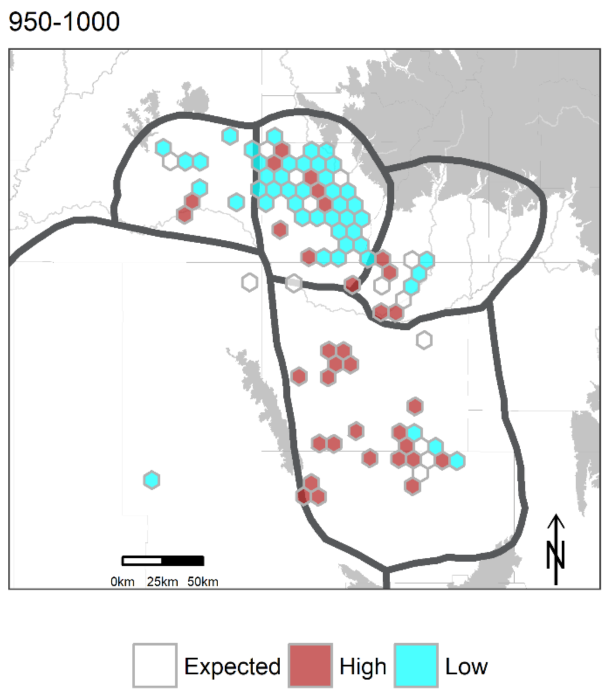


Figure 6.3 (continued).

5MT3034 are both located between Dolores, Colorado and the Utah border in Central Mesa Verde. The largest homogeneous concentration of San Juan Red Ware is along the San Juan River in Utah, but other large concentrations are found near Blanding, Utah and the Abajo Mountains. Still, a number of hexagons in Utah show significantly less San Juan Red Ware than expected. Assemblages with more than 15% San Juan Red Ware are spread throughout the Central Mesa Verde region, but none are found east of Mesa Verde National Park. The most homogenous cluster of assemblages with high proportions of San Juan Red Ware in Colorado is found near the center of Canyons of the Ancients National Monument near the Utah/Colorado state line. Seven assemblages are clustered together within about 10 km and contain between 9-56% San Juan Red Ware. Another concentration is found in the northernmost Central Mesa Verde area best represented by the Coffey Hamlet site (5DL1120) with 13.8% San Juan Red Ware. A few small clusters are notable representing several assemblages in close proximity with high proportions of San Juan Red Ware, although a number of assemblages with little or no San Juan Red Ware

are located nearby. Two of these small clusters are evident in Mesa Verde National park. Five assemblages within 300 meters on Park Mesa have San Juan Red Ware proportions between 10 and 43%, and four assemblages within about 1.5 km of the Morefield Community have between 25 and 32% San Juan Red Ware. San Juan Red Ware is common in the Morefield Community area, but a number of assemblages located within this area have little or no San Juan Red Ware. San Juan Red Ware is not common in the Greater Chaco region, but the assemblages with the highest relative concentration are located near the Chuska Mountains. Mitten Rock (LA 8243) has the most with 4.7% San Juan Red Ware in this period. The Durango, Colorado area in this period has significantly less San Juan Red Ware than the rest of Eastern Mesa Verde, but San Juan Red Ware concentrations are sporadic in this region. Overall San Juan Red Ware is highly concentrated in Utah, and much more dispersed in the rest of the northern San Juan.

Fewer assemblages with high percentages of San Juan Red Ware are found outside Southeast Utah in the AD 900-950 period than earlier. Only one site with more than 30% San Juan Red Ware appears outside of Utah. This site, Teec Nos Pos (AZ-I-8-23-NN), is just across the Utah border in the far northeast corner of Arizona and arguably could be more closely connected to the Southeast Utah region than the other nearby regions. Within Southeast Utah, the main concentrations of San Juan Red Ware appear to run north/south following the Cottonwood Wash and Montezuma Creek drainages. In aggregate, only the assemblages along Montezuma Creek and an area just north of the San Juan River have higher proportions of San Juan Red Ware than the rest of the region, but this is primarily a factor of having a high number of assemblages with little San Juan Red Ware located near assemblages with high concentrations. Central Mesa Verde has a number of assemblages with more than 10% San Juan Red Ware scattered around much of the region. Notable areas with higher than expected values are again found in the Dolores area, Mesa Verde National Park, and a number of assemblages near the Utah Border. No assemblages with more than 10% San Juan Red Ware appear in Eastern Mesa Verde. A subunit of Casa del

Rio is the only assemblage in Chaco Canyon with more than 5% San Juan Red Ware, although a number of assemblages have smaller percentages. The highest percentages of San Juan Red Ware in the Greater Chaco and Little Colorado regions are concentrated in an area near the Chuska Mountains. This period also shows a wide scattering of San Juan Red Ware with a number of areas with higher or lower percentages of San Juan Red Ware than expected based on the region and period averages; however, this region does have a few larger, aggregate concentrations represented by Montezuma Creek in Utah and the Dolores area in Colorado.

Assemblages with high San Juan Red Ware values are less concentrated in Southeast Utah in the AD 950-1000 period than the last two periods. More assemblages with greater than 30% San Juan Red Ware are located in Central Mesa Verde than Southeast Utah. The few assemblages located along Montezuma Creek in this period have much less San Juan Red Ware than the AD 950-1000 period, although this may be caused by assemblages with long occupations dating to other periods. The highest concentrations of San Juan Red Ware are located near the San Juan River in Utah and Little Baullie Mesa west of Blanding, Utah, although only the areas located along the San Juan River have more San Juan Red Ware than expected. The highest concentrations of San Juan Red Ware in Central Mesa Verde are located north of Canyons of the Ancients National Monument in between Dolores and Mesa Verde National Park, and approximately 15 km south of McElmo Creek in western Colorado. This last area is represented by sites 5MT9873 and 5MT9863. These assemblages have between 40 and 60% San Juan Red Ware. No other assemblages in my database are located nearby, and both assemblages are small. While there are a few small clusters of sites in Central Mesa Verde with high San Juan Red Ware proportions, a number of sites scattered throughout the region have greater than 10% San Juan Red Ware. Based on the confidence intervals in Figure 6.3, a number of areas in the Greater Chaco region have more San Juan Red Ware than expected, but this is due to the low amount of San Juan Red Ware generally found there. Only one assemblage (Site 522 in the Chaco Coal

Gasification Project) has greater than 5% San Juan Red Ware.

This analysis indicates that San Juan Red Ware was widely dispersed throughout the northern San Juan region, but it is clearly most common in Southeast Utah. San Juan Red Ware is common in a number of areas of Central Mesa Verde, including the Dolores area, Mesa Verde, the northernmost area, and areas close to the Utah border, but proportions fluctuate through time. Eastern Mesa Verde has a number of assemblages with high proportions of San Juan Red Ware. These assemblages are mostly concentrated in the Durango area in the AD 800-850 period, but this changes to the Navajo Reservoir/Fruitland districts in the next period. Only a small amount of San Juan Red Ware is present in the Greater Chaco region prior to 900-950, but the highest concentrations are mostly found around the Chuskas. Little can be said about the Little Colorado region due to the paucity of data. San Juan Red Ware was certainly present in this area but seems most common in the eastern part of the region near the Chuskas. Primarily this distribution analysis demonstrates that San Juan Red Ware was available at great distances from its likely production area, but it does not follow a smooth decline in frequency as distance increases from the production areas. Many areas in within or near what are likely production areas have much less San Juan Red Ware than expected.

Fall-off Curves

The distribution analysis demonstrates that San Juan Red Ware was found in relatively high concentrations in many different areas, but appears most common within and near Southeast Utah. One of the most effective methods for evaluating the relationship between artifact frequency and distance is a fall-off curve. The fall-off curve analysis was conducted using the natural log of the San Juan Red Ware proportion against the distance in km from the source area (see Figure 6.4 for fall-off curves by period). Fall-off curves often represent a log linear relationship, and this holds true for San Juan Red Ware (see Renfrew 1977). The center point was chosen by taking a point in the middle of the areas with the highest proportions of San Juan Red Ware in the Southeast Utah region. A loess (locally weighted least-squares regression) smoothing curve is used along with a linear regression line. Linear regression fits a straight line through all points, and the loess uses subsets of points in smaller areas to fit a line that better represents the relationship between San Juan Red Ware and distance at different intervals. The results of the linear regression show a weak correlation to distance in the early periods and a somewhat stronger correlation in the later periods. Some of the difference in periods may be explained due to the changing distance scale, as the later periods have sites at almost twice the distance as some sites in the first period.

The AD 750-800 period shows almost no correlation with distance, and San Juan Red Ware values vary tremendously, even at the same distance. The r^2 value is only 0.006, which indicates that distance from the production area is not a primary factor in the proportion of San Juan Red Ware within an assemblage. This effect is somewhat caused by the greater variance in assemblages within or near the production zone than distant assemblages. Central Mesa Verde assemblages generally have less San Juan Red Ware than expected, despite several assemblages with San Juan Red Ware values nearly as high as in Southeast Utah. More distant assemblages, such as the Eastern Mesa Verde assemblages in the Durango district, generally have more San Juan Red Ware than predicted by the linear regression.

The AD 800-850 period shows similar patterns, although with fewer outliers in Southeast Utah with less San Juan Red Ware than expected. The r^2 value is slightly higher at 0.062. Central Mesa Verde once again shows extreme variation and overall slightly less San Juan Red Ware than expected. Assemblages in the Durango district also have more San Juan Red Ware than expected. A number of assemblages appear centered around 175 km in the Piedra and Navajo Reservoir/Fruitland districts. Overall, San Juan Red Ware values are as expected in this area, but even at

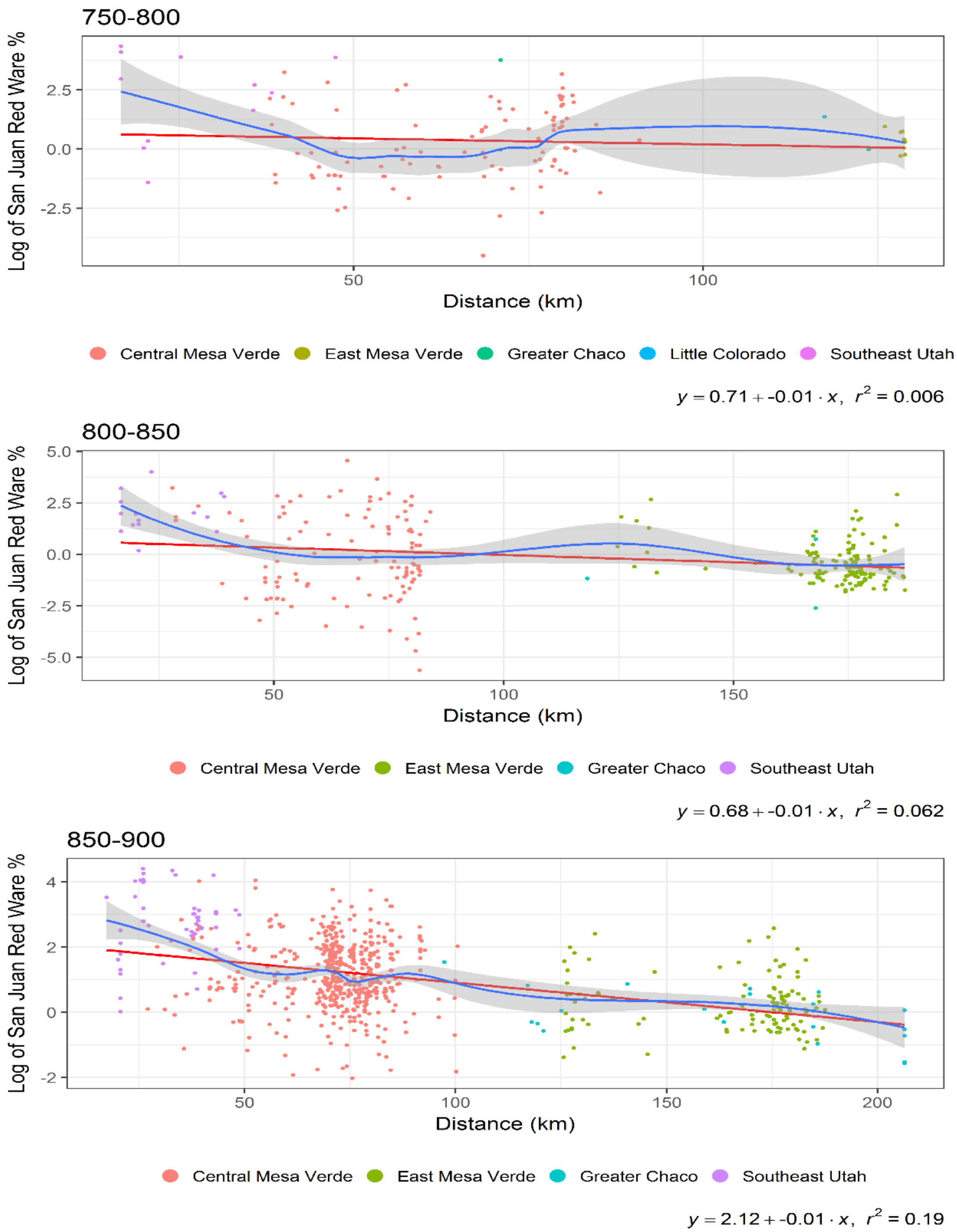
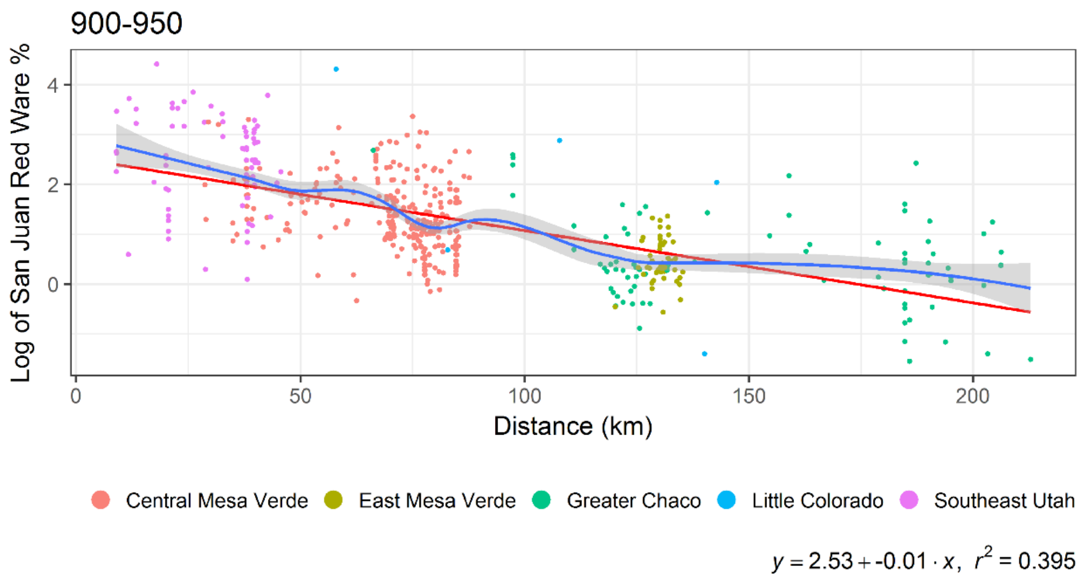


Figure 6.4. Fall-off curves showing the log of San Juan Red Ware against the distance from the center of the presumed production zone by period. The linear regression line (red) and loess curve (blue) with 95% standard error range (gray shaded area) are shown.

this distance some assemblages have nearly as much or more San Juan Red Ware as assemblages in Southeast Utah.



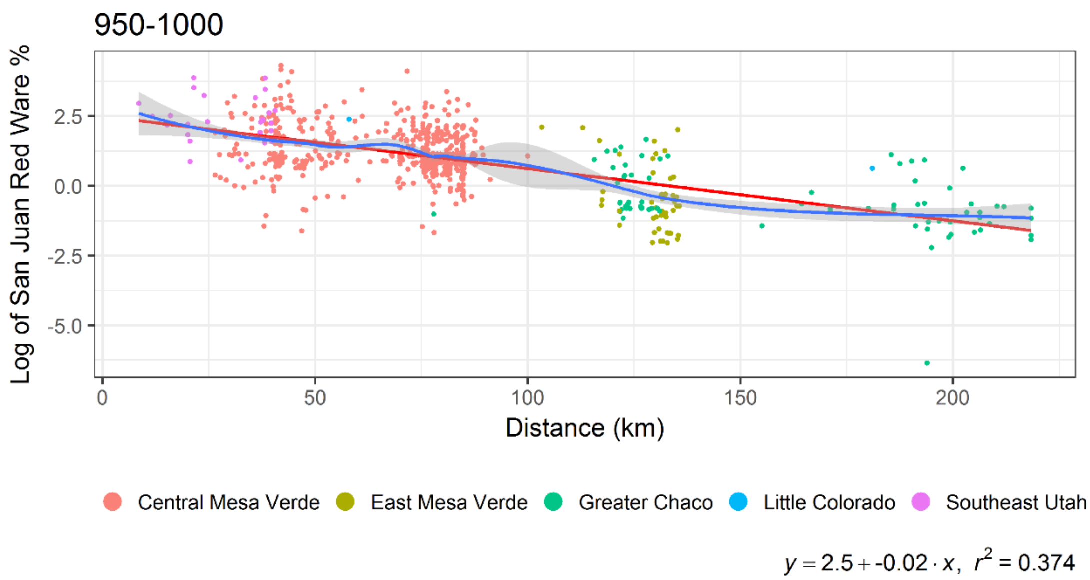


Figure 6.4 (continued).

The AD 850-900 begins to show a greater correlation with distance. The r^2 value is 0.19. Central Mesa Verde still has the greatest variation, but Southeast Utah now has a number of assemblages with higher San Juan Red Ware values. Assemblages in the Piedra and Navajo Reservoir/Fruitland districts again have higher San Juan Red Ware values than expected. Assemblages from Chaco Canyon first appear in my database and have only a small proportion of San Juan Red Ware that for the most part fall within the expected range. Overall, variation is smaller than in prior periods (note the changing scales), but still significant.

The correlation between distance and San Juan Red Ware is highest in the AD 900-950 period with an r^2 value of 0.395. Central Mesa Verde still has significant variation. Assemblages closer to the Utah border generally have higher San Juan Red Ware values than expected, whereas the more distant Central Mesa Verde assemblages have less than expected. The remaining Eastern Mesa Verde assemblages, mostly in the Durango district and the Cedar Hill area of New Mexico, have less San Juan Red Ware than expected. Several assemblages in and around Chaco Canyon now show much more variation than the preceding period, including a few assemblages with values closer to those expected for assemblages in Southeast Utah and Central Mesa Verde.

The AD 950-1000 period has only a slightly smaller r^2 value than the preceding period at 0.374. Variation in this period is much smaller than in earlier periods. Several assemblages in Central Mesa Verde have higher San Juan Red Ware values than assemblages in Southeast Utah and in this period the local regression indicates that average assemblages have the same or more San Juan Red Ware than expected. Assemblages in the Cedar Hill area again have generally less San Juan Red Ware than expected. Variation near Chaco Canyon is also less than the preceding period, but also has more San Juan Red Ware than expected at this distance.

This analysis further supports the tremendous variation in San Juan Red Ware from assemblage to assemblage seen in the distribution analysis. Distance is a factor in the distribution of San Juan Red Ware, but less so in the early periods, and distance never accounts for the majority of variation. Eastern Mesa Verde assemblages generally have more San Juan Red Ware than expected in the earlier periods, but this changes to a negative association over time. San Juan Red Ware appears to have very little association with early assemblages at Chaco Canyon, but it becomes more common over time. Distribution and fall-off curves only consider spatial distance and San Juan Red Ware values, but this next analysis attempts to consider variation across all ceramic types.

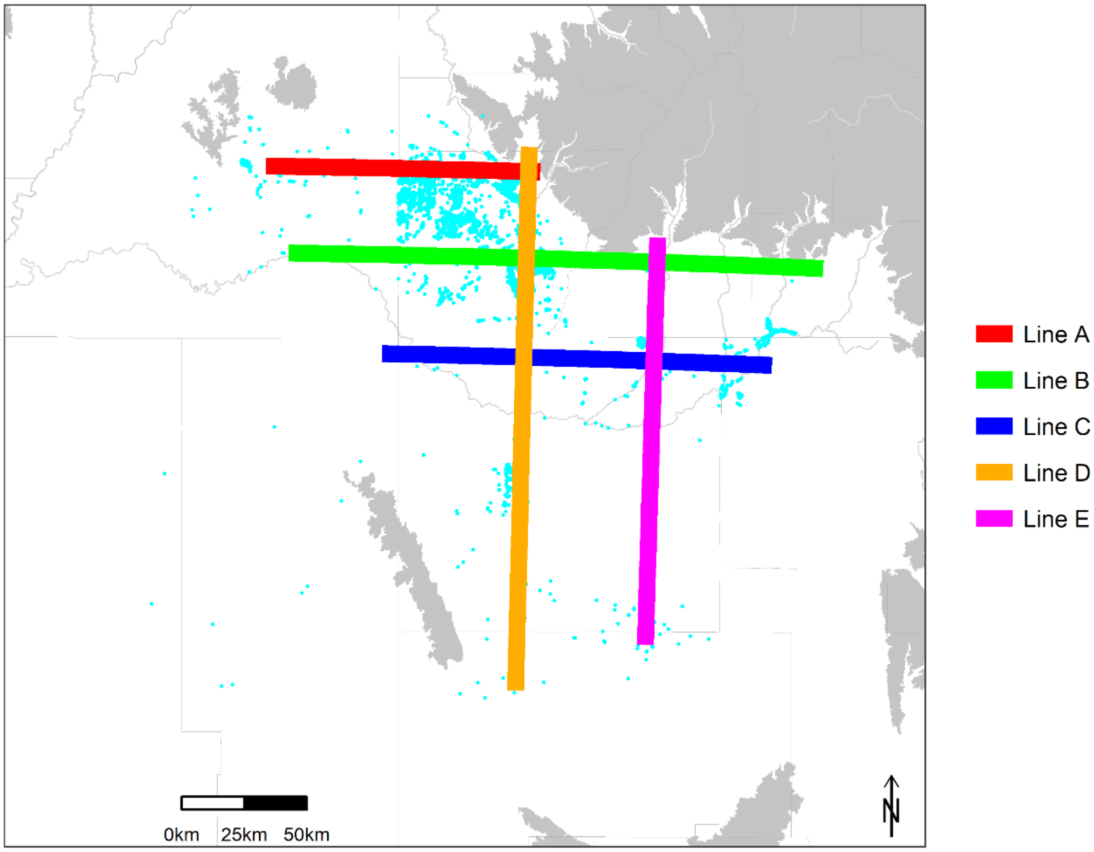


Figure 6.5. This map displays the cross-sections used to create distance diagrams comparing changes in Typenspektren and interpolated San Juan Red Ware values across geographic space (note the lines follow UTM grid lines and do not follow true north/south).

Distance Diagrams

As discussed in Chapter 4, distance diagrams can be used to evaluate the relationship between interpolated Typenspektren derived from similarities in ceramic assemblages and interpolated San Juan Red Ware proportions using IDW. Five cross-sections, or distance diagrams, of the Typenspektren and IDW were created to analyze these data in different areas. Figure 6.5 displays the lines discussed in this section. These lines were placed to best sample variation across four of the five regions in this study. The Little Colorado region has too little data to be of much value and is not well covered in this analysis. Note that for Typenspektren the lines do not need to directly cross assemblages in order to be influenced by them as the density

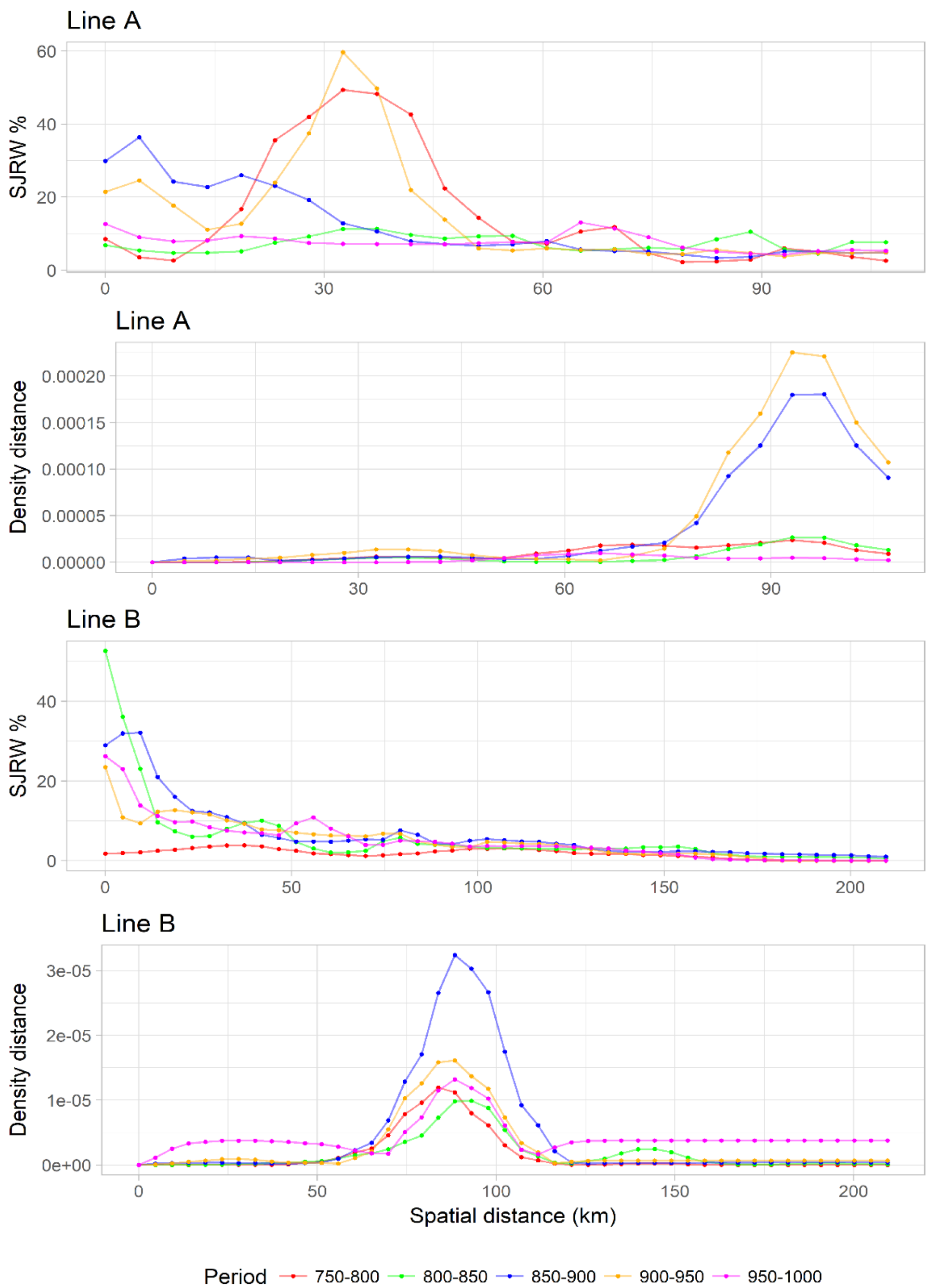


Figure 6.6. These plots use the lines shown in Figure 6.5 to compare Typenspektren and interpolated San Juan Red Ware (SJRW) proportions across geographic space by period.

values are interpolated using a bandwidth value of 9 km. The IDW values are also interpolated as discussed previously. The starting point is at zero density distance (density distance being the measurement derived from the Typenspektren), as that is the comparison point. Each point

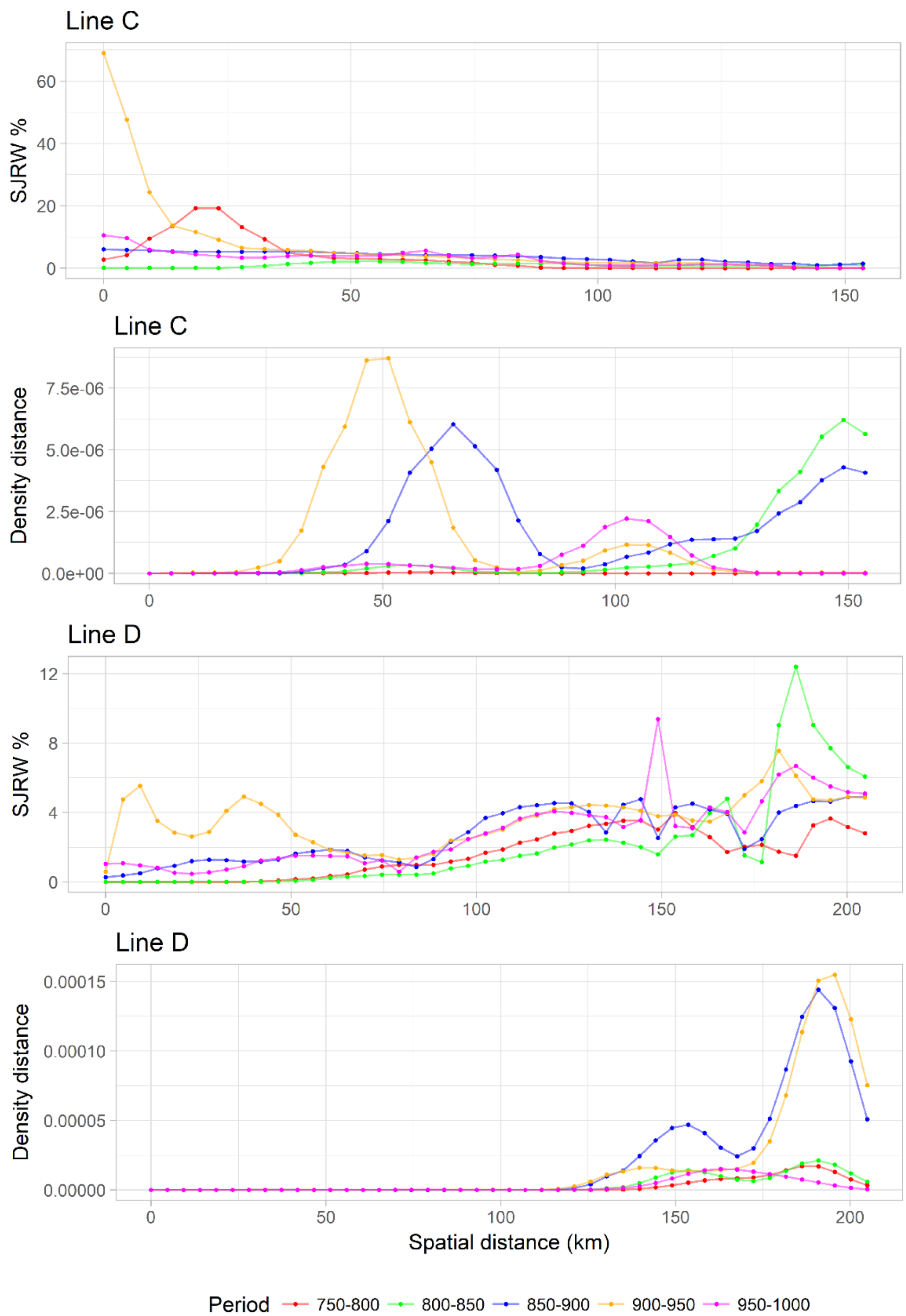


Figure 6.6 (continued).

along the line is compared to the starting value to determine how “distant” the area is from the comparison point using the computed Typenspektren values. Note that areas with low site density will show as very different from areas with high density, but the site density will have little

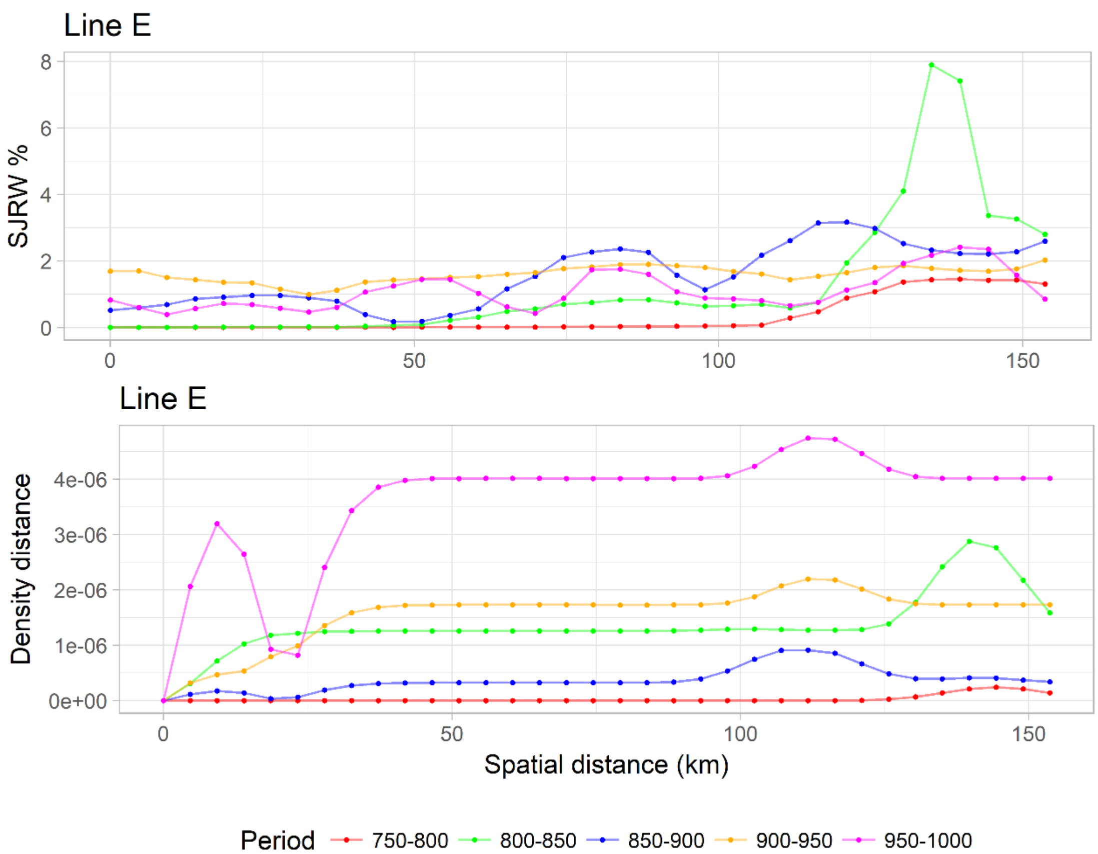


Figure 6.6 (continued).

impact for areas with at least a few sites. The average values in areas with no sites also varies by period. Starting points were chosen in areas where sites are found, as otherwise the comparison is only whether an area is different from an area with no sites. This discussion will consider each line separately by time period for both Typenspektren and IDW values (see Figure 6.6).

Line A runs across the northern portion of my study area from east to west. Only two periods, AD 850-900 and 900-950, show the Central Mesa Verde region as notably different than Southeast Utah. This result is unexpected, as particularly the AD 850-900 period has high San Juan Red Ware values, and I expected them to be more similar in this period. For these two periods a change in density distance occurs close to the Utah/Colorado border. San Juan Red Ware values show major variation in Southeast Utah from period to period, but are generally high except for the AD 800-850 and 950-1000 periods, where values are much lower. Many of

Table 6.4. Comparison of Ceramic Types Found at 42SA8308 and Sacred Ridge.

42SA8308	Sacred Ridge
Abajo Red-on-orange	Abajo Red-on-orange
Bluff Black-on-red	Arboles Gray
Chapin Gray	Bluff Black-on-red
Deadmans Black-on-red	Chapin Black-on-white
Mancos Black-on-white	Moccasin Gray
Mancos Gray	Rosa Black-on-white
Mesa Verde Black-on-white	Rosa Gray
Moccasin Gray	Rosa Neckbanded
White Mesa Black-on-white	

the assemblages with high San Juan Red Ware proportions in the AD 800-850 period are located near the San Juan River to the south and do not show on this line. Assemblages in Eastern Mesa Verde have almost as much San Juan Red Ware as the assemblages along this line in Southeast Utah. A small fall-off from east to west is visible.

Line B runs east to west starting near the Bluff sites along the San Juan River in Utah and runs across the Durango area in the northern part of Eastern Mesa Verde. Unlike Line A, the density distance increases significantly across the southern part of Central Mesa Verde. Curiously, assemblages in the Durango area do not show as very different from assemblages in the Bluff area, although the ceramics are quite different. For example, Table 6.4 shows the different ceramic types found at one site for each area. There are certainly similarities, but also many differences. This is likely due to low site density which is discussed later. San Juan Red Ware values are low along the San Juan River during the AD 750-800 period, but are very high in all other periods. The interpolated values show a fairly smooth fall-off from the Colorado border all the way across the northern San Juan, with a small increase in the Durango area in the AD 800s.

Line C starts in the northeast corner of Arizona and runs through the Navajo Reservoir/

Fruitland District of Eastern Mesa Verde. There are almost no assemblages near this line in the AD 750-1000 period and few assemblages in the 950-1000 period. Overall, the site density for this line is too low for much of a meaningful interpretation, but it is clear that the eastern part of the line has continuity between AD 800-850, although the area is not occupied after that point. The San Juan Biwall site causes a small jump in San Juan Red Ware values on the western portion of the line in the AD 750-800 period, but very little San Juan Red Ware is found in any period throughout the rest of the lines other than the 900-950 period where a few assemblages have extremely high proportions of San Juan Red Ware. Generally, this line shows very little San Juan Red Ware along the Colorado/New Mexico border, with the only exceptions in the western portion.

Line D runs from south to north and covers assemblages near the Chuskas, along the Chaco River, and up through Central Mesa Verde and particularly the Dolores area. The density distance changes little from period to period, with the exception of AD 850-900 and 900-950, which matches the changes shown in Line C at approximately the same area. No assemblages are present in my database in the first two periods for the southern part of the line, but it is clear that Central Mesa Verde is very different from the southern area in several time periods, although I would expect it to show major differences in all periods. San Juan Red Ware values increase as the lines run north, although notably AD 900-950 has a large spike in the south with average San Juan Red Ware values almost as high as those found in Central Mesa Verde during the same period. The Central Mesa Verde region shows much more variation running south to north than it does running east to west, although it is not clear why this would be the case.

Line E is the most difficult to interpret. The line starts approximately 13 km south of Chaco canyon and runs north through the Fruitland District to the San Juan Mountains. There is a jump in distance between the assemblages near the starting point and Chaco Canyon representing an area with no assemblages, which drops near Chaco Canyon and then increases again until the line meets the Fruitland district, where the site density increases for periods hen this area is occupied. The line also increases in the AD 800-850 period near the Durango, Colorado area. The steady portions of the line represent areas with no assemblages. The differences between periods likely reflect the differing backgrounds of the periods. It is notable that the distant assemblages always increase in density distance, indicating little ceramic similarity to the assemblages around Chaco Canyon. San Juan Red Ware values are low throughout the line with the highest values at close to 7% in the Durango area during the AD 800s.

Overall, the Typenspektren analysis does not show clear social boundaries. Whether this is caused by the analysis or reflects the reality that this area does not have strong social boundaries is not clear. The strongest social boundary appears to run along the Colorado border, but is only apparent in two periods. San Juan Red Ware values do decrease rapidly at around this this point, which may support the existence of a social boundary of some sort at this point. In other areas, San Juan Red Ware does not appear to rise or drop dramatically in any other area that might represent a social boundary, such as Chaco Canyon or the upper San Juan area in Eastern Mesa Verde. The large areas with no assemblages may be too problematic for this analysis to be truly effective, but it certainly shows cultural differences, in ceramics at least, between several areas.

Social Network Analysis

Social network analysis (SNA) was used to calculate eigenvector centrality scores for each assemblage in my database using the methods detailed in Chapter 4 (see Figure 6.7). Other measures were explored, but this measure appears to best represent the importance of each assemblage in the overall network structure and also deals well with missing nodes, which is advantageous for many archaeological networks where a number of assemblages are not represented. Higher eigenvector values represent assemblages that are more central in

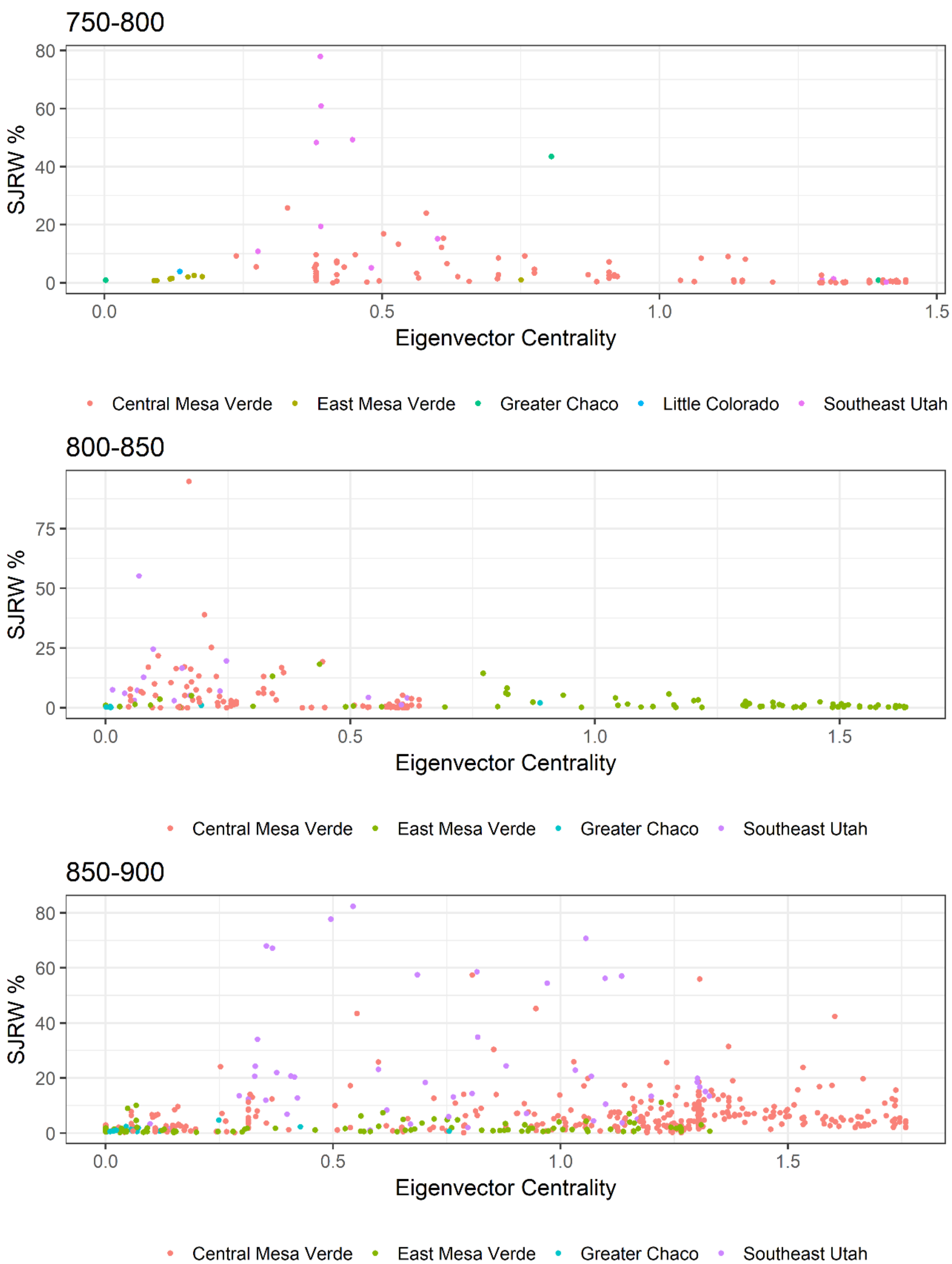


Figure 6.7. Comparison of eigenvector centrality for weighted social networks to San Juan Red Ware (SJRW) proportions by period.

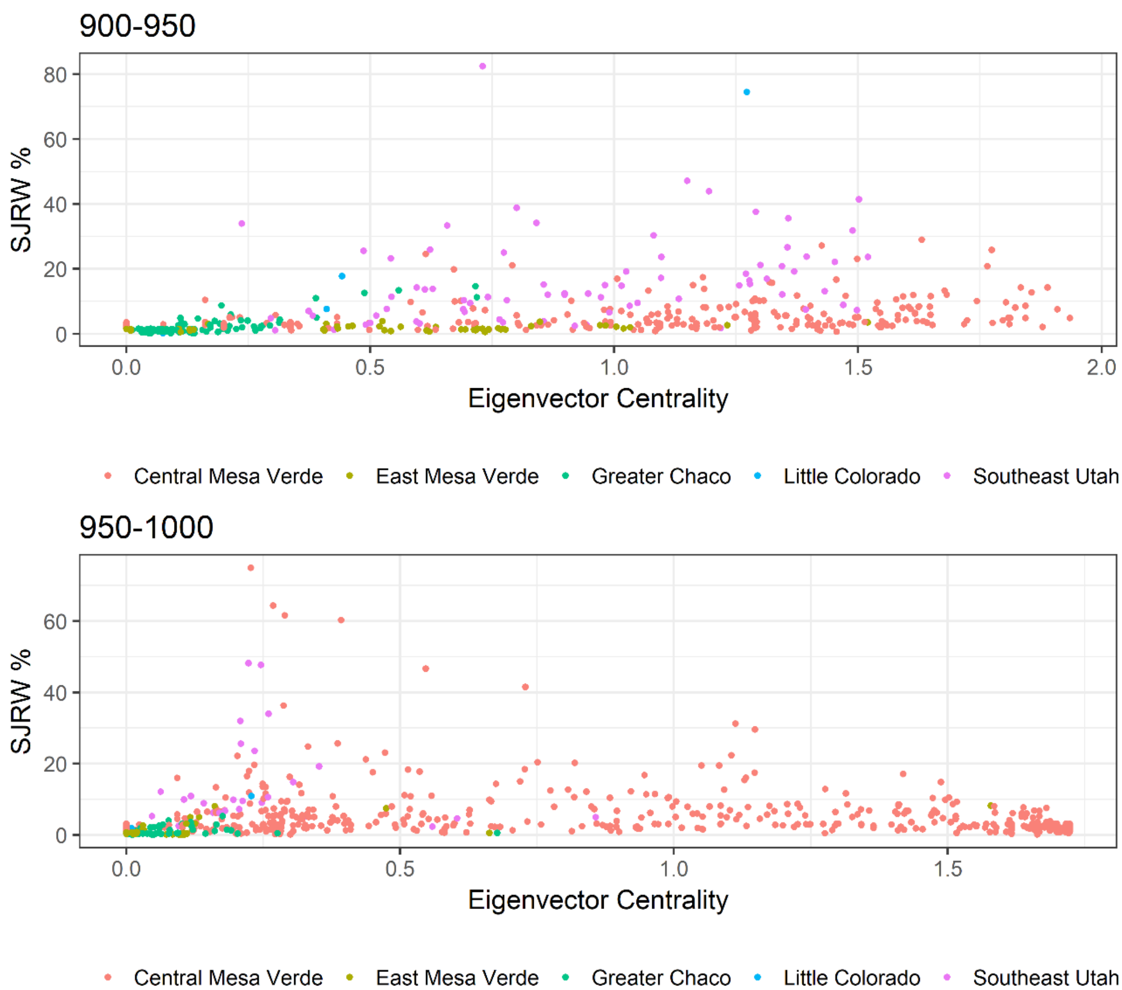


Figure 6.7 (continued).

the network. Most of the plots show little linear correlation between centrality and San Juan Red Ware proportions, thus regression analysis was not used for this analysis. I first discuss the centrality scores for the full networks. I then compare these data to the centrality scores computed after removing all other assemblages within 18 km.

Assemblages that have little to no San Juan Red Ware are both the most and least central assemblages in the AD 750-1000 period. Assemblages in Southeast Utah and Central Mesa Verde with the highest San Juan Red Ware proportions are somewhat less central than the average assemblage. The AD 800-850 period shows a marked decrease in centrality for assemblages

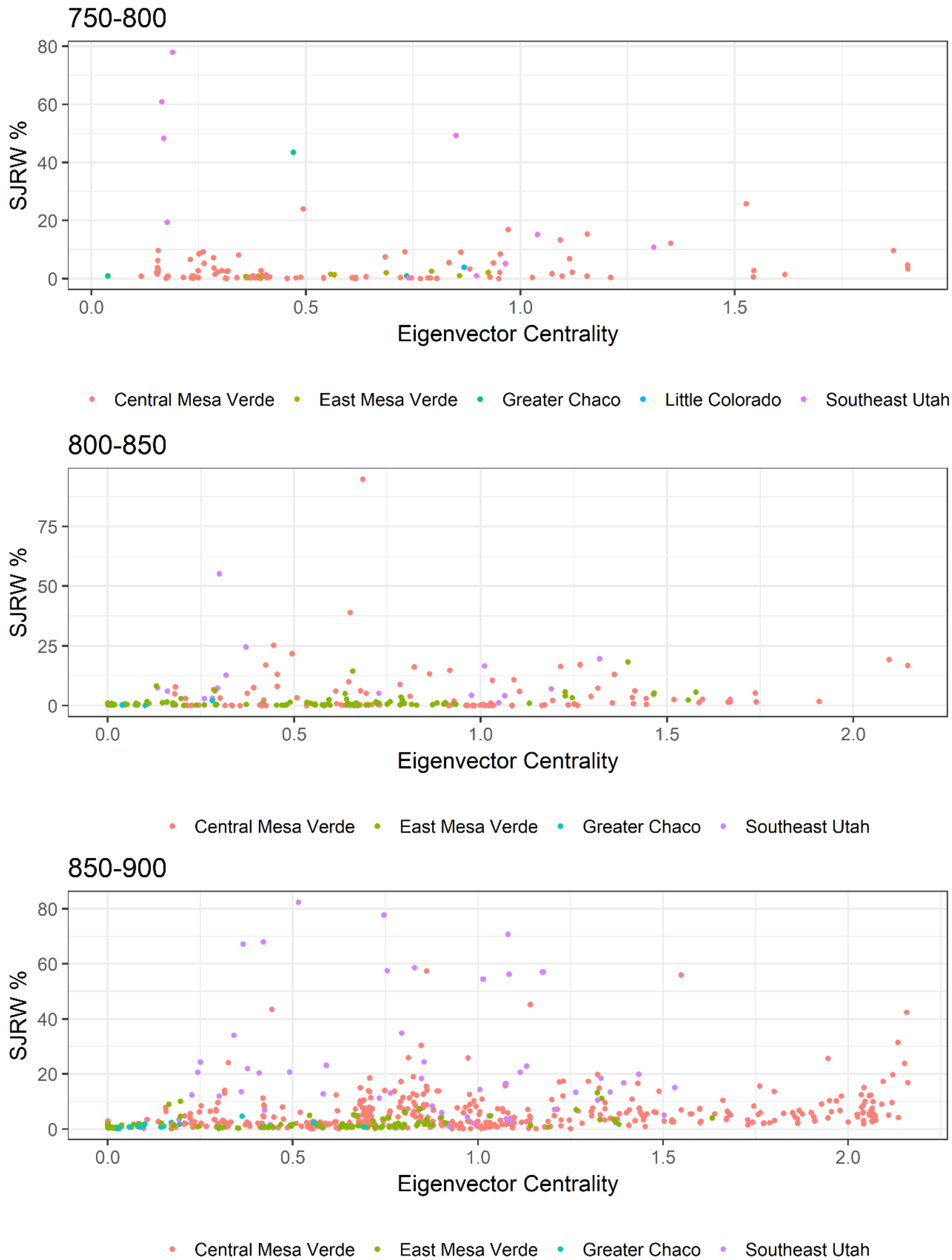
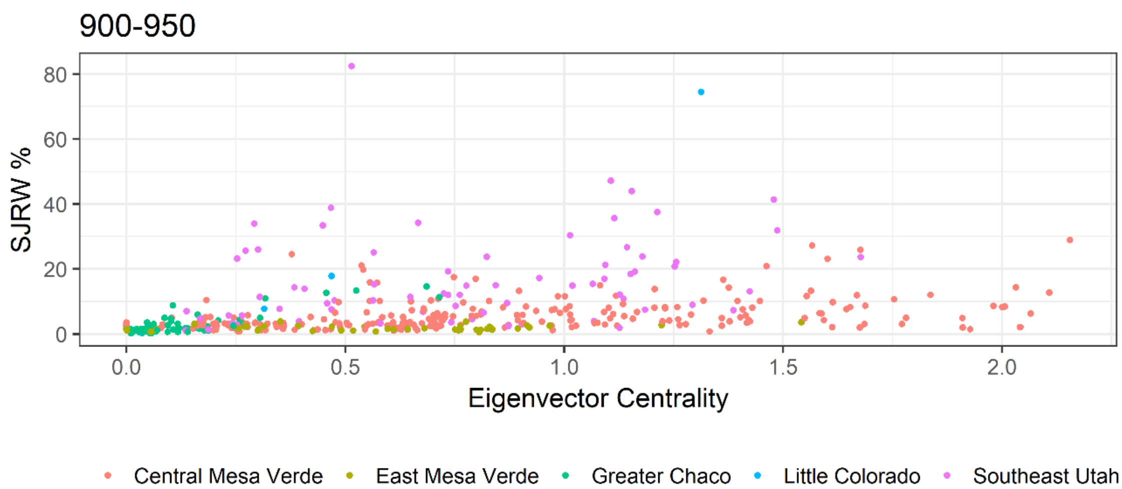


Figure 6.8. Comparison of eigenvector centrality for non-local weighted social networks to San Juan Red Ware (SJRW) proportions by period.



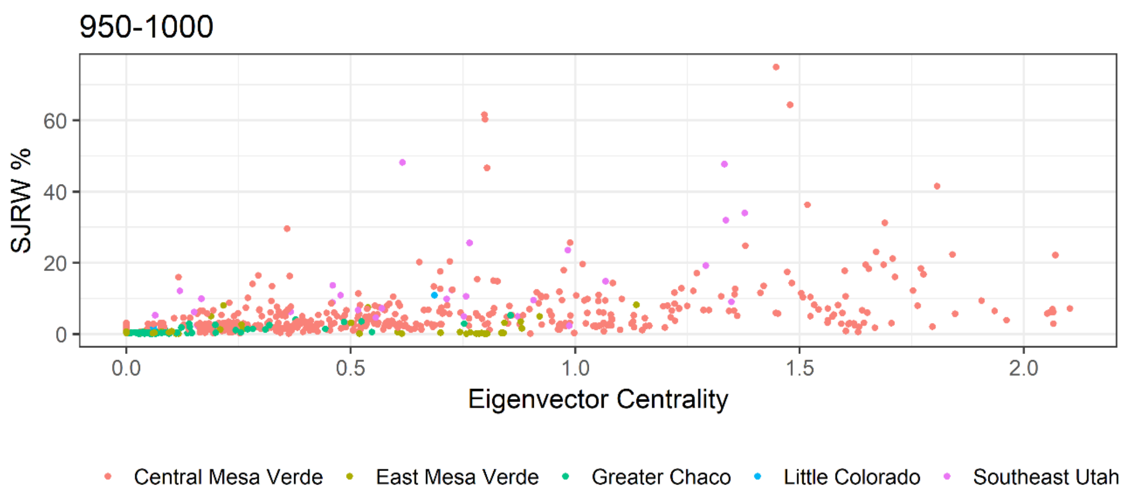


Figure 6.8 (continued).

with high San Juan Red Ware proportions. This appears to be caused by the high centrality of assemblages in Eastern Mesa Verde. This likely is caused by the large number of assemblages in my database from Eastern Mesa Verde during this period. This region has the highest number of assemblages for any region during this period, whereas Central Mesa Verde has significantly more assemblages in later periods. The effects of local assemblages are addressed in the next paragraph. The AD 850-900 period shows a complete change in centrality. Some Eastern Mesa Verde assemblages now show as the least central assemblages, although there is a large continuum, and San Juan Red Ware values are above 10% for several of the most central assemblages. There is no strong correlation during this period, as many assemblages with high San Juan Red Ware values also have low centrality. Greater Chaco assemblages also have low centrality during this period and for each of the following periods. This matches observations from the Chaco Social Networks project (Peeples, Mills, Clark, Bellorado, et al. 2016) that the northern San Juan region was mostly disconnected from the Chaco network for much of the height of the Chaco period. The AD 900-950 period has less variability between San Juan Red Ware proportions and network centrality than the preceding period, but is overall similar. The AD 950-1000 period shows the strongest correlation between San Juan Red Ware proportions and network centrality, but it is a negative correlation. Centrality decreases along with the San Juan Red Ware proportion. A number of assemblages with little or no San Juan Red Ware also have low centrality. Despite the negative correlation, a number of highly central assemblages have almost 10% San Juan Red Ware, indicating that San Juan Red Ware is still somewhat important to network centrality.

A potential problem for this analysis is best demonstrated in the AD 800-850 period in Figure 6.7. The most central assemblages are all in the Eastern Mesa Verde region, but it appears this is due to the large concentration of assemblages in the database. Thus, the network centrality may be more indicative of local connections rather than long distance connections, which are of primary interest in this thesis. As discussed in Chapter 4, eigenvector values were also calculated for each assemblage after removing all other assemblages within 18 km (see Figure 6.8). The most notable difference in these plots is that the Eastern Mesa Verde assemblages that were highly central in the AD 800-850 period now show low centrality values. These plots also show little correlation between San Juan Red Ware proportions and network centrality, but many of the most central assemblages now show higher proportions of San Juan Red Ware than in the previous analysis. This matches expectations that San Juan Red Ware would be associated with assemblages that demonstrate greater long-distance connections. Similar trends, however, are

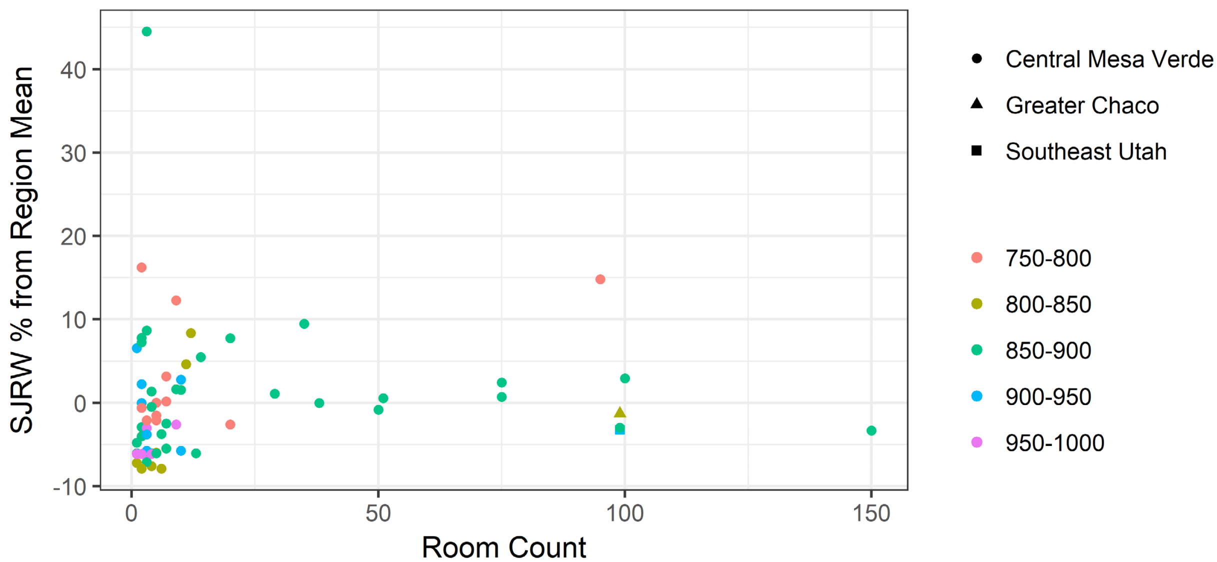


Figure 6.9. Comparison of the difference in San Juan Red Ware (SJRW) proportion from the region mean compared to the number of rooms at the site.

still identified in these plots, as San Juan Red Ware proportions are highest for highly central assemblages in the AD 850-900 period, and in general highly central assemblages have higher proportions of this ware in later periods than in earlier periods. Notably, the negative centrality to San Juan Red Ware proportion correlation during the AD 950-1000 period is no longer visible after adjusting for local sites in the network.

Overall, this analysis correlates well with my other analyses. SNA indicates that San Juan Red Ware was not strongly associated with highly central assemblages early in its production history, although it was present, but it became more common at assemblages that were highly central in ceramic exchange networks over time.

Room Counts

The Village Ecodynamics Project and Chaco Social Networks Database both contain room counts estimates for each site where data is available. This is the best proxy for site size available in these data and can be used to compare the relationship between site size and San Juan Red

Ware proportion. Because San Juan Red Ware proportions vary by region and period, I chose to compare the difference between the observed San Juan Red Ware proportion and the mean value for San Juan Red Ware for each region and period that was used as the prior estimate in the Bayesian empirical estimation discussed in Chapter 4.

Many of the sites containing data on room counts have multiple occupations or multiple subunits of the site reported. This is problematic as the room counts are only reported at the site level. To mitigate these effects, I removed all sites with subunits dating after AD 1000 and combined the data for all subunits in the remaining sites. Some of these sites likely have occupations spanning more than one period, but given the available data the best solution is to recalculate the mean ceramic date using the combined data. The room count data covers multiple periods and regions, and the mean San Juan Red Ware proportion varies with both variables. Figure 6.9 shows the difference between the San Juan Red Ware proportion and the mean San Juan Red Ware proportion for each period and region compared to total room counts. The greatest variation in San Juan Red Ware proportions occurs for small sites, although it may be a sample size issue. Only two sites with more than 25 rooms have San Juan Red Ware proportions more than 5% above the region and period mean, and no sites have less than 5% difference from the region and period mean. The Periman Hamlet site (5MT4671) is in Central Mesa Verde in the AD 850-900 period and has 35 rooms with 16% San Juan Red Ware, but over 98% of the decorated ceramics are San Juan Red Ware. Martin Site 2 is also in Central Mesa Verde and dates to the AD 750-1000 period with 95 rooms. This site has 17% San Juan Red Ware and 97% of the decorated ceramics are San Juan Red Ware. Its sister site Martin Site 1 has 75 rooms and two great kivas. This site only has 8% San Juan Red Ware, but 93% of the decorated ceramics are San Juan Red Ware. This shows one of the advantages of also looking at decorated percentages. This analysis shows that large sites are close to average for San Juan Red Ware proportions.

Martin Site 1 and Martin Site 2 were excavated by Paul Martin (1939) and are located in western Colorado about 21 km from the Utah border. Site 1 and Site 2 are located less than 50 meters from each other. Site 1 has an adjusted MCD of AD 858, while Site 2 has a date of 791. Tree-ring dates reported by Martin (1939) for several structures at Site 1 all date between AD 855 and 872. Tree-ring dates from Site 2 place initial construction at around AD 760. This fits Allison's (2008a, 2008b) proposed modified start date for Abajo-Red-on-orange. These sites show a continued, strong association with San Juan Red Ware for more than a century.

There are not enough data for sites with room counts to say much outside of Central Mesa Verde. It appears that, in this region at least, large sites typically had an average amount of San Juan Red Ware for the region and period.

DISCUSSION

A synthesis of the results and further discussion is included in the next chapter. Here I briefly evaluate the effectiveness and advantages or disadvantages of the methods used for this analysis. The IDW is effective at showing hot spots where San Juan Red Ware is generally common, but it was limited by the large variability from assemblage to assemblage and really only showed large hot spots in areas with few assemblages. It was still useful in many areas; however, and was particularly useful for showing the widespread, but low distribution of San Juan Red Ware. The hexagon bins were effective for smoothing the data and have the additional advantage of more clearly showing where assemblages are not present. The major drawback for this method is that the size and placement of the hexagons can give different results. Overall, this is not an issue, but can cause differences in smaller areas.

The fall-off curves were not particularly useful for determining exchange patterns, but were useful in showing either a lack of correlation with distance in the early periods, or a somewhat stronger correlation in the later periods. This method was also one of the more effective methods for showing the extreme variability in San Juan Red Ware percentages for assemblages located approximately the same distance from the production center of San Juan Red Ware. One of the challenges of this method was picking a production center, as San Juan Red Ware was produced across a large area, but the chosen point does not appear to have greatly biased the analysis. The Typenspektren analysis was the most problematic. The primary issue appears to be the large areas with low site density. Areas with high site density can be problematic if the wrong bandwidth is used for the kernel density estimation, but the value chosen appears to match the density well and mostly eliminated problems in high density areas. This analysis does appear to be useful in certain situations and it clearly distinguished some areas that were markedly different, although it appeared to not separate other areas as well as it should have. The density diagrams were useful for examining the IDW values from a different viewpoint. These diagrams are similar to the fall-off curves but use smoothed data, which better shows the effects of distance on San Juan Red Ware proportions.

The SNA proved useful for looking at San Juan Red Ware from a different perspective, particularly a perspective that does not include geographic distance. Likely the uneven coverage of assemblages in many areas affected the analysis in some ways, but in general the results correlate well with the results from the Chaco Social Networks Project (Peeples, Mills, Clark, Bellorado, et al. 2016). While the shapes of the networks are not shown or discussed, the most relevant factor was the ability to calculate the centrality for each assemblage and compare it directly to San Juan Red Ware values. The results also fit expectations for San Juan Red Ware becoming more central over time. In general, these methods prove complementary and indicate that the use of multiple methods can better uncover patterns in the data.

7 Discussion and Conclusions

In the previous chapter, I presented and discussed the results of the several analyses I conducted. This chapter discusses these results in the context of other San Juan Red Ware research as well as general historical trends, such as population movement, for the northern San Juan. I first discuss the relationship between the distribution of San Juan Red Ware and exchange. I next discuss how my results and prior studies contribute to an understanding of the relationship between San Juan Red Ware and identity. Several studies discuss San Juan Red Ware in a ritual context, and I discuss how my research contributes to these studies. I also present my conclusions to the various questions posed in this thesis, summarize my results, and discuss suggestions for future research that will further contribute to understanding the social context of San Juan Red Ware.

SAN JUAN RED WARE EXCHANGE

The location of the production area of San Juan Red Ware is, perhaps, the first question that should be addressed. The NAA results are the most effective method so far applied to San Juan Red Ware (Hegmon 1995; Glowacki et al. 2002; Allison 2010; Allison and Ferguson 2015), but a better understanding of the distribution of San Juan Red Ware also bears on this problem. If areas with the greatest proportion of San Juan Red Ware in Utah represent production locales, then production was centered around Montezuma Creek, the San Juan River, and Blanding, Utah. This analysis suggests the production centers may have shifted over time. For example, no assemblages are found along the San Juan River near Bluff, Utah, in the AD 750-800 period, but all assemblages found in later periods in this area have high proportions of San Juan Red Ware. Any conclusions regarding shifts in production locales should be considered tenuous, as not all assemblages have been located or included in my database. Also, I only show each assemblage in one period, but the assemblages could represent occupations belonging to more than one or even all periods used here. Overall, my analysis confirms that Southeast Utah is the most likely production area for most San Juan Red Ware. Western Colorado, near the Utah border, is the most likely location for production of this ware outside of Utah, as there are many assemblages in different periods with unusually high proportions of San Juan Red Ware. This matches the proposed location of an NAA source group identified by Allison and Ferguson (2015) and a production location suggested by Glowacki and colleagues (2002). Other potential production locations would be the Dolores area or the northernmost assemblages in Central Mesa Verde, but the high proportions of San Juan Red Ware there easily could be accounted for by exchange and no other indicators I am aware of suggest that these locations are likely production areas.

The distribution analyses also demonstrate that San Juan Red Ware was found throughout the area of this study, although it was less common in the southern areas. Comparably little San Juan Red Ware is found in the area of Chaco Canyon, but it is notable that there is a relatively significant increase in San Juan Red Ware from the AD 850-900 period to 900-950 period in the southern Greater Chaco region. AD 850 is the start of great house building in Chaco Canyon, and it appears that the events in and around Chaco Canyon may have drawn some individuals who participated in San Juan Red Ware exchange or at least increased participation in San Juan Red Ware exchange; however, San Juan Red Ware proportions are higher to the west of Chaco Canyon near the Chuska Mountains than in the canyon itself. Also, this relationship doesn't seem to last long, as the proportion of San Juan Red Ware decreases in the AD 950-1000 period.

While the question of where San Juan Red Ware production is most abundant is easily answered, the question of why it was traded so far is more complicated. There are a number of aspects of exchange that cannot be reasonably determined by the analyses used in this thesis; however, some possibilities can be discussed. San Juan Red Ware is likely a "socially valued good" as defined by Spielmann (2002) and discussed in Chapter 1. San Juan Red Ware was exchanged widely across great distances and "transcends the technical and stylistic boundaries apparent in gray and white wares" (Hegmon et al. 1997:452). Morris (1939) describes San Juan Red Ware vessels as better formed than other ceramic wares in the region, which also relates to its social value. Wilshusen and Ortman (1999:387) also state, "Red ware most commonly occurs as well-made, carefully painted bowls and clearly was a valued non-local pottery." The reason San Juan Red Ware was exchanged so widely must relate to its social value, as a utilitarian explanation is unlikely (Hegmon et al. 1997:452). The question remains whether these vessels were valued generally across the northern San Juan. In other words, did everyone want them or have access to them?

The various distribution maps and fall-off curves clearly indicate that many assemblages in Southeastern Utah did not have much San Juan Red Ware. Distance would not have much of an effect on the proportions of San Juan Red Ware at these sites. If everyone wanted San Juan Red Ware, then there must be other factors preventing individuals from acquiring it. On the other hand, not everyone may have wanted these vessels. The large variation in San Juan Red Ware proportions seen in Southeastern Utah is also found in many other areas. The fall-off curves particularly show tremendous variation in San Juan Red Ware proportions for assemblages located the same distance from the hypothesized center of San Juan Red Ware production. Likely, some individuals chose not to participate in San Juan Red Ware exchange.

One purpose of the social network analysis is to attempt to measure how San Juan Red Ware relates to ceramic exchange networks in the area. Were individuals at sites with the most connections to other areas acquiring San Juan Red Ware more, less, or the same as individuals living at sites with fewer of these ties. The measure used to indicate how closely individuals at a site were connected to other sites through ceramic similarity is network centrality. The relationship between assemblages with high proportions of San Juan Red Ware and their centrality in ceramic similarity networks changes over time. Network ties do not necessarily mean that assemblages with similar assemblages participated in exchange with each other, but it does indicate a strong social connection. My analysis indicates that highly central assemblages had less San Juan Red Ware initially, with only a few exceptions. San Juan Red Ware was most strongly associated with assemblages with high centrality in the AD 850-900 period, and although the relationship decreased somewhat in the last two periods, it remained stronger than the earliest periods. The centrality scores calculated after removing local assemblages does show that most highly central assemblages did have some San Juan Red Ware. A possible interpretation for these results is that individuals with San Juan Red Ware vessels became more integrated with other social groups over time.

Social boundaries affect exchange and interaction in many ways. The distance diagram analysis using Typenspektren does show clear differences between ceramics in Central Mesa Verde, Eastern Mesa Verde, and Chaco and smaller differences between other areas, such as Southeast Utah. This matches existing regional ceramic traditions (see Chapter 3). The uneven site density proved problematic in identifying specific social boundaries, but the San Juan Red Ware IDW indicates that a boundary for the ware may have existed somewhere close to the Utah/Colorado border. After this point, the smoothed San Juan Red Ware distribution does not indicate any other social boundaries that inhibited the movement of San Juan Red Ware. This seems to indicate that although distinct geographically-bound ceramic traditions existed, they did not have much impact on long distance San Juan Red Ware exchange.

The analysis of the effects of site size using room counts was limited mostly to Central Mesa Verde. In this region at least, assemblages from large sites have approximately as much San

Juan Red Ware as would be expected. This analysis suggests that there is no strong relationship between site size and the proportion of San Juan Red Ware where data was available for this study, but a more detailed analysis is necessary to analyze this relationship.

If we assume that San Juan Red Ware held general value, then we must first account for why some people hundreds of kilometers away from Southeast Utah acquired more than people in or near Southeast Utah. Hegmon and colleagues (1997:460) do not rule out movement by migration, but they suggest that at least some of the vessels were moved by exchange. They note that further research is needed on the distribution of San Juan Red Ware to address its relationship to population movements. Allison (2008a:63) suggests that individuals in the northern San Juan maintained individual exchange networks, which allowed some individuals to obtain more San Juan Red Ware than others. He further notes that ethnographic data indicated these networks were likely kin-based (Allison 2008a:63). In other papers, Allison (2017a, 2017b, 2018) has used agent based modelling to simulate kinship networks across villages to study how kinship ties to villages producing pottery affect the number of pots they were able to obtain. He found that individuals in distant villages from the producing villages obtained a large number of pots based on close kinship connections to the producing villages. In the context of San Juan Red Ware, this could explain some of the variation found in closely related sites that have large variations in the relative proportion of San Juan Red Ware vessels each village acquired. My study cannot identify individuals, but the variation at each site could be explained by only a few individuals with close kinship or other connections to individuals within San Juan Red Ware production locales or even with the potters producing San Juan Red Ware. Thus, sites with little or no San Juan Red Ware may not have had easy access to it.

While individual migration, such as movement resulting from marriage, can account for these patterns, larger migrations can also change individual exchange networks. Widespread migration is a common theme for the Southwest. The recent synthesis of the early Pueblo period by Wilshusen and colleagues (ed. 2012) indicates several major migrations occurred in the area of this study. As discussed in Chapter 2, much of the AD 800s is characterized by a major population influx into Central Mesa Verde, primarily from the regions to the east and west. San Juan Red Ware is most common and, perhaps, socially most important during the AD 850-900 period. This seems a likely outcome of the migration of a large number of people from Southeast Utah, which probably occurred during this period. Some of the San Juan Red Ware found in Central Mesa Verde would have been carried directly by migrating individuals, but the large number of San Juan Red Ware vessels also suggests continued ceramic exchange using connections with individuals still in Southeast Utah. Although perhaps not everyone wanted San Juan Red Ware and only individuals with a specific social identity associated with these vessels acquired it.

Another explanation for the variability in San Juan Red Ware could be economic, but this is unlikely. It is possible that some individuals had greater access to San Juan Red Ware due to their economic success as specialized craftsmen, owners of desirable resources, or other means; however, I am not aware of any evidence to suggest this is the case. I would expect distance to play a greater role if economic factors are the main driver of San Juan Red Ware acquisition and that larger villages would have more San Juan Red Ware. I find it more likely that individuals sought access to San Juan Red Ware as an important part of their identity and acquired these vessels through individual exchange networks.

SAN JUAN RED WARE, IDENTITY, AND RITUAL

Allison (2008a:63) states, “The relationship between San Juan Red Ware exchange and identity is complex and changed over time.” Much of the discussion on the relationship between San Juan Red Ware and identity focuses on communal rituals. Allison (2008a:43) notes that individual exchange networks can crosscut social boundaries but are usually formed from individuals with similar group-level identities. This fits well with the categorical and relational identities discussed in Chapter 1. Relational identities are often strongest among individuals with similar categorical identities. Allison (2008a) relates communal activity to building group-level or categorical identities. San Juan Red Ware appears to be associated with communal activities that helped construct a local categorical identity in the late AD 800s (Blinman 1989), but, outside of Southeast Utah in the late 700s and early 800s, it appears to be either strictly relational or, more likely, a combination of a widespread categorical identity and a relational identity created through San Juan Red Ware exchange (Allison 2008a). Spielmann's (2004b) study at Site 13 on Alkali Ridge suggests that San Juan Red Ware was important for local community building in the early AD 700s in Southeast Utah, and she suggests this association spread over time. This observation matches well with changes in distribution and network centrality during the same periods in my analysis, as exchange of these vessels appears to become more common and widespread over time. Additional evidence that San Juan Red Ware is important to social identity is discussed by Allison (2008a; see Chapter 3 for additional discussion). He suggests that some San Juan Red Ware vessels may have been specifically acquired as burial objects. This suggests that San Juan Red Ware was important to identity and is also tied to a belief system.

Wilshusen and Ortman (1999) suggest that multiple social groups were present in the Dolores, Colorado area. Architectural differences are primarily used to infer that at least two social groups occupied the area and were separated by the Dolores River (see Figure 7.1 for location). They also note that San Juan Red Ware is concentrated in the horseshoe-shaped roomblocks on the west side of the river (Wilshusen and Ortman 1999:388). Figure 7.2 shows the sites within the Dolores Archaeological Program area by period, as well as the proportion of San Juan Red Ware to the total decorated assemblage. The association between San Juan Red Ware and the western side of the river is evident, but San Juan Red Ware is still present in high amounts at a number of sites on the eastern side of the river, particularly for the AD 850-900

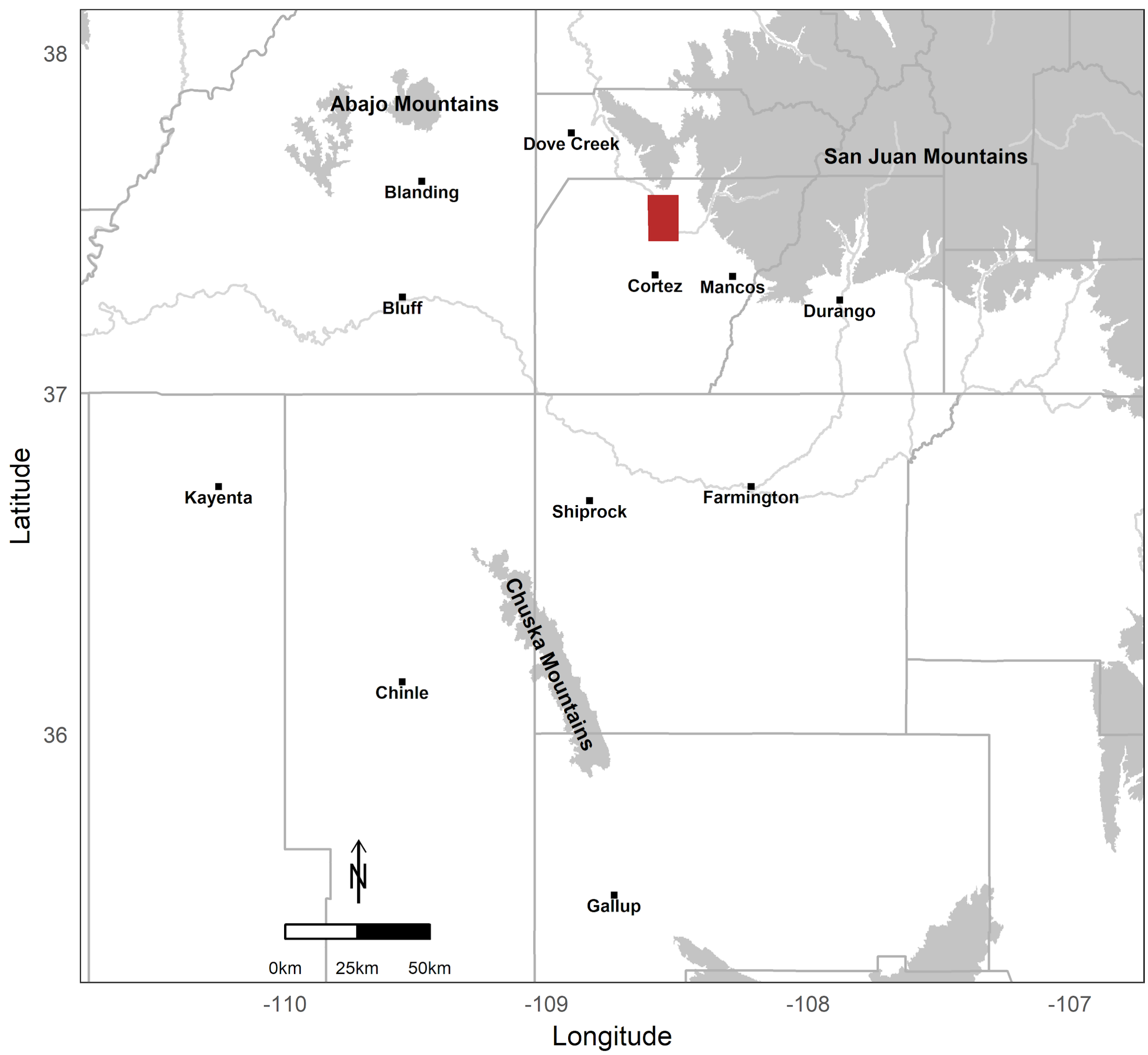


Figure 7.1. Location of the Dolores Archaeological Project.

period. Thus, even though San Juan Red Ware may have been more associated with individuals on the west side of the river, it still crosses social boundaries (if the river is indeed a social boundary).

According to the definition of relational identity discussed in Chapter 1, San Juan Red Ware exchange builds a shared identity due to the interaction required to exchange goods. There is also good evidence that this ware reflects a categorical identity; however, what is less clear is

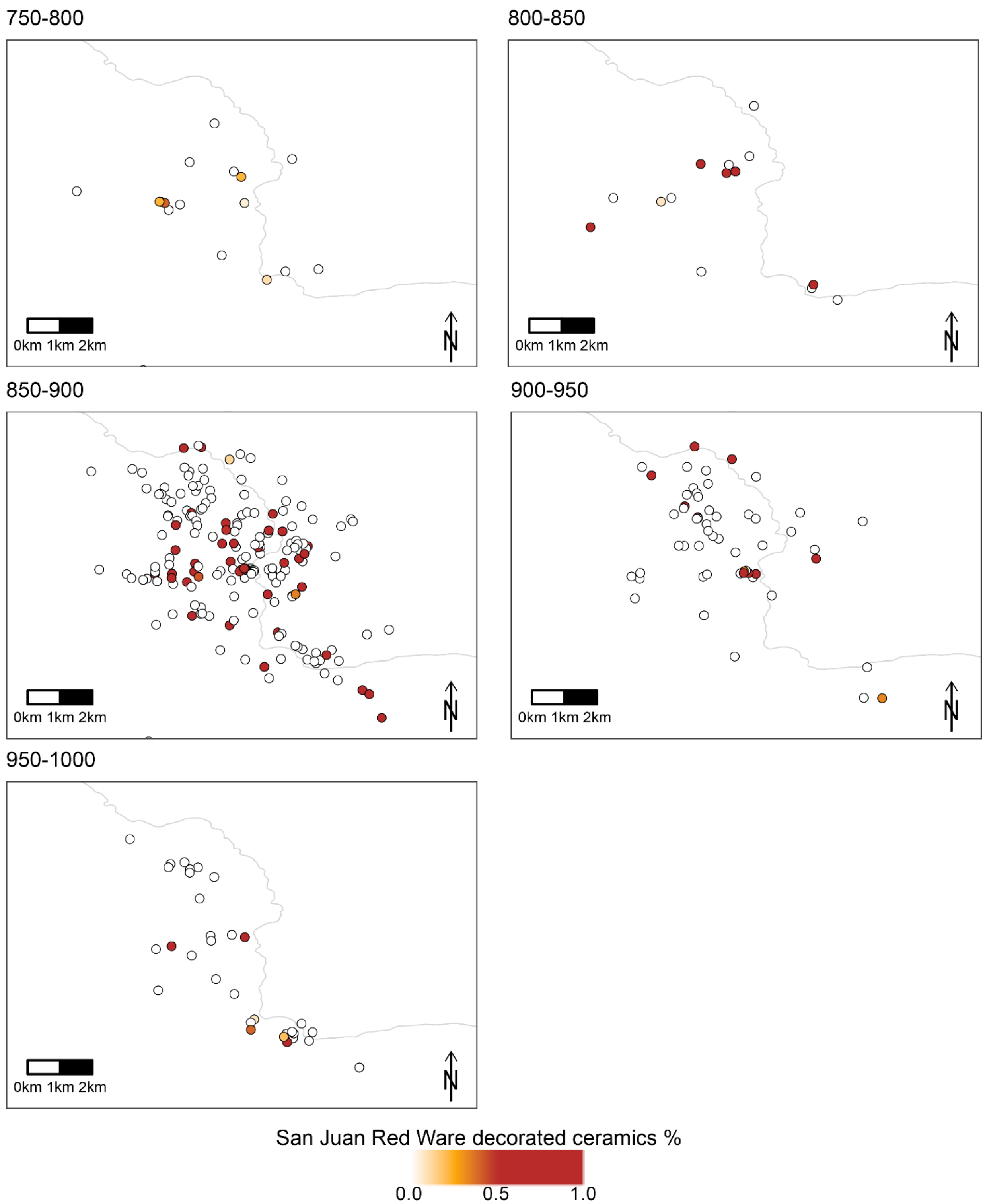


Figure 7.2. Sites within the Dolores Archaeological Project boundary by period showing the proportion of San Juan Red Ware.

the nature of the categorical identity it represents. The data available in this thesis limit what can be said about the categorical identity represented by San Juan Red Ware, as this identity likely involved much more than a few pots, but the distribution of San Juan Red Ware does indicate something about the geographic space of this San Juan Red Ware identity. The distribution analysis demonstrates that there are few areas where San Juan Red Ware is common at all the assemblages in an area, and all of the areas with a sufficient number of assemblages to represent a strong cluster of assemblages with high San Juan Red Ware proportions are located in Southeast Utah. Elsewhere, assemblages with high proportions of San Juan Red Ware are scattered among assemblages with little or no San Juan Red Ware. In these areas, San Juan Red Ware does not appear to be associated with a local categorical identity. Thus, San Juan Red Ware, in most cases, seems to represent a broadly shared categorical identity across the northern San Juan and some areas to the south, although it is likely not shared by all the inhabitants of this region. The categorical identity represented by San Juan Red Ware could represent a number of different relationships: possibilities include kinship, belief system/religion, political system, or sodality. It is unlikely to be a political system, as it is found in so many sites and areas. If it is a kinship connection, then it represents a large group of related people. These groups could be clans or moieties or, perhaps, just a large network of affinal ties. Likely it is a combination of kinship connections and specific beliefs held in common by individuals participating in San Juan Red Ware exchange. Spielmann (2004b:223) suggests the following about San Juan Red Ware:

> Red ware bowls may materialize some aspect of a new ideology that likely developed as formerly dispersed people established the first large villages ever to be occupied on the Colorado Plateau. The scale of early aggregation in southeastern Utah indicates that the Pueblo I period villages in this area were organized very differently, both socially and ceremonially, from the earlier

> Basketmaker populations. It is possible, then, that the scale of early aggregation that briefly characterizes southeastern Utah in the Pueblo I period was such that new forms of ceremonial organization involved food consumption, and new symbolic systems developed that were later emulated elsewhere in the region.

Spielmann's connection between San Juan Red Ware and a new form of ceremonial organization is one explanation for the widespread exchange of San Juan Red Ware, although there are a few complications. One complication is that Allison's (2008a) later study does not show a relationship between San Juan Red Ware and communal activity in earlier periods outside of Utah where San Juan Red Ware was still present. Another complication is that the association found between San Juan Red Ware and communal feasting by Blinman (1989) was only demonstrated in one area and may not be true elsewhere. My analysis found San Juan Red Ware to be much more common in the Dolores, Colorado area than in most other areas outside Utah. Further research is necessary to study the relationship between San Juan Red Ware and feasting at other sites, but I suspect that it may not be a widespread association and has more to do with the people coming to the feast than the nature of the communal rituals. As discussed in the previous section, the variability in San Juan Red Ware proportions may be explained simply by variation in individual kinship networks. I suspect this plays an important role, but, additionally, I believe San Juan Red Ware was restricted to individuals with a particular categorical identity associated with San Juan Red Ware, meaning that some individuals chose not to acquire it, as these vessels were not related to their identity. A complementary explanation may be the nature of settlement formation. As discussed in Chapter 1, several studies indicate villages were formed by individuals with multiple and varied categorical and relational identities. Several of these studies consider the northern San Juan, and the widespread distribution of San Juan Red Ware reflects the presence of individuals with related categorical identities spread among a number of sites.

In general, I suspect that San Juan Red Ware often reflects kinship relations, but also reflects a shared belief system. This belief system was likely not exclusive, and individuals who acquired San Juan Red Ware assuredly held a number of categorical identities. San Juan Red Ware was probably an important part of the identity of these individuals, as, in some cases, great effort was expended to acquire these vessels for use in feasting, burials, everyday use, and likely other important events.

CONCLUSION

This thesis demonstrates that San Juan Red Ware was present throughout most of the area of this study early in its production history in the AD 700s, which includes the northern San Juan, portions of northeastern Arizona, and areas as far south as Chaco Canyon. It was always most common in Southeast Utah, although it was also common in many areas of Central Mesa Verde, particularly in the AD 850-900 period. It was never particularly common in the southern regions. Too little data are available for the Little Colorado region to say much, but little San Juan Red Ware is found in the Greater Chaco region until the AD 900-950s.

This thesis also serves as a test for the several methods used in this study. Each method had some advantages and disadvantages, and I found it useful to compare patterns across multiple methods. The various distribution maps all provided a different view of the same data, and the fall-off curves were most useful for gauging the effects of distance on San Juan Red Ware proportions. The social network analysis provided useful results, but would benefit from a more refined analysis with more variables and different scales. The distance diagrams provided another way to view the inverse distance weighted interpolation, but the Typenspektren analysis appears to be negatively affected by the large areas of low site density in this thesis, although it shows promise for use in more suitable studies.

The nature of San Juan Red Ware exchange cannot be specifically determined in this analysis, but participation in this exchange appears to be common, but highly variable, and distance has much less of an effect than expected. Economics also seems unlikely to be much of a factor in the exchange of these vessels. Individuals who acquired San Juan Red Ware do not appear to have been concentrated in villages that were highly centralized in regional social networks prior to the AD 850-900 period, at least not based on ceramics similarities between sites. The change in network centrality and its relationship to San Juan Red Ware changed after this period, which also matches the more widespread distribution of San Juan Red Ware and the gradually changing design patterns of San Juan Red Ware. San Juan Red Ware design patterns change from patterns easily distinguishable from local white wares to sharing some design elements near the end of San Juan Red Ware's production (see Chapter 3). I believe this relates to social integration. Allison (2008a:64) states, "It does seem clear, however, that early Pueblo I communities in southwestern Colorado, and especially at Ridges Basin, were less integrated than the large late Pueblo I villages." This statement matches the results of my study. As the technology, and perhaps the symbolism, associated with San Juan Red Ware most likely was introduced from individuals who migrated from the south (Allison 2008a, 2008b, 2012; Washburn 2006), this ware may be an example of migrants moving into a new area, spreading out, and becoming integrated with the social networks of this region; however, I do not argue that San Juan Red Ware was only acquired by individuals whose ancestors were part of this migration. This is one possibility, but social identity is fluid, and it is possible that other individuals chose to participate in the identity associated with San Juan Red Ware and adapted their identity accordingly. It is likely that the individuals whose categorical identity was associated with San Juan Red Ware played important roles in the social events of the northern San Juan from the ware's earliest appearance at the start of village formation in the Pueblo I period through at least the start of the Pueblo II period. It also seems that, from a material perspective, San Juan Red Ware vessels were important agents (as defined by Actor-Network Theory) in building and reinforcing social identity across the northern San Juan. I suggest that an inability to acquire San Juan Red Ware has a negative effect on an individual's attempts to build or strengthen the categorical identity symbolized by San Juan Red Ware, but this identity was important enough to expend significant energy in acquiring these vessels.

The analysis completed in this study combined with prior research into both this ware and the area in general, suggests to me a possible narrative for the history of San Juan Red Ware. First, it seems a group of people from the southern Southwest moved to the general Mesa Verde area and settled in villages, such as Site 13 at Alkali Ridge. They may have heard that farming was better in this location, but, whatever the reason, they settled in this area and began producing a unique, decorated red ware. Perhaps these villages were some of the original villages that define the Pueblo I period, but many other groups were likely involved in this process. Through migration, marriage, and probably other means, these people, and those who became closely associated with them or their ideas or beliefs, rapidly spread throughout the wider region, or at least began to exchange their red ware vessels widely. Despite the widespread exchange, many individuals chose not to participate in the exchange or did not have access, likely because they belonged to other social groups, and individuals with San Juan Red Ware were not as well integrated into the local social networks prior to about AD 850. Evidence of violence in the region, including at Alkali Ridge Site 13 (Brew 1946), may be an indication of poor social integration during this period. After AD 850, San Juan Red Ware becomes much more common and more closely connected to regional social networks. My study ends at AD 1000, but further research should reveal a larger narrative regarding the producers and consumers of San Juan Red Ware, as it spreads throughout the Ancestral Pueblo areas west of this study area.

FUTURE RESEARCH

The database assembled for this thesis research can be used in a number of ways, but I focus on directions for future research for San Juan Red Ware. One of the earliest studies to note the potential significance of San Juan Red Ware was Blinman's (1989) study of San Juan Red Ware and feasting at McPhee Pueblo. Based on the concentrated distribution of San Juan Red Ware near McPhee Pueblo at the time the structures were in use, I suspect that this relationship is not common across the northern San Juan, although I would be surprised if no other sites bear this relationship. Detailed studies of the intrasite context of San Juan Red Ware and its association with public architecture are necessary to conclusively determine how widespread this phenomenon is. Also, the connection between San Juan Red Ware and large villages can be further studied using more detailed data and sites in other areas. A major social element I do not discuss much in this thesis is violence. Violence was widespread in the Southwest and was likely a contributor to a number of social phenomena (see LeBlanc 2000). An analysis of San Juan Red Ware and violence may further contribute to the social context of this ware (see Allison 2008a:64 for a possible example of San Juan Red Ware and violence). One of the major limitations in this study of San Juan Red Ware is that I end the study before the end of San Juan Red Ware production, which continues for possibly a century after the end of this study period. San Juan Red Ware becomes much more widespread after approximately AD 1000 and can be found in relatively large quantities in the Flagstaff area and as far as the Moapa Valley in Nevada. Tsegi Orange Ware may also be a continuation of San Juan Red Ware and reflect a similar categorical identity. If this is the case, then further studies on the distribution of San Juan Red Ware late in its production and its connection to Tsegi Orange Ware would further our understanding of the social context of San Juan Red Ware.

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Appendix A: Ceramic Types and Dates

Table A.1. Ceramic Types and Dates Used in this Study.

Ceramic Type	Start Date	End Date	Mean Date
ABAJO RED-ON-ORANGE	760	880	790*
ALMA SERIES TYPE	300	1000	
ARBOLES BLACK-ON-WHITE	950	1050	1000
ARBOLES CLAPBOARD	800	1000	900
ARBOLES GRAY	900	1050	975
ARBOLES NECKBANDED	900	1050	975
BANCOS BLACK-ON-WHITE	825	1000	913
BENNETT GRAY	700	850	775
BLACK MESA BLACK-ON-WHITE	1000	1100	1050
BLACK MESA/SOSI BLACK-ON-WHITE	1000	1180	1090
BLACK-ON-WHITE ORGANIC	575	1280	
BLUE SHALE CORRUGATED	925	1150	1038
BLUFF BLACK-ON-RED	800	925	863
BMIII WHITE WARE UNDIFFERENTIATED	550	750	650
BMIII/PI WHITE WARE TYPE UNDIFFERENTIATED	550	900	
BRIMHALL BLACK-ON-WHITE	1040	1150	1095
BROWN WARE UNDIFFERENTIATED	500	1450	
BURNHAM BLACK-ON-WHITE	860	1000	930
CAMERON POLYCHROME	1040	1170	1105
CAPTAIN TOM CORRUGATED	890	1000	945
CHACO BLACK-ON-WHITE	1075	1150	1113
CHACO CORRUGATED	1050	1100	1075
CHACO-MCELMO BLACK-ON-WHITE (CARBON PAINT)	1090	1175	1133
CHAPIN BLACK-ON-WHITE	575	880	728
CHAPIN GRAY	575	980	
CHAPIN GRAY FUGITIVE RED	575	980	
CHUSKA BLACK-ON-WHITE	1040	1125	1083
CHUSKA BMIII/PI BLACK-ON-WHITE TYPE UNDIFFERENTIATED	700	900	
CHUSKA CARBON PAINTED WHITE WARE UNDIFFERENTIATED	800	1300	
CHUSKA CLAPBOARD CORRUGATED GRAY UNDIFFERENTIATED	900	1100	1000
CHUSKA CORRUGATED GRAY WARE UNDIFFERENTIATED	890	1300	
CHUSKA GRAY WARE TYPE UNDIFFERENTIATED	700	1300	
CHUSKA INDENTED CORRUGATED GRAY	1040	1300	1170
CHUSKA MINERAL PAINTED WHITE WARE UNDIFFERENTIATED	800	1300	
CHUSKA NARROW NECKBANDED	825	950	888
CHUSKA NECK INDENTED CORRUGATED GRAY	950	1025	988

Table A.1 (continued).

Ceramic Type	Start Date	End Date	Mean Date
CHUSKA NECKBANDED	800	950	875
CHUSKA PI/PII BLACK-ON-WHITE TYPE UNDIFFERENTIATED	700	1100	
CHUSKA PII GRAY TYPE UNDIFFERENTIATED	1040	1100	1070
CHUSKA PII/PIII BLACK-ON-WHITE TYPE UNDIFFERENTIATED	900	1300	
CHUSKA PII/PIII GRAY TYPE UNDIFFERENTIATED	1040	1300	1170
CHUSKA PLAIN GRAY WARE TYPE UNDIFFERENTIATED	700	925	
CHUSKA WHITE WARE TYPE UNDIFFERENTIATED	800	1300	
CIBOLA BLACK-ON-WHITE UNDIFFERENTIATED	550	1325	
CIBOLA BMIII/PI WHITE WARE TYPE UNDIFFERENTIATED	550	900	
CIBOLA CLAPBOARD CORRUGATED GRAY	900	1100	1000
CIBOLA CORRUGATED GRAY WARE UNDIFFERENTIATED	900	1400	
CIBOLA GRAY WARE UNDIFFERENTIATED	550	1400	
CIBOLA INDENTED CORRUGATED GRAY	1040	1400	1220
CIBOLA NARROW NECKBANDED	900	1025	963
CIBOLA NARROW NECKBANDED GRAY	900	1025	963
CIBOLA NECK INDENTED CORRUGATED	950	1025	988
CIBOLA NECKBANDED GRAY	850	1025	938
CIBOLA PI/PII WHITE WARE TYPE UNDIFFERENTIATED	700	1100	
CIBOLA PII GRAY WARE TYPE UNDIFFERENTIATED	950	1100	1025
CIBOLA PII WHITE WARE TYPE UNDIFFERENTIATED	880	1100	990
CIBOLA PII/PIII GRAY WARE TYPE UNDIFFERENTIATED	950	1300	
CIBOLA PII/PIII WHITE WARE TYPE UNDIFFERENTIATED	880	1300	
CIBOLA PIII GRAY WARE TYPE UNDIFFERENTIATED	1100	1300	1200
CIBOLA PIII WHITE WARE TYPE UNDIFFERENTIATED	1100	1300	1200
CIBOLA PLAIN GRAY	550	1040	
CIBOLA WHITE WARE UNDIFFERENTIATED	550	1325	
CIBOLA WIDE NECKBANDED	850	925	888
CITADEL POLYCHROME	1040	1200	1120
COCONINO GRAY	950	1100	1025
COILED GRAY	975	1050	1013
COOLIDGE CORRUGATED	1050	1100	1075
CORRUGATED GRAY WARE UNDIFFERENTIATED	800	1400	
CORTEZ BLACK-ON-WHITE	880	1060	970
CORTEZ/RED MESA BLACK-ON-WHITE	880	1060	970
CROZIER BLACK-ON-WHITE	800	900	850
CRUMBLED HOUSE BLACK-ON-WHITE	1150	1300	1225
DEADMANS BLACK-ON-RED	880	1050	965
DECORATED TYPE UNDIFFERENTIATED	300	1900	
DINETAH GRAY	1500	1750	1625

Table A.1 (continued).

Ceramic Type	Start Date	End Date	Mean Date
DOGOSZHI BLACK-ON-WHITE	1040	1210	1125
DOGOSZHI POLYCHROME	1040	1320	1180
DOLORES CORRUGATED	1100	1200	1150
DROLET BLACK-ON-WHITE	900	1000	950
EARLY CORRUGATED	920	1150	1035
EARLY WHITE WARE	575	920	
EARLY-INTERMEDIATE WHITE WARE	575	1150	
ESCAVADA BLACK-ON-WHITE	1000	1100	1050
ESCAVADA-PUERCO BLACK-ON-WHITE	1000	1100	1050
FILLETED NECKBANDED	850	1025	938
FLAGSTAFF BLACK-ON-WHITE	1150	1220	1185
GALLUP BLACK-ON-WHITE	1040	1150	1095
GOBERNADOR CORRUGATED	1500	1800	1650
GOBERNADOR INDENTED	1500	1800	1650
GOBERNADOR POLYCHROME	1650	1775	1713
GOBERNADOR-NAVAJO POLYCHROME	1500	1800	1650
GRAY HILLS BANDED	850	950	900
GRAY WARE UNDIFFERENTIATED	400	1400	
HAWIKUH GLAZE POLYCHROME	1630	1700	1665
HISTORIC ANASAZI	1630	1700	1665
HOLBROOK BLACK-ON-WHITE	1050	1150	1100
HOVENWEEP CORRUGATED	1100	1280	1190
HUNTER CORRUGATED	1100	1300	1200
INDENTED CORRUGATED GRAY WARE UNDIFFERENTIATED	950	1400	
INTERMEDIATE WHITE WARE	900	1150	
JEDDITO BLACK-ON-YELLOW	1300	1450	1375
JEMEZ BLACK-ON-WHITE	1300	1750	
KANA'A BLACK-ON-WHITE	825	1000	913
KANA'A GRAY WARE	865	1050	958
KAYENTA BLACK-ON-WHITE	1250	1300	1275
KIATUTHLANNA BLACK-ON-WHITE	850	925	888
KIATUTHLANNA-RED MESA BLACK-ON-WHITE	850	1040	945
LA PLATA BLACK-ON-WHITE	550	750	650
LATE CORRUGATED	1150	1280	
LATE WHITE WARE	920	1280	
LEUPP BLACK-ON-WHITE	1200	1250	1225
LINO BLACK-ON-GRAY (CIBOLA)	600	850	725
LINO BLACK-ON-GRAY (TUSAYAN)	550	850	700
LINO GRAY	550	950	
LINO GRAY (CIBOLA)	550	950	

Table A.1 (continued).

Ceramic Type	Start Date	End Date	Mean Date
LINO GRAY (TRACHYTE)	550	950	
LINO GRAY (TUSAYAN)	550	950	
LINO GRAY FUGITIVE RED [CIBOLA SERIES]	550	850	700
LINO GRAY FUGITIVE RED [TUSAYAN SERIES]	600	880	740
LINO/PIEDRA BLACK-ON-WHITE	550	920	735
LINO/ROSA/CHAPIN STYLE BLACK-ON-WHITE	550	880	715
LITTLE COLORADO GRAY WARE UNDIFFERENTIATED	850	1300	
LITTLE COLORADO WHITE WARE UNDIFFERENTIATED	825	1250	
MANCOS BLACK-ON-WHITE	980	1180	1080
MANCOS CORRUGATED	950	1180	1050
MANCOS GRAY	880	1060	970
MANCOS/ESCAVADA BLACK-ON-WHITE	980	1180	1080
MANCOS/GALLUP BLACK-ON-WHITE	980	1180	1080
MANCOS/GALLUP/ESCAVADA BLACK-ON-WHITE	980	1180	1080
MCELMO BLACK-ON-WHITE	1060	1260	1160
MCELMO/MESA VERDE BLACK-ON-WHITE	1060	1280	1170
MCPHEE BLACK-ON-RED	800	925	863
MEDICINE BLACK-ON-RED	1040	1170	1105
MEDICINE/TUSAYAN BLACK-ON-RED	1040	1240	1140
MESA VERDE BLACK-ON-WHITE	1180	1280	1230
MESA VERDE BMIII/PI WHITE WARE TYPE UNDIFFERENTIATED	575	920	
MESA VERDE CORRUGATED	1100	1280	1190
MESA VERDE CORRUGATED UNDIFFERENTIATED	930	1280	
MESA VERDE GRAY WARE UNDIFFERENTIATED	575	1280	
MESA VERDE GRAY WARE UNDIFFERENTIATED EARLY	500	975	
MESA VERDE LATE WHITE WARE MINERAL PAINT	920	1280	
MESA VERDE LATE WHITE WARE ORGANIC PAINT	920	1280	
MESA VERDE NECK CORRUGATED GRAY	950	1025	988
MESA VERDE NECKBANDED GRAY	800	1060	
MESA VERDE PI WHITE WARE TYPE UNDIFFERENTIATED	750	920	835
MESA VERDE PI/PII WHITE WARE TYPE UNDIFFERENTIATED	750	1180	
MESA VERDE PII WHITE WARE TYPE UNDIFFERENTIATED	920	1100	1010
MESA VERDE PII/PIII WHITE WARE TYPE UNDIFFERENTIATED	920	1280	
MESA VERDE PIII WHITE WARE TYPE UNDIFFERENTIATED	1100	1280	1190
MESA VERDE PLAIN GRAY	575	1020	
MESA VERDE WHITE WARE MINERAL	700	1280	
MESA VERDE WHITE WARE ORGANIC	700	1280	
MESA VERDE WHITE WARE UNDIFFERENTIATED	575	1280	
MESA VERDE/CIBOLA WHITE WARE UNCLASSIFIED	550	1280	

Table A.1 (continued).

Ceramic Type	Start Date	End Date	Mean Date
MOCCASIN GRAY	800	980	890
MOENKOPI CORRUGATED	1130	1250	1190
MOGOLLON BROWN WARE UNDIFFERENTIATED	900	1400	
MOGOLLON PATTERNED CORRUGATED BROWN WARE	1000	1400	
MOGOLLON PLAIN BROWN WARE SMUDGED	300	1400	
MOGOLLON PLAIN CORRUGATED BROWN WARE SMUDGED	900	1400	
MUDWARE UNDIFFERENTIATED	400	1400	
MUMMY LAKE	1050	1200	1125
MUMMY LAKE GRAY	1150	1280	1215
NARROW NECKBANDED GRAY WARE TYPE UNDIFFERENTIATED	900	1025	963
NASCHITTI BLACK-ON-WHITE	900	1000	950
NAVA BLACK-ON-WHITE	1100	1275	1188
NAVAJO	1500	1800	1650
NECK INDENTED CORRUGATED GRAY WARE TYPE UNDIFFERENTIATED	950	1025	988
NECKBANDED GRAY WARE UNDIFFERENTIATED	850	1025	938
NEWCOMB BLACK-ON-WHITE	875	1000	938
NEWCOMB CORRUGATED	875	950	913
NEWCOMB OR BURNHAM BLACK-ON-WHITE	860	1000	930
OBELISK GRAY	450	800	625
ORANGE WARE UNDIFFERENTIATED	1000	1350	
PADRE BLACK-ON-WHITE	1100	1250	1175
PAYAN CORRUGATED	1000	1200	1100
PENA BLACK-ON-WHITE	800	900	850
PI WHITE WARE ORGANIC	750	920	835
PI WHITE WARE TYPE UNDIFFERENTIATED	700	900	800
PI/PII WHITE WARE MINERAL	750	1180	
PI/PII WHITE WARE TYPE UNDIFFERENTIATED	700	1100	
PIEDRA BLACK-ON-WHITE	800	920	860
PIEDRA GRAY	850	1050	950
PII GRAY RIM TYPE UNDIFFERENTIATED	900	1100	1000
PII WHITE WARE TYPE UNDIFFERENTIATED	900	1100	1000
PII/PIII GRAY RIM TYPE UNDIFFERENTIATED	900	1300	
PII/PIII WHITE WARE TYPE UNDIFFERENTIATED	900	1300	
PIII GRAY RIM TYPE UNDIFFERENTIATED	1100	1300	1200
PIII WHITE WARE TYPE UNDIFFERENTIATED	1100	1300	1200
PLAIN BROWN SMUDGED UNDIFFERENTIATED	400	1450	
PLAIN BROWN WARE UNDIFFERENTIATED	400	1450	
PLAIN GRAY WARE UNDIFFERENTIATED	500	1300	

Table A.1 (continued).

Ceramic Type	Start Date	End Date	Mean Date
POLACCA BLACK-ON-WHITE	1150	1250	1200
POLYCHROME UNDIFFERENTIATED	700	1900	
PUERCO BLACK-ON-RED	1000	1175	1088
PUERCO BLACK-ON-WHITE	1030	1200	1115
RED MESA BLACK-ON-WHITE	880	1040	960
RED WARE UNDIFFERENTIATED	700	1700	
RESERVE BLACK-ON-WHITE	1050	1200	1125
RINCON RED-ON-BLACK	700	1150	
RIO GRANDE GLAZE UNDIFFERENTIATED	1313	1700	
RIO GRANDE GLAZES E AND F	1300	1500	1400
ROSA BLACK-ON-WHITE	700	875	788
ROSA BROWN	700	950	825
ROSA CORRUGATED	775	900	838
ROSA GRAY	700	1000	850
ROSA NECKBANDED	775	900	838
SAMBRITO UTILITY WARE UNDIFFERENTIATED	300	700	
SAN BERNARDO POLYCHROME	1625	1740	1683
SAN JUAN RED WARE UNDIFFERENTIATED	750	1050	
SAN JUAN WHITE WARE UNDIFFERENTIATED	700	1280	
SANOSTEE BLACK-ON-RED	825	875	850
SANOSTEE RED-ON-ORANGE	825	875	850
SHATO BLACK-ON-WHITE	1080	1130	1105
SHEEP SPRINGS GRAY	800	850	825
SHEEP SPRINGS/TOCITO GRAY	800	875	838
SHOWLOW RED	1000	1100	1050
SOCORRO BLACK-ON-WHITE	1050	1300	1175
SOSI BLACK-ON-WHITE	1070	1180	1125
ST. JOHNS BLACK-ON-RED	1200	1300	1250
ST. JOHNS BLACK-ON-RED OR POLYCHROME	1200	1300	1250
ST. JOHNS POLYCHROME	1200	1300	1250
TALLOHOGAN RED	620	775	698
TAYLOR BLACK-ON-WHITE	1000	1100	1050
THEODORE BLACK-ON-WHITE	800	825	813
TIN CUP POLYCHROME	1000	1100	1050
TOADLENA BLACK-ON-WHITE	975	1125	1050
TOCITO GRAY	825	875	850
TSEGI ORANGE WARE UNDIFFERENTIATED	1000	1300	
TULAROSA BLACK-ON-WHITE	1180	1300	1240
TUNICHA BLACK-ON-WHITE	850	900	875
TUSAYAN A POLYCHROME	1110	1320	1215

Table A.1 (continued).

Ceramic Type	Start Date	End Date	Mean Date
TUSAYAN B POLYCHROME	1110	1320	1215
TUSAYAN BLACK-ON-RED	1045	1240	1143
TUSAYAN BLACK-ON-WHITE	1200	1300	1250
TUSAYAN CORRUGATED	1020	1210	1115
TUSAYAN CORRUGATED GRAY WARE UNDIFFERENTIATED	865	1285	
TUSAYAN GRAY WARE UNDIFFERENTIATED	500	1285	
TUSAYAN INDENTED CORRUGATED GRAY	1040	1300	1170
TUSAYAN PII/PIII WHITE WARE TYPE UNDIFFERENTIATED	900	1300	
TUSAYAN PIII WHITE WARE TYPE UNDIFFERENTIATED	1100	1300	1200
TUSAYAN PLAIN GRAY	600	1300	
TUSAYAN POLYCHROME	1110	1320	1215
TUSAYAN WHITE WARE UNDIFFERENTIATED	825	1300	
TUSAYAN/MOENKOPI CORRUGATED	1020	1320	1170
TWIN TREES PLAIN	500	700	600
TYPE UNDIFFERENTIATED	300	1950	
UNCOMPAHGRE	1500	1800	1650
UNDECORATED TYPE UNDIFFERENTIATED	300	1950	
UPPER SAN JUAN PI GRAY WARE	700	900	800
UPPER SAN JUAN WHITE WARE UNDIFFERENTIATED	700	1300	
WALNUT BLACK-ON-WHITE	1100	1250	1175
WETHERILL BLACK-ON-WHITE	1060	1180	1120
WHITE MESA BLACK-ON-WHITE	850	1000	925
WHITE MOUND BLACK-ON-WHITE	700	850	775
WHITE MOUNTAIN RED WARE UNDIFFERENTIATED	1200	1400	1300
WHITE WARE UNDIFFERENTIATED	550	1900	
WIDE NECKBANDED GRAY WARE TYPE UNDIFFERENTIATED	850	925	888
WINGATE BLACK-ON-RED	1050	1225	1138
WINGATE POLYCHROME	1100	1225	1163
WOODRUFF BROWN	500	1100	
WOODRUFF RED SMUDGED	400	1100	
WOODRUFF SMUDGED	500	1100	

Note: Ceramic types and dates from the Chaco Social Networks Project (Peeples, Mills, Clark, Aragon, et al. 2016).
Mean Date cells with no values indicate types that were not included in mean ceramic dating.
* Value changed to increase the accuracy of mean ceramic dating based on personal communication with .James Allison (2018).