EXAMINING SUBSISTENCE STRATEGIES AND BEHAVIOR THROUGH PROJECTILE POINTS IN THE AMERICAN SOUTHWEST

by

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An honors thesis submitted to the University of Colorado in fulfillment

of the requirement for the Honors Thesis of the Department of Anthropology

2023

Defense Date: April 10, 2023

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Abstract:

The primary focus of this honors thesis is to establish a methodological framework to assess behavioral patterns in prehistoric projectile use and subsistence strategies. Since projectile points in the American Southwest are under-analyzed, I aim to rectify this gap in analysis while furthering the ability of archaeologists to extrapolate behaviors from lithic assemblages. To that end, this thesis integrates data collected from the Tewa Basin and Pajarito Plateau into a broader dataset from the Southwest to compare the relative abundance of projectile points and large game remains (Arakawa et al. 2013). This work draws on previous research on accumulation and subsistence patterns to distinguish the relative investment in hunting across Ancestral Puebloan societies. Finally, I compare projectile points' physical metrics and morphologies from relatively high and low hunting investment sites to assess their application toward hunting or warfare.

First, I describe patterns in material selection (primarily based on color), morphology, and breakage resulting from design and cultural behaviors such as hunting by Ancestral Puebloans. I strongly consider Tewa oral traditions. Next, I use the broad intersite analysis of assemblages to discuss subsistence strategies for the early inhabitants of the Tewa Basin: the winter people in the Tewa tradition. The sample size for this broader study includes 61 sites, counts of projectile points, counts of identified faunal bone from large game, and counts of grayware sherds. Finally, I directly compare the projectile assemblages of Castle Rock Pueblo and the Pojoaque Grant site. The results of this thesis benefit the archaeological community by providing an innovative approach for evaluating subsistence strategies in the Southwest and evaluating projectile point use. This work also offers further archaeological perspective on traditional knowledge to the Pueblo of Pojoaque.

DEDICATION

To those I will love, those I have loved, and those I have loved and lost;

To my mother for supporting me the best a mother ever could, for pushing and encouraging me, for being as interested in my successes and my failures as any mother ever has been; and

To my grandparents for offering me advice from lives that seem so different from my own, yet have contributed so clearly and perfectly to the person I am today, for teaching me new ways to see myself and the world, and for helping to raise such a curious child; and

To Audrey, metaphorically and literally picking me up and dusting me off at the end and sometimes the beginning of the day, my number one cooking, eating, working out, hiking, camping, mountain adventuring, backpacking, traveling, and life-doing Bonnie to my Clyde; and

To my friends- for those coming and going, but especially for those staying, for helping me grow past what I ever could have imagined as a horizon, for Wednesday dinners and everyday conversations, for coffee and car rides, road trips and regular errands, for showing me corners of the earth and myself I would have never otherwise seen, for sharing in this world with me; and

To my close ancestors for paving the way for me, for similarly five-fingered relatives who are far more distantly related, and for the lives of others' ancestors whom I am grateful to study.

I would never have had the gumption, guts, or desire to finish it without all of you; thank you.

ACKNOWLEDGEMENTS

I extend deep gratitude towards the following individuals and organizations (and any others I have neglected to mention), without whom I would not have completed this project. This project began with a visit to the office of Dr. Scott Ortman. I cannot overstate his patience in helping me pour over data, statistical results, and any and every issue along the way. I have never been so enthralled by being in the field as I was in the two short days we were able to walk the landscape. All the trials and tribulations of this thesis were worth it for that experience. I am forever grateful for sharing his perspective on what it can look like to practice archaeology. Dr. Doug Bamforth always has good advice, especially when keeping things effective and meaningful. Thank you for being the first person to teach me about flintknapping. I wish I had followed some of his advice more diligently. I appreciate Dr. Carl Simpson reminding me that we must all learn to communicate across disciplines. I am also grateful for the advice, resources, and expertise of Dr. Devin Pettigrew in inspiring some of my flintknapping, as well as skills and ideas about projectile point analysis. I am sure others in this honors cohort agree that Steve Leigh has been an invaluable resource for his experience, wisdom, and wit in theory and in practice. I wish to thank the Pueblo of Pojoaque for allowing me to research their past; the University of Colorado at Boulder, specifically the Museum of Natural History for its excellent staff and their generosity in awarding a research grant to examine collections analyzed in this thesis; the "Brain Trust" Honors Cohort, Walton Zientek, Ella Stritzel, Spencer Burke, Em Fox, Aidan Marler; Katie Portman for always telling me what I need to hear, Eric Gilmore and Ritchie Sahneyah for their encouragement, and Tanachy Bruhns for his enthusiasm and attitude; Crow Canyon Archaeological Center for helping foster my archaeological interest and capacity, in particular Steve Copeland for being a mentor unlike any other, Kellam Throgmorton for going above and beyond, Mark Varien for his encouragement, Susan Ryan for her direction, Susie and Tammy for putting a smile on my face, and Tim Wilcox for helping me to see beyond horizons; the Office of Archaeological Studies: specifically Julia Clifton, Amy Montoya; Fumiyasu Arakawa, Rich Wilshusen, and Brad Vierra. I look forward to celebrating the completion of this thesis with all of you and moving forward with everything I have learned. Thank you all.

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CHAPTER I

INTRODUCTION

A. Topic of the Study

After over a century of archaeology, debate continues over various analytical methods applied to understand the past use of projectile points. In the American Southwest, projectile points (and lithic artifacts generally) are understudied due to their relative lack of abundance (Arakawa et al. 2013; Vierra and Heilen 2020). Thus, more attention is devoted to the material remains of pottery, ground stone, and architecture. Further, difficulties in determining the use of projectile points have limited applications of their analysis in academic and contract archaeology settings. This thesis bypasses complex use-wear or other intensive methods in favor of intersite statistical approaches using projectile points and faunal remains to understand Ancestral Puebloan ways of life. I assess relative investment in hunting, the intentional selection of raw material, and the morphology of projectile points. Can the uses of warfare and hunting be distinguished for projectile point assemblages? If not, how can the relationship between projectile point use rates and large game processing rates inform ideas about subsistence strategy? What about comparing Ancestral Puebloan projectile point assemblages from relatively high and low hunting investment occupations?

In a basic sense, people manufacture projectile points to injure or kill humans or animals. Like other tools, though, they are multifunctional and can be used for cutting, slicing, and many other tasks. Therefore, the overarching challenge in projectile analysis can be described as difficulty correlating use-wear or other diagnostic criteria with behavior. After initially pursuing a direct method of distinguishing between the uses of hunting and warfare for projectile points, this thesis moved toward investigating this distinction through relative investment in hunting, point morphology, and raw material selection. The evidence for warfare at Castle Rock Pueblo in the dataset provides an opportunity to discuss how the models employed in this thesis have relevance for discerning the application of projectile points toward warfare and hunting. This discussion takes place in Chapters II and III.

Firstly, this thesis uses statistical methods to correlate the relative processing rates of hunted animal remains with projectile point use rates at an intersite scale. Data from sites in New Mexico, southeastern Utah, and southwestern Colorado permit the exploration of subsistence strategies of Tewa ancestors and other Ancestral Puebloan people in the study region (Arakawa et al. 2013, Morris 1991, Pierce and Varien 1999, Kohler ed. 1989, 1990; Akins in Akins et al. 2010; Schutt in Post et al. 2010; Schmidt et al. 2006, Vierra et al. 2002, Vierra & Schmidt eds. 2008). The methodology proposed, and considerations in this work focus specifically on collections from the Pojoaque Grant site and other sites in the Tewa Basin, given that the function of the models employed follows the analysis completed and the data available. Secondly, I compare the morphologies and physical metrics of points from relatively high and low projectile point assemblages to assess their use for hunting and warfare.

Since populations in the broader study region used utility ware or cooking pottery (grayware) at consistent rates (Varien and Mills 1997), this allowed for comparing the abundance of artifacts like projectile points and hunted animal remains within and between sites. Following previous research by Arakawa et al. (2013), I analyzed relative use rates of projectile points and relative processing rates for the remains of hunted prey (artiodactyls: even-toed hoofed animals such as sheep or pronghorn antelope). Following Arakawa et al., I propose that the correlation of relatively high use rates of projectile points with relatively high processing rates for large game indicates sites with relatively high investment in hunting practices. Conversely, relatively low use rates of projectile points and low processing rates of large game indicate sites with relatively low investment in hunting, which more than likely represent agriculturally-focused lifeways.

The study region saw significant population and cultural change over the past 1,500 years, with many people and ideas moving across the landscape. Focusing on the Tewa Basin (see *Figure 1* in section II.B.1) contributes to research in the region on little-studied materials and adds to the existing literature on subsistence strategies. Scholars have generated numerous theories about the movement of peoples in and out of these areas, but more recent ideas have begun to align more closely with traditional knowledge passed down orally in Tewa communities (Ortman 2012, Bernstein and Ortman 2020, Cooper 2020). Though there were people in New Mexico over twenty thousand years ago (Bennett et al. 2021), the first large permanent settlements in the Tewa Basin appeared on the east side of the Rio Grande (Ortman 2012; Stubbs 1954; Cooper 2020; Scheick 2007). Tewa oral tradition accounts for two migrations, with those settling east of the Rio Grande being the first (Ortman 2012, Bernstein and Ortman 2020; Cooper 2020). This thesis focuses on the period beginning with the appearance of pottery in the region and ending with shifts to agricultural ways of life near the end of the occupation of the Pojoaque Grant site- the transition to a Tewa way of life (Ortman 2012). Scheick aptly recognizes this period as the 1000s to the early 1200s (all dates CE unless otherwise specified) for this region and by archaeologists worldwide as the Neolithic Demographic Transition (2007:133; Bocquet-Appel 2002; Kohler et al. 2008).

While existing research has focused on population aggregation (Arakawa et al. 2013), none have employed these techniques with projectile point assemblages and faunal data to compare their use rates by Ancestral Puebloans across regions and time periods to examine subsistence patterns. Other perspectives focus on the lifeways of these same groups from the perspectives of ethnography, warfare, and agricultural production. These explorations have primarily shown

Ancestral Puebloan groups to be heavily invested in farming and with limited emphasis on hunting. This work examines the potential that the early population in the Tewa Basin invested relatively intensely in hunting. Statistical tests indicate similarities between assemblages from Tewa Basin sites and those in Arakawa et al.'s Western Periphery (relatively low-density settlements focused on hunting in southern Utah). Additionally, I speculate on the morphological features of projectile points as they relate to functional use.

B. Importance of the Study

This thesis contributes to the relatively sparse literature on projectile point assemblages in the Southwest, the methodology and applications of accumulation research for the study of subsistence strategies, and provides another example of collections research benefiting descendant communities and the museum community.

Studies on projectile points in the Southwest would be more plentiful if points themselves were more prevalent compared to other materials, as noted by Brad Vierra, one of the experts in lithic analysis in the region. Since population densities in the Southwest were relatively low until agricultural developments with a lack of extremely large game such as the bison of the plains, people did not produce many projectile points (Cordell & Gumerman, eds. 2011, Arakawa 2012, Scheick 2007). Early archaeologists in the Southwest, such as Earl Morris, recognized this phenomenon and let ceramics dominate the archaeological discussion (1939; Mera 1935, Stubbs & Stallings 1953, Wendorf & Reed 1955). This bias limits the current understanding of the Southwest, hampers research with confusing typologies, propagates the dearth of lithic sourcing information and supports lower attention to detail in the analysis of lithic assemblages in reports across the larger region. This work also benefits from previous work in lithic analysis in the Southwest by the likes of Brad Vierra, James Moore, and Tim Graves, to name a few.

This thesis combines faunal data, lithic analysis data, and statistical approaches, proposing an innovative method to compare the relative frequency of projectile points and faunal remains across sites to illustrate trends in subsistence strategies and behavior. Increased proportions of projectile points indicate an increased investment in hunting and corroborate a lack of agricultural activity otherwise visible archaeologically. This methodological framework will allow future research to answer questions more adeptly regarding subsistence patterns, specifically in the Southwest. Thus, the significance of this research to the archaeological community is twofold: first, providing alternative ways of comparing sites and evaluating subsistence by viewing projectile point variation through the lens of regional variation, and second highlighting the importance of integrative material analysis.

Finally, I see this research as concrete evidence that collections research can benefit descendant communities and the museum community. For example, the documentation of lithic artifacts in the collections at UCB (University of Colorado Boulder) and ARC (Archaeological Research Collections, Laboratory of Anthropology) in Santa Fe, NM resulted in their digitization. This inaccessible data from the 1950s is readily available to permitted archaeologists and Pueblo of Pojoaque tribal members. While preparing exhibits is essential to museum studies, this would never be possible without documentation, provenience, packaging, and analysis. This project focuses on these aspects of museum studies by demonstrating the benefit of curation in returning to collections for new research. The Pueblo of Pojoaque was willing to lend part of this collection to UCB due to Dr. Ortman’s commitment to structuring collaborative research with members of the Pueblo that directly benefits the Pueblo. This specific collection generates excitement because it demonstrates the deep history of the Pojoaque community and the relevance of traditional history. I have shaped my research in response to this interest. Rather than setting oral traditions in stone (as they often are when they are not dismissed outright), I hope to provide an opportunity for growth in meaning and interpretations by documenting evidence of social connections of Pojoaque ancestors and sharing this information with the present-day community. This outlook is vital for supporting Indigenous communities. This stakeholder/community-based approach significantly improves museum collections studies' promise and ethics. As of April 2023, I have met with Bruce Bernstein, the THPO (Tribal Historic Preservation Officer), and shared the results of this research and will hopefully share them at a meeting with members of the Tribal government.

C. Summary of Methods

To investigate the subsistence strategies of the Ancestral Puebloans, 186 projectile points were analyzed for this project in person, with 1440 included from existing data. The total count across sites analyzed for artiodactyl remains is 6183. I calculated the proportions of projectile points and artiodactyl remains with a new technique using grayware sherd count as the denominator for both proportions. The Pojoaque Grant site receives the most attention as it has the largest sample from the target area of the Tewa Basin, with a critical and well-dated context beginning in the mid-900s and ending before 1175 (Wiseman & Ohlinger 1991, Wiseman 1995). Intra-site provenience data is essentially omitted aside from the general discussion of the site due to its imprecise nature and unavailability. The projectile point assemblage from the Pojoaque Grant site is compared to that of Castle Rock Pueblo to examine differences in projectile design attributes between sites of relatively high and low hunting investment. Data for the sites in the Mesa Verde region and others outside the immediate vicinity of the Pojoaque Grant site were identified based on available data and occupation period. Basic statistical tests showcase differences between broad-scale regional groups in rates of projectile point use rates and large game processing rates in the assemblages as well at a site-level scale between the high and low hunting investment sites above. Sites without adequate data were not tabulated. The Tewa Basin data and improved Arakawa dataset, along with all information collected, are available from ARC, and the author.

D. Summary of Results

Tewa Basin sites during population influx (~850-1000) have significantly higher projectile point use rates and large game processing rates than later farming sites in the Northern Rio Grande region (Pajarito Plateau) and the farming populations of the Mesa Verde region. The Tewa Basin sites are most similar to populations' mixed hunting and foraging strategies in the Western Periphery of the Arakawa et al. study (2013). The results indicate a strong correlation between relative investment in hunting (points per person meal) and relative returns on that investment (hunted animals per person meal). Two groups dominate the analysis: those of sites known to be highly agricultural with a low relative abundance of both projectile points and artiodactyl remains and those with high relative abundances of the same measures considered to have mixed hunting and farming lifeways. However, subsistence strategies are still poorly understood at Northern Rio Grande sites due to a lack of excavated sites relative to other regions (Scheick 2007). I glean insight into subsistence strategies by examining relative investment in hunting (whether high or low) for the regions included in this study using proportions of projectile points and artiodactyl remains to grayware sherds. Comparing the Castle Rock Pueblo and Pojoaque Grant site projectile point assemblages elucidates unforeseen trends. Notably, side-notched points dominate the assemblage from Castle Rock Pueblo (nearly 90% of the complete points) with only a couple of corner-notched and one simple triangular, unnotched point. At the Pojoaque Grant site, point design has much more variation, with some side-notched points exhibiting 3+ notches and a more balanced spread across forms. Still, the weight of points is the only statistically distinguishing metric between the assemblages and may relate to increased hunting investment. These results speak overall to the significant investment in hunting in the early settlement of the Tewa Basin.

E. Organization of the Thesis

The contents of this thesis are laid out with page numbers on page V, and they are explained chronologically here. Building on the introduction made in this chapter, Chapter II provides the background information necessary to understand the theory backing this thesis in accumulation research, projectile point analysis, subsistence patterns in the Southwest, and choices in point design related to the uses of hunting and warfare. Chapter II includes site backgrounds by region, expected results, and alternative ideas. Chapter III describes the collections and data analyzed, the methods for data recording, and those for statistical analysis. Chapter IV presents the analysis results for this thesis, while Chapter V summarizes lines of evidence and discusses the results of the previous section and potential sources of error. This thesis concludes in Chapter VI with the study's merits and future research. The bibliography is provided next, followed by the appendix. The appendix clarifies data collection methods.

CHAPTER II

BACKGROUND

To properly analyze the results of this study, it is necessary to review the theoretical basis and approaches for this work, in addition to the regional particularities in geography and archaeology. This chapter first examines the broader frameworks and theory for accumulation research, projectile point analysis, determining subsistence strategies, and delineating between uses of projectile points for hunting and warfare. Next, I will provide details on settlement in the Northern Rio Grande and the Pojoaque Grant Site. Finally, I discuss the origins of the data in this study.

A. Frameworks and Theory

1. Accumulation Research

Beginning with the theory for the broader of the two scales of analysis for this study, I review the literature regarding the use of utility wares in Southwest archaeology as the denominator in proportions comparing the relative frequencies of artifacts after briefly summarizing issues with preservation. In archaeological contexts, subsistence strategies are most readily understood via coprolites, isotope data, and other residues or information regarding the diets of past humans and societies (Decker and Tieszen 1989). However, numerous issues are associated with taphonomic biases and the degradation of those sorts of data (Arakawa et al. 2013). Since isotope or coprolite data illuminating past diets do not allow for an examination of subsistence strategies broadly in the Southwest, accumulations research uses more readily available data to answer the same questions from different angles.

a. Organic Material Accumulation: Faunal Remains. I will briefly summarize taphonomic issues in the preservation of faunal bone or other organics utilized to understand human subsistence in the past, given that a full review is not within the scope of this honors thesis. Arakawa et al. point out that not all possible remains are preserved in all cases, so this research focuses on often-recoverable faunal remains: data critical to this thesis (2013). Behrensmeyer and Dechant carried out some of the first work examining the taphonomic degradation of bone in Kenya (Behrensmeyer 1978). They linked the surficial exposure of bones to temperature and moisture changes to the rapid degradation of bone and noted the detrimental effects of alkaline soil (Behrensmeyer 1978). Thus, it is clear why the preservation of buried bone is overwhelmingly more excellent. This is why the site sample includes only excavated sites.

Another issue in taphonomic preservation relevant to this research is the differential preservation of bones of different densities, sizes, and animals. Lyman and others have treated issues such as these extensively (Lyman 1984, 1994, 2008; Marean 1991). In earlier studies, Lyman focused on the importance of bone density, structure, and size on degradation, notably finding that NISP[1] positively correlates with bone density (Lyman 1984, 1994). This has significant implications for using the artiodactyl index reviewed later in III.C, as it suggests differential preservation for artiodactyls (deer-like animals) and lagomorphs (rabbits and hares). Marean also discussed the necessity to consider differential taphonomic degradation across sites in any research engaging in intersite comparisons of faunal assemblages (1991). Later, Lyman elaborated on the trouble introduced by fragmentary specimens in attempts to tally the NISP for taxa at sites (2008). Following the approaches of Schollmeyer and Driver and Arakawa et al., this research assumes that using large sample sizes across many sites balances out taphonomic processes that affect sites differentially (2013:4; 2013).

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[1]NISP is the number of identified specimens of a particular genus, species, etc., or group thereof.

Furthermore, regarding how archaeological practices affect the collection of faunal remains, "it is known that the use of different-sized screens in excavations affects the relative abundances of different-sized taxa" (see Arakawa et al. 2013:154). This introduces another bias towards a lower preservation rate of lagomorph bone and another reason to avoid utilizing the artiodactyl index. While Arakawa et al. continued with the best data available at the time, a result of the attention paid to faunal analysis in the Southwest, this paper takes an innovative approach detailed in III.C.

b. Inorganic Material Accumulation: Pottery and Projectile Points. The fundamental understanding behind utilizing grayware and projectile points at a large scale to understand subsistence strategies builds on the separate work of Wilshusen and Bradley (1999; 1988), combined by Arakawa et al. (2013). Wilshusen suggests that using large bodies of data on artifact accumulation, artifact distribution, and other factors could dramatically increase understanding of subsistence strategies and other behaviors (1999:185). This approach uses a large base of research in the Southwest, relying on broad patterns to emerge in analyzing many sites. Of course, this approach is highly dependent on sample sizes and prior knowledge regarding the categorization and use of artifacts. Specifically, Wilshusen mentions "ceramic vessels and lithic tools" as items that may reflect subsistence patterns more accurately than the often poorly preserved evidence mentioned previously (1999:185). This research follows precisely in that vein of thinking, utilizing grayware and projectile points in an integrated analysis of subsistence patterns.

Bradley's work grapples with the same conundrum as this paper: how to compare the relative frequency of projectile points between sites with variable excavation intensity, sampling, and strategy (1988). Working with the assemblages from Wallace Ruin in the Mesa Verde region, Bradley's attempts to standardize the frequency of projectile points between sites employed whiteware (serving pottery) sherds as a denominator for comparison (1988). Bradley assumed that whitewares are found ubiquitously and accumulate at similar rates across sites and time in the larger region (1988). Following Arakawa et al. (2013), I avoided the above assumption and improved the procedure. This analysis takes advantage of another type of pottery, grayware, as the vehicle for artifact frequency comparison across sites.

Following Arakawa et al., grayware or utility ware sherds provide a "means of standardizing data for intersite comparisons" (2013:154). Unlike whitewares and many other artifacts, utility ware sherds accurately assess site occupation intensity across sites in the Southwest (Kohler 1978; Lightfoot 1993, 1994; Varien and Mills 1997; Varien and Ortman 2005; Varien and Potter 1997). Site occupation intensity is the result of the duration of a population occupying a site; advantageously, neither of these factors bias the evaluation of occupation intensity grayware provides. Additionally, Schlanger found that utility wares accumulate more constantly than other artifacts between sites (1990). This trait suggests that grayware is most suited for standardizing comparisons across sites. Arakawa et al. also points out that "ethnoarchaeological, experimental, and archaeological studies of pottery cooking vessels show them to have relative short use lives, to exhibit a narrow range of variation in use life, and to occur with relatively high frequencies in given assemblages" (2013; see also Lightfoot 1994; Schlanger 1990; Varien and Ortman 2005; Varien and Potter 1997). The traits outlined above indicate that utility ware can function as a reliable measure for comparing the frequencies of artifacts in assemblages.

With the topics of faunal remain accumulation and grayware sherds as a denominator addressed, I now consider the accumulation of the other numerator in the proportions to be examined in this study: projectile points. As mentioned, projectile points are not as common as many other artifacts at sites in the Southwest (Arakawa et al. 2013; Morris 1939), and in general (Christenson 1997:131). Moreover, projectiles are not distributed evenly throughout sites as grayware or other ubiquitous artifacts, given their relatedness to particular activities thought to be spatially segregated (O'Connell 1987). This thinking is incredibly informative in analyses of a finer resolution, but these approaches are not examined in this thesis due to a lack of appropriately acceptable provenience. So, at a broad scale across sites and regions, differential accumulation increases sampling error from partially excavated sites (most site samples in this analysis are not from complete excavations). Therefore, deposition in areas not sampled by excavation can skew results. I employ the same reasoning as Arakawa et al. in assuming that the sampling methods used to collect artifacts are not a significant source of bias for the present research (2013:154). This assumption comes in part from a study as part of the Dolores Archaeological Program, where Kohler et al. (1988) "found that there was no significant correlation between many different collection practices (screening vs. not screening) in the relative representation of most artifact categories, including projectile points" (Arakawa et al. 2013:154).

Moreover, there are many use-case scenarios to consider in examining the accumulation of projectile points at archaeological sites in the Southwest. While primarily used to hunt deer and other artiodactyls or to engage in warfare, these are not the only eventualities that result in projectile point deposition at sites (e.g., use as knives, drills, ceremonial objects, etc.) (Ellis 1997:53; Whittaker 2012). In the more distant past, just like today, old points have a tradition of being curated by descendants or by those who find them. This phenomenon results in points of very different sizes or styles deposited in the same strata as much younger artifacts (Whittaker 2012). Due to site-formation and degradation processes (Schiffer 1995, 1996), discarded projectile points may have gone through various cultural and natural processes. Of course, these taphonomic processes do not erode the projectile points as seen in the case previously explained for organic materials.

Finally, while taphonomic processes are less detrimental to lithic artifacts over time, the distribution of projectiles made of bone at a site can be quickly affected by preservation conditions. Though preferential to wet or acidic environments, the bone does not necessarily preserve well in the dry and hot Southwestern US, similar to the environment Behrensmeyer worked with (1978). Data from Mesa Verde National Park sites were discarded from this study due to ethnographic and archaeological data from the early 1900s relating the use of bone projectile points as a local custom (see Lister 1966 for discussion). Since traces of these bone points are gone, it would be unreasonable to attempt to use these data, given the lack of recordable projectile points.

In entirely different circumstances, none of the faunal remains or their datasheets from the Cowboy Wash sites in Southwest Colorado will ever enter the archaeological record. This resulted from a catastrophic fire in 1997 (Billman ed. 1997). Differential accumulation and preservation of projectile points and faunal remains can introduce challenges in concluding excavated material, even in archaeological curation. This work seeks to minimize the impact of the challenges inherent in using data collected disparately in space and time, often with different methods and goals.

2. Projectile Point Analysis: The Southwest and Beyond

I analyze projectile points through multiple lenses in this analysis, first using standard measurements of size, weight, and form. The literature on projectile point analyses mainly consists of these sorts of morphometric approaches (for some relevant examples, see Thomas 1981; Office of Archaeological Studies (OAS) Staff 1994; Thoms 1977; Loendorf et al. 2015; Vierra and Heilen 2020). The procedures used and how these data are analyzed are seen in III.Materials and Methods and IV.Results. This thesis follows research in breakage patterns to elucidate the patterns of use for projectile points at the site and intersite levels of analysis. Differences in methodologies between projects and the scope of this thesis limited the analysis of use-wear or breakage. Finally, this work considers aspects of previous research on archaeological, experimental, and ethnographic data concerning the function and form of projectile points, especially as they relate to their use, seen in II.A.4.

Centrally, this thesis applies Chamberlain's method of multiple working hypotheses, recognizing that multiple factors contribute to the functional needs of a projectile point in a given context (Chamberlain 1890). In other words, there are multiple reasons for people of the past to have chosen a specific material to make a projectile point, for adding notches, for shaping a blade in a particular manner, etc. This perspective is foundational for a comprehensive view of the patterns seen later in assemblage data and the processes from which they may have resulted.

a. Use-wear and impact analysis. The goals of breakage pattern analysis and the limitations of the analysis itself are clearly at odds. The archaeologist seeks to infer information about the intended and actual targets (not always the same, even for professionals), the result of a projectile's impact, the sender, and more from observing the projectile points of an assemblage. Nevertheless, it is impossible to understand past projectile points use precisely. Therefore, it reasons to use only the most reliable methods to make even the most basic assumptions about how a point was broken based on unambiguous patterns of breakage (Rots and Plisson 2014).

The seminal works of Semenov published in English in 1964 sparked an intense interest in use-wear and impact analysis, providing practical scientific approaches for understanding the use of lithic artifacts in previously unknown detail. As more recent analysts note, the field has significantly benefited from these approaches (Dockall 1997; Fischer et al. 1984; Rots and Plisson

2014; Andrefsky 2006). However, there is a tendency in the field to make broadly reaching claims lacking evidence, often citing the author's interpretation, experience, or intuition (e.g., the Solutrean Hypothesis) (Rots and Plisson 2014). Furthermore, lithic analysis is challenging in terms of intrinsic factors such as projectile shape, weight, or hafting and extrinsic factors of environmental conditions, targets, and projecting mode (Rots and Plisson 2014). For example, considerations made by Forsom and Smith examining medieval projectile penetration through experimental and archaeological analysis are entirely different from those employed by Loendorf et al. in examining material selection (2017; 2018). Thus, following Rots and Plisson, Bamforth, and others, this analysis takes a conservative approach towards identifying breakage due to use as a projectile in projectile point assemblages (2014; 2006; Dockall 1997; Loendorf et al. 2015, 2018).

Although Fischer et al. provide a handy overview of terminology and physical understanding of projectile point breakage, they assert that step-terminating fractures with spinoff along the longitudinal axis of a point directly correlate with using a point as a projectile (1984:23-24). As Rots and Plisson point out, the possibility for equifinality (of other activities producing the same result) is high for lithic objects whose tendency is to fracture (2014). For a more thorough discussion of some of these intricacies of lithic analysis, see the referenced literature (Rots and Plisson 2014; Andrefsky 2008; Bamforth 2006 for quarrying and procurement; Loendorf 2018 for material strength). Moving on, the in-person analysis of projectile point assemblages from sites in the Tewa Basin used much of the terminology from Fischer et al. and Dockall (1984:23-25; 1997:323-333). Unfortunately, at least some lithic analysis in the Northern Rio Grande has fallen victim to the abovementioned issue. In the report on excavations at Pena Blanca, "tip damage" represents use as a projectile point 62% of the time based on one experiment (Schutt in Post et al.

2010). The term "breakage" in this thesis reflects the same criteria as above from Fischer et al.: longitudinal fractures with spinoff, but does not assume that this resulted from being fired as a projectile point (1984).

b. Material, durability, and use. This work also incorporates literature on material selection for the durability and use or reuse of projectile points since material selection has implications for properties of penetration and durability. In one study, Loendorf et al. tested the durability and reuse potential of obsidian, chert, siltstone, and basalt (2018). They outline the historical shortcoming of lithic research in failing to define "quality" since it is situational and measurable through multiple metrics (Loendorf et al. 2018). Notably, the similarly sized chert points in their trials were 1/3 heavier than their obsidian counterparts, and the impact strength of siltstones such as cherts or basalts was twice as strong as the obsidian samples (Loendorf et al. 2018). These disparities figure into the analysis of the assemblages reviewed in IV.Results. The article also posits that the assessment of materials must follow the functional parameters important for their purpose: essentially linking material selection and use of projectile points for warfare or hunting.

Given the intense attention dedicated to measuring, analyzing, or otherwise determining biface- specifically projectile point- use, this thesis can only briefly touch on this issue in lithic analysis as it pertains to the present research. William Andrefsky has written extensively on reduction (2008 and others), use-wear and reuse (2006; 2008; 2010), projectile point provisioning strategies (2008; 2010), projectile damage (2010), raw-material availability (1994, 2008), among other topics. Indeed, the literature on lithic analysis is extensive (for quarrying, transport, and mobility, see Bamforth 2006; Bebber 2017 for citations covering many areas; Loendorf et al. 2018 for durability; Knecht 1997 for a technological review). Nonetheless, the most relevant of these topics to this research is the discard pattern of impact-damaged projectile points (Andrefsky 2010).

Andrefsky analyzed points from the Birch Creek Site in Eastern Oregon to illustrate that points made from near raw-material sources tend to be associated with impact damage, while those from distant sources tend to be associated with reworking (2010). Lewis Binford discusses a related pattern in a much-cited paper on the Nunamiut of Alaska, describing how hunters on trips leave few objects in the field (Binford 1977). These lines of thinking must be considered when examining habitation sites with evidence of hunting. Following Andrefsky, what conditions would allow hunters to dispose of damaged points versus reworking them? Logically, a supply of raw material or complete points nearby would allow hunters to dispose of damaged points, whereas necessity would force them to rework their points to be used again. Now I review how projectile points fit into current understandings of Ancestral Puebloan subsistence strategies. Of course, these ideas also naturally lead to warfare: the final consideration in this subsection.

3. Subsistence Strategies: Hunting and Agriculture

Ancestral Puebloan subsistence strategies have long been considered primarily agricultural due to early colonial contact, looting, and excavation (see Shearn in Brown et al. eds. 2020 for a review of subsistence strategies). Wendorf and Reed’s chronology of the Northern Rio Grande exemplifies this thinking, stating, “both the San Juan and Rio Grande Anasazi depended primarily on agriculture for subsistence” (1955:207-208). Cherie Scheick offers a more up-to-date perspective on the Northern Rio Grande in a 2007 article, reviewing data from excavated sites in the region dating to Wendorf and Reed’s Early Developmental Period (600-900). Scheick highlights the separation of time and process in Wendorf and Reed’s model, acknowledging that subsistence strategy change occurs differently within regions. The relative abundances of artiodactyls and small game are most presently understood to “vary enormously through space and time" (Schollmeyer and Driver 2013:2). Subsections II.B.Background by Region relates background information for the Northern Rio Grande (NRG) and Central Mesa Verde (CMV) regions as well as the specific sites compared in IV.Results. The primary focus of this thesis applies innovative methods to examine these spatial and temporal variances in subsistence strategies via relative hunting investment. In the interest of brevity, I only touch on the study of hunting and gathering, optimal foraging theory, the bow and arrow, sedentary agricultural lifeways, and the correlation between agricultural strategies and violence/warfare.

Similar to the study of anthropology more broadly, hunter-gatherer studies have been mired since the 1970s by critiques seeking to restructure, revise, or entirely do away with the entire area of study (Kelly 2013; Lee 1992; Cummings 2013). I would be remiss not to point out that these studies differ significantly from those of Ancestral Puebloans in that the appearance of pottery around 500 led food storage and sedentism to become staples of most Ancestral Puebloans (Reynolds 2012; see Vierra in Vierra ed. 2013 and Vierra et al. in Bousman et al. ed. 2012 for discussions of preceramic lifeways in the Northern Rio Grande; Cordell and Gumerman 2011 for a broader perspective on Southwest prehistory). Instead, I wish to reiterate two relevant aspects of hunter-gatherer studies: separating economic activity from the political structure and the flexibility hunting adds to dietary options.

Kelly and Lee both rightfully distinguish between economic and political aspects of subsistence in the face of a body of research that often conflates hunting, foraging, or horticulture food procurement with specific political structures, usually described as egalitarian or band societies (2013; 1992). I find this a necessary distinction as my research makes no claims regarding the political or social organization of the Ancestral Puebloan societies represented in the data presented. Instead, I seek to emphasize the variability in hunting investment between site occupations and districts from an economic perspective and speculate on the possibility of warfare. This distinction leads directly to the second critical aspect of hunter-gatherer studies in this thesis: the contribution of hunting to subsistence strategies.

Of course, hunting is covered in greater detail by other publications (for an introduction, see Cummings 2013:15; for a more detailed discussion of hunting in various environments, see Kelly 2013:40; for a faunal analysis perspective, see Schollmeyer and Driver 2013; for an efficiency-bound perspective on obtaining sufficient nutrition see Arakawa et al. 2013; for reasons hunting and gathering persist into the present see Codding and Kramer 2016). Essentially, meat obtained from hunting or domestic animals makes up for nutritional deficiencies created by relying on carbohydrate-rich agricultural diets (Arakawa et al. 2013). Optimal foraging theory relates the effort in calories put into hunting to the return on that investment in the form of calories provided (Arakawa et al. 2013; Kelly 2013). Schollmeyer and Driver suggest that large game would logically be pursued over small game unless their availability was lower (2013). Additionally, humans are very efficient in food procurement (Cummings 2013) and tend to value meat more than other food sources (Schollmeyer and Driver 2013). For an in-depth analysis of factors influencing the efficiency of agriculture and farming, see Schollmeyer and Driver (2013). Kelly (2013) and Cummings (2013) describe the cultural importance and environmental constraints that may influence hunting behavior depending on the context. Of course, technology also plays a role in subsistence strategies and the efficiency of various modes of food procurement.

Bow and arrow technology appears in the archaeological record in the Southwest around 500, similar to that of pottery mentioned earlier (Whittaker 2012:80-81). There is no known variation in bow and arrow use for any of the data used in this study, though it is important to note that this technology plays a crucial role in hunting as it is more effective and versatile than the atlatl (Koerper et al. 1996; Whittaker 2012). Koerper et al. note the bow and arrow's adaptability in adjusting to various game opportunities (1996:277). Whittaker (2012:82-83) reviews advantages over the atlatl, such as range, accuracy, reload times, and stealth. Even before the bow and arrow, there was significant variation in the relative abundance of large and small game in Ancestral Puebloan diets (Reynolds 2012). However, the bow and arrow played a crucial role in the ability of hunters to procure food and provided advantages over the atlatl given the prevalence of relatively small points (<3 grams) in assemblages across the Southwest after ~500 (for discussion, see Whittaker 2012; Bohr 2014; Kelly 2013:133; Cummings 2013:15; for a perspective on transitions from Paleoindian to Archaic ~9,000 to 5,000 BP foraging strategies see Vierra et al. in Bousman et al. 2012:463).

Finally, I discuss agricultural lifeways broadly in the Southwest, especially concerning violence and risk. The agricultural production of maize, beans, and squash in the Southwest contributed heavily to population aggregation around 900-1300 (Arakawa et al. 2013). Before domesticated turkeys became prevalent in the CMV around 1000 and 1280 in the NRG these populations relied on various hunting strategies to supplement their diets (Kemp et al. 2017; Akins in Akins et al. 2010:40). Both lagomorphs and turkeys were primary sources of meat among many historic Pueblos (Kuckelman ed. 2000). Interestingly, Kohler et al. (2014) examined trends in violence as they relate to aggregation, per capita production, and subsistence patterns in the NRG and CMV and found the CMV to be one of the most violent societies ever examined archaeologically. In comparison, the NRG was peaceful, even during high resource variability or low per capita production (Kohler et al. 2014). During this time, the Chacoan system, climate, and other conditions of the CMV and NRG also likely contributed to the disparity in violence/warfare observed between the two regions (Kohler et al. 2014). Most notably, the correlation between violence and agricultural subsistence is essential in light of the differences in assemblages between sites from the two regions in IV.Results.

A risk framework is often applied to subsistence studies, and for a good reason: this provides a way to quantify the costs and benefits associated with various behaviors (Bamforth and Bleed 2008; Kelly 2013:122; Nelson 1996). The risks associated with hunting, foraging, horticulture, and agriculture vary with environment, technology, year-to-year climate, among other factors (Shearn in Brown et al. eds. 2020; Kelly 2013; Akins in Akins et al. 2010:40). Kelly (2013:123) treats the topic of risk in terms of subsistence strategies from the standpoint of mobility, relaying research from Dwight Read (2008) that found a direct correlation between mobility and risk. Read found that increasing mobility correlates strongly with decreased complex tool use (2008). These findings track with the work of Bamforth and Bleed on risk (2008), who discuss how hunters and gatherers expose themselves to risk by failing to kill prey, and therefore it is worth the increased cost to make projectile points more complex (i.e., notching, basal tapering) to increase hunting success rates.

4. Delineating between Hunting and Warfare Uses for Projectiles

A substantial body of literature discusses methods for distinguishing between the use of projectile points in assemblages for hunting and warfare. Some take ethnographic and archaeological approaches (see Keeley 1996:52; Christenson 1997:134; Loendorf et al. 2015, 2019; Kelly et al. 2013:133; Ellis 1997:46), while others take experimental or form/function-based approaches to understand variation in projectile point design (Vierra and Heilen 2020; Bebber et al. 2017; Loendorf et al. 2018; Forsom and Smith 2017; Fischer et al. 1984; Ahler and Geib 2000; Bamforth and Bleed 2008). Indeed, the study of warfare in the Southwest has its history of taboos, perhaps most notably covered by LeBlanc (1999:3). But addressing the political correctness of the study of warfare is not within the scope of this research.

Beginning with ethnographic and archaeological data, I recognize that it is unreasonable to assert whether certain morphological intricacies of archaeological assemblages result from intentional or inadvertent design following Bebber et al. (2017). I continue to apply Chamberlain's multiple working hypotheses here by making no assumptions about the cause(s) for the morphological variation in the projectile point design observed in IV.Results. Still, it has been observed in multiple archaeological and ethnographic instances that point design, specifically the implementation of notching, is related to using points for warfare versus hunting large game (Loendorf et al. 2019, 2015; Christenson 1997; Keeley 1996, among others). It is often suggested that unnotched points fracture more easily, break off inside wounds, and are otherwise more difficult to remove and reuse while maximizing the probability of injury compared to notched points (Loendorf et al. 2019, 2015; Christenson 1997; Keeley 1996). These topics relate to a previous discussion regarding durability, as brittle materials with high penetration, such as obsidian, seem to be the prime choice for warfare across ethnographies (Loendorf et al. 2019, 2015). Other situational factors are bound to exist here too. For example, notched points securely attached to shafts and manufactured from durable materials may be more likely to remain usable by an enemy after a miss in battle, whereas the same design might be retrieved and reused to kill large game using encounter hunting tactics described by Vierra and Heilen (2020). Building on the previous discussion of use and durability, the quality of material or points is determined by how well they match task-oriented functional parameters (Rots and Plisson 2014).

Considering previous research in differential uses of notched and unnotched points in the Southwest, I present my observations from conversations with tribal members of the Pueblo of

Pojoaque. After showing tribal members photos of various points from collections from their ancestral sites, I was met with enthusiastic responses. Projectile points with multiple notches or simple side-notching made of red or white materials were immediately recognized as hunting points related to the winter moiety. Additionally, it was suggested that there are intentional differences between points made for hunting large game such as deer or elk. Unfortunately, this distinction was not elaborated upon. Still, this provides some direct ethnographic evidence that projectile points made with Tewa culture in mind would exhibit differences depending on the specific target game.

Returning to the latter method of delineating between the uses of warfare and hunting involves relying on the argument that form follows function. Conjecture is prevalent regarding projectile point form and material selection following their use for hunting or warfare, though this need not be negative (Vierra and Heilen 2020; Loendorf et al. 2015; Bebber et al. 2017). Most of these approaches take some form of data (faunal, ethnographic, etc.) and form a claim that the functional parameters of the points were modified to fit this constraint (Bebber et al. 2017 propose that the size of deer ribs might influence points; Loendorf et al. 2015 propose that unnotched points were designed for warfare in Gila River communities; Vierra and Heilen 2020 propose a correlation between factors of durability and those of penetration). Vierra and Heilen also evaluate point morphology to discuss using different designs for encounter versus intercept hunting tactics where durability is more critical for encounter hunting as misses are more likely than in the close-quarters nature of intercept hunting (2020). These ideas also reflect an essential aspect of risk from Bamforth and Bleed's work: that technological adaptations generally reduce the risk of failure (2008). In this case, relatively high or medium-cost behavior would be strongly selected against unless it proves beneficial. An example might be designing points intending to retrieve the arrow with the point (durable material selection) given their functional parameters (encounter hunting). Notching and material selection for the data in this thesis will be discussed in IV.Results.

Finally, I return to the idea that points made by Tewa ancestors may have varied morphologically for various target game, considering Nelson's argument for culturally appropriate forms of projectile points (1997:372). Nelson posited that the notion of an "expended state" for a projectile point is, to a degree, culturally defined (1997). Moreover, morphological variation between assemblages may be partly due to cultural variation in what constitutes a point's "appropriate form" (Nelson 1997). For instance, it can be difficult to tell if a multi-notched point is an attempt to fix a botched notch or an intentional and distinct form. Some cultures might view the extra notch as unsuited to a particular purpose, while others may not consider this odd. Thus, this analysis can only go so far as to produce more conjecture as to the intentionality of variations in morphology between assemblages.

Still, the hunt for morphological factors distinguishing the uses of hunting and warfare is not fruitless. More archaeological, ethnographic, ethnohistorical, and experimental data and testing will continue to reveal patterns in projectile point design and use. One crucial reflection remains though: "As the much repeated quote 'pots do not equal people' suggests, archaeologists generally agree that there is no predictable correlation between material culture and language/ethnicity" (Cooper 2020:19). Although patterns in the material or form of projectile points may correlate with their uses, this does not reliably allow for the assumption that similar material patterns represent a direct cultural affiliation. These summaries provide the necessary theoretical background to understand the larger dataset and the two assemblages analyzed in this thesis.

B. Background by Region

This section details the cultural background of the NRG and the CMV, focusing on 600-1300 as this is the necessary context. I provide background on the specific sites, the Pojoaque Grant Site and Castle Rock Pueblo, as those assemblages are the subject of direct comparison. The discussion of subsistence strategies above (II.A.3) introduced the general subsistence systems of the Ancestral Pueblo world, while this section adds geographic and temporal precision.

1. Northern Rio Grande

Bradley Vierra describes the uplands of the Southwest in general as rich and various in their resources, and the NRG exemplifies this pattern (2013). The NRG is "a crossroads that linked the San Juan Mountains to the north with the Chihuahua Desert to the south and the Colorado Plateau to the west with the Great Plains to the east" (Vierra 2013). It is a relatively high valley of juniper savanna and pinyon-juniper woodland surrounded by the forested orogenous result of tectonic and volcanic forces with elevations ranging from 5,200-14,000 ft (Vierra 2013). Vierra noted, "lithic raw materials also abound in the area, including obsidian, fine-grained dacite, and Pedernal chert in the Jemez Mountains area, ancient gravel terraces along the Rio Grande, and fine-grained dacite around San Antonio Mountain" (Vierra et al. in Bousman et al. 2014:424). While technically, this area includes the San Luis Basin, *Figure 1* on the following page illustrates the NRG area for the purposes of this research, which only includes the Tewa Basin and some surrounding areas.

The chronology of Wendorf and Reed (1955) proposed a cultural-historical sequence as a Rio Grande equivalent of the Pecos classification. While critiques have been made (see Scheick 2007, for example), this chronology (with revisions) has become ubiquitous in studies of the area.

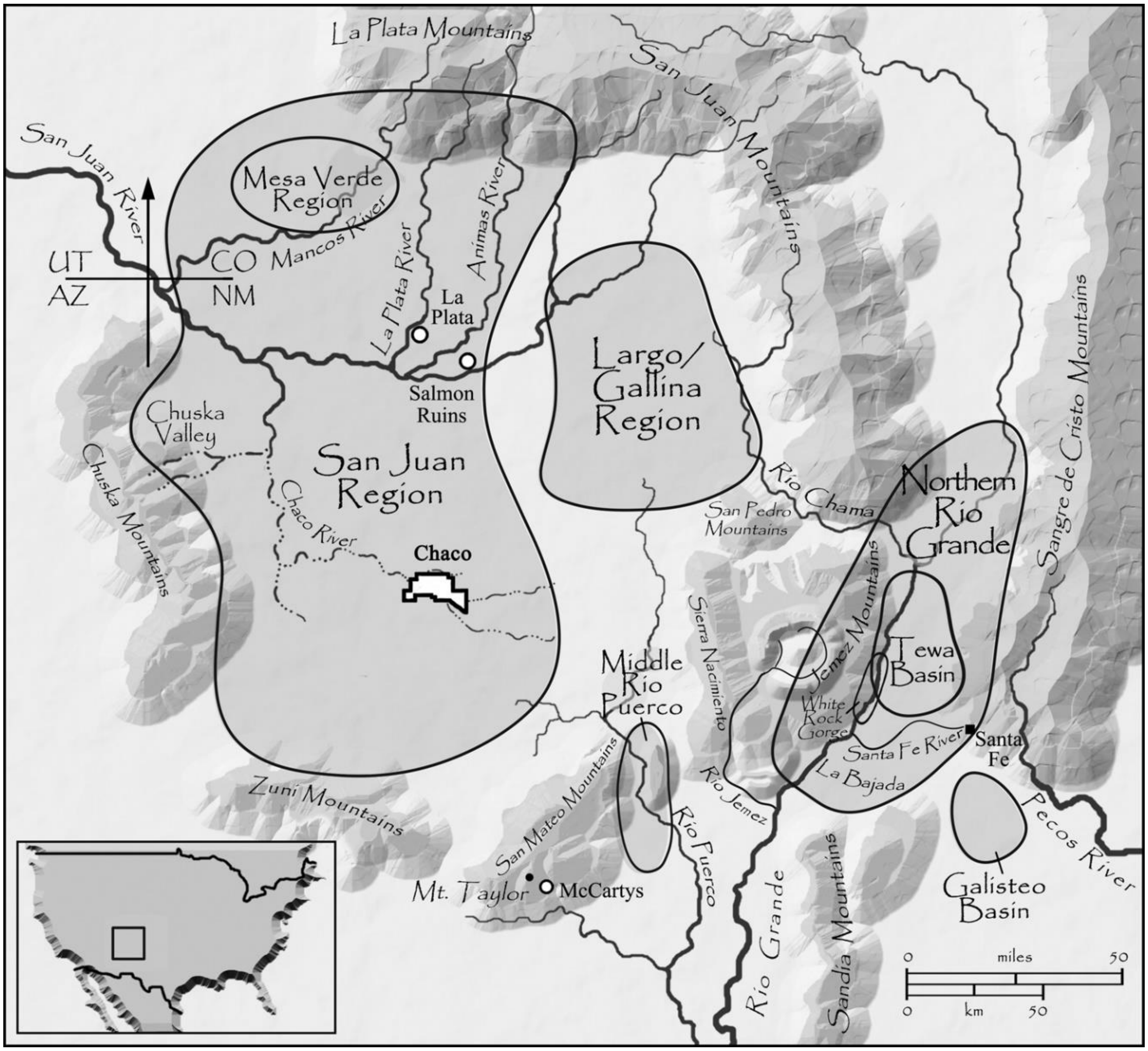

Figure 1 - Regional map of the Four Corners highlighting regional distinctions corresponding to those discussed in this thesis. Adapted from Moore et al. 2020.

I use dates in this thesis to improve accessibility, though the basic sequence of Wendorf and Reed is still applicable. Essentially, 600-900 marks the first aggregated settlements in the area, along with agricultural developments (Scheick 2007; Moore et al. 2020; Lakatos 2007). The period of 900-1000 saw a significant population increase, restructuring of social organization, and further economic shifts towards agriculture (Scheick 2007). According to Scheick, “populations reached thresholds again circa A.D. 1275/1325 when major substantive changes occurred in how populations organized, how they used and modified the land, and how they related to each other as well as outsiders" (2007:147-148). While this does not line up perfectly with Wendorf and Reed's suggested date of 1200 for a shift to the Coalition period, more recent excavations point to dates in the late 1200s (around the time of the depopulation of the CMV) for shifts in behavior, culture, and significant population aggregation (2007). Archaeologists currently present differing perspectives on these population movements: an in-situ development (Moore et al. 2020; Lakatos 2007; Boyer et al. 2010) and a migration from the north (Ortman 2012; Cooper 2020; Bernstein and Ortman 2020; Kemp et al. 2017). This paper contributes relatively minimally to this debate. Scheick's argument for behavioral shifts defining chronologies stands in the face of the analysis presented in IV.Results as I examine behavioral shifts in subsistence strategies that are representative of the variable process of cultural transformation. Nancy Akins hinted at this phenomenon (Maxwell et al. 2000:133-134) in observing more hunting/foraging or horticulture than agriculture from sites in the Tewa Basin around 750-1150.

Akins analyzed the faunal remains of the Pojoaque Grant Site and other nearby sites and presented high artiodactyl indices such as .94 for LA 835 (Maxwell et al. 2000:133; see *Figure 2*). In general, these indices are used in the Southwest as an indicator of hunting behavior via the relative prevalence of hunted artiodactyls compared to rabbits or hares (artiodactyl NISP/ (artiodactyl NISP + lagomorph NISP)) (Maxwell et al. 2000). Issues with these indices will be elaborated upon in following sections. However, they suffice here in thinking about LA 835 and other sites. The above indices indicate minimal agricultural activity (Maxwell et al. 2000; Arakawa et al. 2013). For the Northern Rio Grande, in particular, populations during this time are known for diversity in subsistence strategies following the excavation of more sites (Scheick 2007; Akins in Maxwell et al. 2000:132). Finally, the availability of large game, productivity of farming, and interaction between spatiotemporally similar groups vary, so changes in subsistence strategies in response come as no surprise (see Ortman 2012; Schollmeyer and Driver 2013; Lakatos 2007).

2. Pojoaque Grant Site (LA 835)

The Pojoaque Grant Site deserves significant attention as it is one of the largest and most unique sites in the Rio Grande Region. LA 835 is situated east of the Rio Grande in the NRG in between Taos and Santa Fe (see *Figure 1*), south of the Pueblo of Pojoaque along the east bank of Tesuque Creek (*Figure 2*). Stanley Stubbs excavated LA 835 in 1953 (all dates in CE) and was unfortunately unable to publish a report. He considered the site crucial to understanding the archaeology of the Rio Grande and was the leading expert on Rio Grande archaeology at his death (Wiseman 1995, p.237). To be clear, there is no accurate provenience for artifacts at this site, nor did the project screen the sediments they removed. The site comprises about fifteen small roomblocks (Wiseman 1995:238). In this report, I use the term “roomblock” following Crow Canyon Archaeological Center vernacular to describe what Wiseman and others refer to as “housemounds”- groups of rooms together. I continue the usage of Pueblo A and Pueblo B as references to respective roomblocks along with their associated structures.

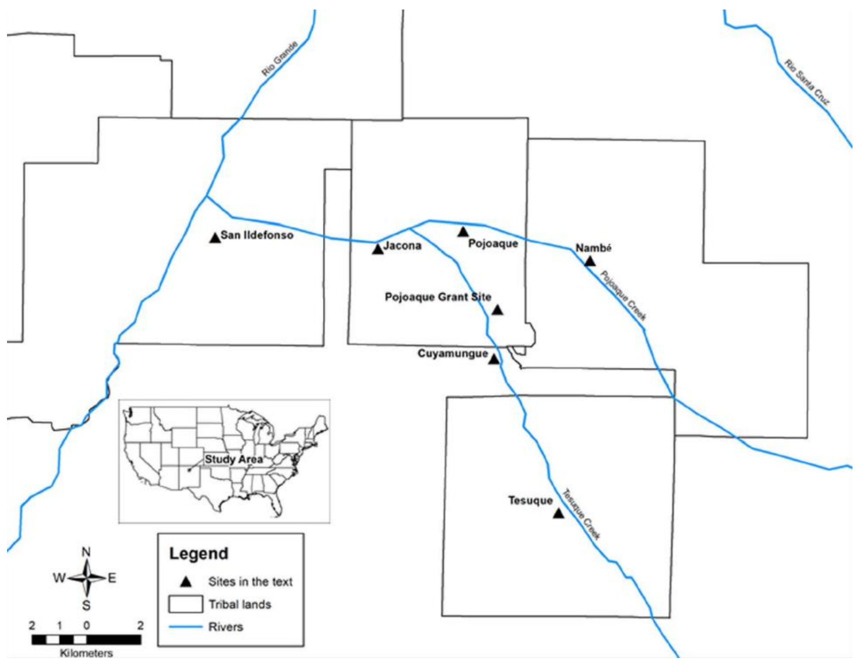

Figure 2- Map of LA835 surroundings (Bernstein and Ortman 2020:97).

The site has multiple temporal components, with "Pueblos" A and B dating quite differently. Pueblo A has tree-ring dates that suggest construction and occupation in the early-to-mid 800s and ceramics, which peak in the distribution in the 900s into early 1000s (Wiseman 1995:242&246). Pueblo B has later distributions with tree-ring dates indicating construction from the early 1000s to the early 1130s and ceramics which illustrate use from the 1000s into the 1100s, but no further than 1175-1200 due to the absence of Santa Fe Black-on-white (Wiseman 1995:242&246). The frequency of all tree-ring dates indicates that the main structural elements of Structure A were built during the early AD 900s and occupied until the mid-1000s, corresponding to the subsequent construction events at Structure B. The low frequency of pre-AD 1000 dates from Structure B likely reflects the reuse of salvageable materials from Structure A or the use of eroded wood. Structure B was initially built during the early AD 1000s and appeared to have been occupied until the late 1100s, corresponding with the site's abandonment. The great kiva was likely built between the late AD 800s and mid-AD 900s, contemporaneous with the construction of Structure A. (Lakatos in Maxwell et al. 2020:83).

These dates are of particular interest because the earlier occupation straddles the early and middle Developmental Period (of which there are no other known sites in the region of such size at the time), and the later date clusters coincide closely with the rise and fall of Chaco Canyon as the center of the Chacoan world (Moore et al. 2020).

Linguistic and ceramic lines of evidence suggest that the Tewa identity emerged sometime after the first people inhabited Pojoaque (Ortman 2012; Cooper 2020). Furthermore, the ceramics from this collection have been analyzed by Dr. Ortman and others, giving the site a firm chronology and jumping-off point for this research. Currently, the Tewa are understood as a linguistic and cultural group encompassing many of the Pueblos around this area of the Rio Grande who came together sometime after the 1200s from at least two separate groups of people, as stated earlier (Ortman 2012; Cooper 2020; Bernstein and Ortman 2020). Linguistic, bioarchaeological, and ceramic analysis suggests that the earliest people to live at LA 835 were migrants to the area, likely related to the migration out of the Northern San Juan Region from the 800s-900s (Ortman 2012, Cooper 2020, Wilshusen and Ortman 1999). Specifically, Tewa oral traditions account for a "winter people" who were hunters and foragers who migrated far from the north to the east side of the Rio Grande in the Tewa Basin, and a later "summer people" who were agriculturalists on the west side (Bernstein and Ortman 2020). The tradition indicates that these peoples interacted closely and formed the society Tewa people know today. This tradition is the main inspiration for research on hunting investment for early occupations at LA 835 and the early settlements of the Tewa Basin.

3. Central Mesa Verde

Vierra's description of the uplands of the Southwest applies once again to the CMV, located on the north end of the Colorado Plateau (2013). The CMV encompasses the Dolores, Mancos, McElmo, Yellowjacket drainages, Mesa Verde, and the Ute Mountain area (Arakawa et al. 2013). There is a great diversity in the environments of the Colorado Plateau, though the CMV considered in this thesis is generally composed of juniper savanna and pinyon-juniper woodland with elevations ranging from 4,500-10,000 ft (Lipe et al. 1999). Arakawa details the lithic raw materials in the CMV where "most sedimentary lithic sources are located in the Monument/McElmo region, while igneous, metamorphic (indurated shale), and river derived gravel sources are located in and around Mesa Verde National Park and the Ute Mountain Ute Tribal Park" (Arakawa 2006:53). While the broader Mesa Verde region extends much further

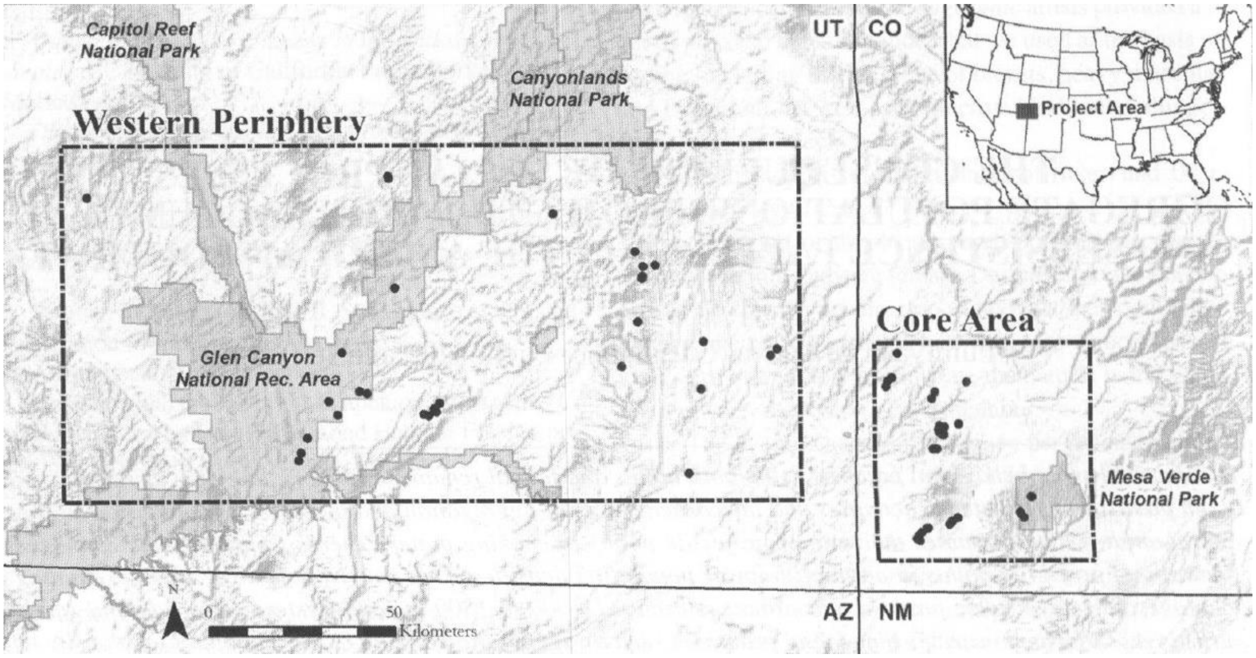

Figure 3 – Study Regions from Arakawa et al. (2013:148).

south and west than the present study area, the CMV presented here has a long and thorough history of archaeological investigation (Arakawa 2006; Arakawa et al. 2013). *Figure 3* from Arakawa et al. (2013) on the following page illustrates the CMV area ("Core") for the purposes of this research while also outlining the "Western Periphery" (WP) of the low-population density area adapted in this thesis.

Of course, the chronology for the CMV was established in 1927 by Alfred Kidder in the famous Pecos Classification, forming the basis for the Rio Grande equivalent of the Pecos classification described earlier. While critiques have been made (see Stein 1998, for example), this chronology (with revisions) is ubiquitous in studies of the area. I use dates in this thesis to improve accessibility, though the basic ideas of Kidder still prove helpful. Essentially, 500-750 (Basketmaker III) marks the first residential pithouses in the area, "widespread use of domesticated crops such as corn; the presence of tools such as plain pottery and the bow and arrow; and a population that did not practice cranial deformation" (Wilshusen in Lipe et al. 1999:166). Ortman et al. (2016) provide a detailed discussion of the Neolithic Demographic Transition in the CMV, including the development of private property and domestic modes of production. The Pueblo I period of 750-900 followed, bringing a significant population increase and aggregation, social reorganization, and the prevalence of above-ground masonry (Wilshusen in Lipe et al. 1999:200). The period of 900-1150 (Pueblo II) saw the emergence of the Chacoan regional system, populations aggregating once more in community centers in the 1000s and 1100s, and architectural variability before construction fell off quickly after 1150 (Lipe and Varien in Lipe et al. 1999:253-260). Finally, Chacoan influence expanded to the north from 1150-1300 (Pueblo III), culminating in rapid aggregation and depopulation of the entire CMV before 1290 (Lipe and Varien in Lipe et al. 1999:290-337). This chronological sequence aligns temporally with the shifts in behavior, culture, and significant population aggregation in the NRG in the 1200s (as noted by Ortman 2012; Moore et al. 2020; Wendorf and Reed 1955).

The faunal remains of a robust sample for 840-1285 from the CMV were analyzed by Schollmeyer and Driver (2013). The broad trends are clear: early occupations and those during low population have relatively higher artiodactyl indices from .13-.25, with artiodactyls becoming less abundant and turkeys far more common over time (Schollmeyer and Driver 2013). Lipe et al. also discuss the previous compositional analysis of bone in the CMV, which suggests high reliance on domesticated maize (1999). Artiodactyl indices in the CMV reached .03-.06 by 1140-1225 and fell below .04 by 1225-1280 (Schollmeyer and Driver 2013:23). It seems likely that extensive hunting in the area affected game, and Schollmeyer and Driver (2013) and Lipe and Varien (in Lipe et al. 1999:337) treat the subject in detail. Additionally, Reynolds (2012) investigated artiodactyl indices from 500 BCE – 500 CE (BMII) communities, finding high variation between sites in the CMV during this earlier period. Thus, CMV communities during the sample period are archaeologically visible as low-hunting investment communities that relied heavily on domesticated maize and, eventually, domesticated turkeys. Schollmeyer and Driver (2013) note that after potential crop failures in the 1250s, communities may have increased their usage of wild resources.

4. Castle Rock Pueblo (5MT1825)

Contrary to the Pojoaque Grant site, Castle Rock Pueblo was excavated using modern techniques, thorough recording, and screening practices from 1990-1994 by Crow Canyon Archaeological Center. Castle Rock fits directly into the latter period described above for CMV sites with extremely low artiodactyl indices (Kuckelman ed. 2000). The site is located at the base of a prominent butte and comprises forty rooms and sixteen kivas for a total of about fifteen households or 75-150 people total (Kuckelman et al. 2002:488). The site is 600m north of McElmo Creek, and the corresponding floodplain has substantial agricultural potential (this area is still farmed today). These factors, combined with the information presented on the CMV more broadly, paint a clear picture of this site as a generally low-hunting investment site focused on agriculture.

Given the improved technology and excavation techniques applied to Castle Rock Pueblo, it is no surprise that it is far more precisely dated and better understood than the Pojoaque Grant Site. According to Kuckelman et al. (2002), "tree-ring dates indicate that construction of the village began around 1256. The latest tree-ring date from the site is 1274 vv, and available data suggest that the demise of Castle Rock Pueblo occurred sometime between 1280 and 1285." These dates represent a short occupation that ended prematurely with a massacre. At least 41 individuals were killed at Castle Rock at or near the time of the end of the site occupation (likely many more due to the nature of sampling), with rooms burned, remains modified, and other evidence confirming one final episode of violence (Kuckelman et al. 2002). Castle Rock is one of the best-documented episodes of violence in the Southwest, and this contributed significantly to the selection of the site for comparison with the Pojoaque Grant site. Moreover, Castle Rock possesses an array of readily available data easily compared to the data collected for this thesis. Finally, it is worth reiterating that according to research on migration in the San Juan Basin, any survivors of the violence at Castle Rock may have been some of the last migrants out of the CMV towards the NRG (Ortman 2012; Bernstein and Ortman 2020; Wilshusen and Ortman 1999; Cooper 2020; Kemp et al. 2017).

C. Data Utilized

The data utilized in this thesis come from the Arakawa et al. (2013) dataset of artiodactyl, lagomorph, projectile point, and grayware pottery sherd counts from sites in the regions in *Figure 3*. I tabulated existing data from six sites in the Tewa Basin (800-1150) and eight sites on the Pajarito Plateau (1150-1400). I also added turkey NISP data for 29 sites. I use these data to evaluate subsistence strategies via relative hunting investment and to contextualize the primary measures for the sites from which I examined points. In addition, I collected data on the projectile points from four sites in the Tewa Basin which had never been analyzed in this manner. These data formed the basis for comparing the assemblages of the Pojoaque Grant Site and Castle Rock Pueblo.

D. Expectations and Alternative Ideas

As mentioned in subsection I.A, distinguishing between warfare and hunting was inspiring in this research's initial stages. The presence or absence of warfare is informed by previous knowledge of warfare at Castle Rock Pueblo (Kuckelman et al. 2002; Billman et al. 2000). When plotting the artiodactyl(y) and projectile point(x) proportions with grayware against each other, it was expected that negative residuals would indicate the prevalence of “extra” points not accounted for by use expected from hunting. I expected to be able to distinguish between sites with hunting investment and warfare investment based on the residuals of this plot. Essentially, I anticipated a strong correlation between projectile point use rates and large game processing rates from which instances of warfare would deviate. This was based on the literature reviewed in the II.A and the basic logic that archaeological materials corresponding to activities should be found in increasing abundance the more said activities are practiced.

Following Kohler et al. (2014), conflict/warfare is difficult to predict, and this research considers multiple hypotheses (Chamberlain 1890) as to why the models employed may not function as anticipated. For instance, the difference in raw materials or cultural ideas surrounding point manufacture may play a role in the morphologies of points compared between Castle Rock Pueblo and the Pojoaque Grant Site. The deposition of points at these sites may not accurately represent the assemblages used by the occupying populations due to excavation sampling or differential deposition or use/discard patterns for points of different morphologies. Finally, in terms of the broader model for relative hunting investment based on projectile point counts, artiodactyl NISP, and grayware counts, a few instances of projectile point use for warfare may not be significant enough to overcome the sample sizes for entire occupations at sites (in some cases hundreds of years of accumulation). Other confounding factors unknown to the author may also exist, and if so, will hopefully be examined in the future.

CHAPTER III

MATERIALS AND METHODS

The materials for this thesis take two forms: the large dataset adapted from Arakawa et al. (2013) and new data added through analysis and research in the literature, and the analysis and recording of attributes for projectile points from Pojoaque-Tesuque Creek area sites in the Tewa Basin dating from roughly 800-1150 (Wiseman 1995; McNutt 1969). Included in the former are the results of a search for excavated sites with full-year habitations and available data on faunal remains, projectile points, and pottery from around 800-1150 in the Tewa Basin and 1200-1400 on the Pajarito Plateau (Kohler et al. 1989, 1990; Schmidt et al. 2006; Vierra et al. 2002; Vierra and Schmidt 2008). The remainder of the data was adapted from Arakawa et al. (2013), representing Pueblo III occupations in their core CMV region and smaller occupations in their WP. These data were verified against the original sources and amended in a few cases.

The sample size for the broader intersite study totals 61 sites, 1626 total and 27.1 average counts of projectile points, and 6,183 total and 103.05 average counts of identified faunal bone from large game. This sample includes data from previously excavated sites in the WP and CMV, available in the Arakawa et al. (2013) dataset as well as the data I assembled from sites on the Pajarito Plateau (west side of the Rio Grande) and those in the Tewa Basin (east side of the Rio Grande). The Pajarito Plateau, CMV, and WP regions allowed for the comparison of other precolonial Ancestral Puebloan communities with long histories of excavation and investigation to lesser-understood communities in the early permanent settlements of the Tewa Basin. Furthermore, the well-documented data from Castle Rock Pueblo and those from the Pojoaque Grant site allowed for a more intensive, higher-resolution examination of projectile point assemblages from settlements with contrasting hunting investment and subsistence strategies. This comparison enabled me to explore the morphologies and raw material use of high and low-hunting investment sites.

The methods revolved around obtaining physical data which are always of use for projectile points: length, width, weight, material, shape, etc. However, conversations with tribal members also prompted a focus on color and the concept of seasonality (duality between winter: red and white, and summer: black and yellow) which is directly related to color. Unfortunately, this approach was only implemented for the new data collected as color has not traditionally been included in lithic analyses.

Firstly, I describe the process by which I was granted the permission to examine, record, and utilize physical data for the projectile points from early Tewa Basin settlement assemblages, followed by an elaboration on the data adapted from site reports and the existing Arakawa et al. dataset (2013). I then note the attributes recorded for projectile points from sites in the Tewa Basin, as well as what methods informed the subsequent analysis. This includes procedures for statistical interpretation, geometric morphometrics, and physical metrics. Lastly, I discuss issues with data collection, measurement confidence, and data integrity. As stated, the data come from a variety of sources, previous analyses, and collections examined in person. Due to the nature of the data utilized in this thesis and the methods taken in their analysis, I will approach each aspect of the materials and methods from the perspectives of the collections analyzed in-person followed by the site report sample.

A. Data Sources and Permissions

As mentioned, collections examined in person were done so at the ARC, part of the Museum of Indian Arts & Culture/Laboratory of Anthropology/Center for New Mexico

Archaeology, and at UCB. I begin by discussing the sources and permissions required to analyze these collections, followed by the same for the dataset created by Arakawa et al. (2013).

1. Museum Collections Analyzed in Person

To obtain data on the collections from Pojoaque-Tesuque area sites, I traveled to Santa Fe where I analyzed physical metrics, noted fractures and macroscopic use-wear, recorded materials, and took photos of each point to perform geometric morphometrics at a later date. I created well-documented data that is compatible with other data from site reports in the region.

I obtained permission first from Dr. Scott Ortman to analyze the points that had been transferred to UCB before obtaining permission from ARC to analyze and photograph the remainder of the collection in person. Though projectile points were cataloged well by site-level provenience, it seems many are simply without more precise documentation.

The sample size of 186 total for LA 835 is seen below in *Table 1* and is much larger than the other three samples analyzed, not to mention larger than any other sample from a site from Tewa Basin dating to 800-1150. These points have previously been written about generally (Lakatos in Maxwell et al. 2020), though not in detail. They were also assigned typologies in 2017 by someone intent on using Noel Justice's classifications that resonate more with pothunters than professional archaeologists (Vierra, Personal Communication 2023). For these reasons, I compare the assemblage from the Pojoaque Grant Site to that of Castle Rock Pueblo to examine differences between high and low-hunting investment projectile points.

Table 1- Projectile Sample Sizes for Sites Analyzed (Note that LA 742 and LA 3415 were not added to the larger dataset due to a lack of faunal data).

LA Site Number	Site Name	Sample Size
742	Tesuque Valley	26
3294	Tesuque By-Pass	14
3415	Cuyamungue High Terrace Site	11
835	Pojoaque Grant	139

2. Site Report Sample

I now discuss the Arakawa et al. dataset (2013) as a source, its permissions, why it was so critical to this research, and issues I remedied. The sample size for this broader intersite study totals 61 sites, 1626 total and 27.1 average counts of projectile points, and 6,183 total and 103.05 average counts of identified faunal bone from large game. I added 419 of these projectile points to this dataset (tabulated in *Table* 2) after receiving a copy from Fumiyasu Arakawa, the lead author of the 2013 study. This includes data from previously excavated sites in the WP, CMV mostly available in the Arakawa et al. (2013) dataset as well as the data I assembled from sites on the Pajarito Plateau (west side of the Rio Grande) and those in the Tewa Basin (east side of the Rio Grande). The Pajarito Plateau, CMV, and WP regions allow for the comparison of other precolonial Ancestral Puebloan communities with long histories of excavation and investigation to lesser-understood communities in the early permanent settlements of the Tewa Basin. Furthermore, the well-documented data from Castle Rock Pueblo coupled with those from the Pojoaque Grant site allow for a more intensive, higher-resolution examination of projectile point assemblages from settlements with contrasting hunting investment and subsistence strategies. This allowed for an exploration of the morphologies and raw material use of high and low hunting investment sites.

Table 2- Projectile Sample Sizes for Sites Added

LA Site Number	Site Name	Sample Size
3852	Casa del Rito	16
4618	Mesita del Buey 2006	9
4624	Mesita del Buey 2002	5
12587	White Rock Tract (A-19)	5
60372	Burnt Mesa Area 1	62
60372	Burnt Mesa Area 2	11
86534	Airport-South Tract (A-3)	5
135290	Airport-Central Tract (A-7)	4
265	Pena Blanca	45
835	Pojoaque Grant Site	139
3294	Tesuque Bypass	20
6170	NA (see Post et al. 2010)	15
46300	KP Site	29
103919	Nambe Falls	58

Unfortunately, no dataset is perfect, and it seems that Arakawa et al. overlooked a key reason to exclude data from Mesa Verde in this study: the use of hardwood projectile points instead of stone (Lister 1966). While they considered the use of organic projectile points, they did not go so far as to omit the data from Mesa Verde (Arakawa et al. 2013). As mentioned in II.A.1 Accumulation Research, this results in significantly lower counts for stone projectile points than expected because of the lack of preservation of these hardwood tips. The result of the lack of use of stone projectile points compared to other districts is clearly visible in *Figure 4* below. This boxplot represents the residuals of the sites by district for the fit line relating the log-transformed proportions of projectile points to gray ware and log-transformed proportions of artiodactyl NISP to gray ware at sites. Given the rest of the data, the sites at Mesa Verde showed far fewer recorded projectile points per gray ware sherd than expected. A simple analysis of variance (ANOVA) resulted in an F-statistic of 9.75 and a p-value of 1.9e-07, meaning it is more than likely that the Mesa Verde mean residuals are statistically significantly different (well beyond the .05 confidence interval). This illustrates how the use of organic projectile points confounds this analysis that assumes all projectile points are stone and recorded due to their preservation. Thus, the Mesa Verde data were omitted.

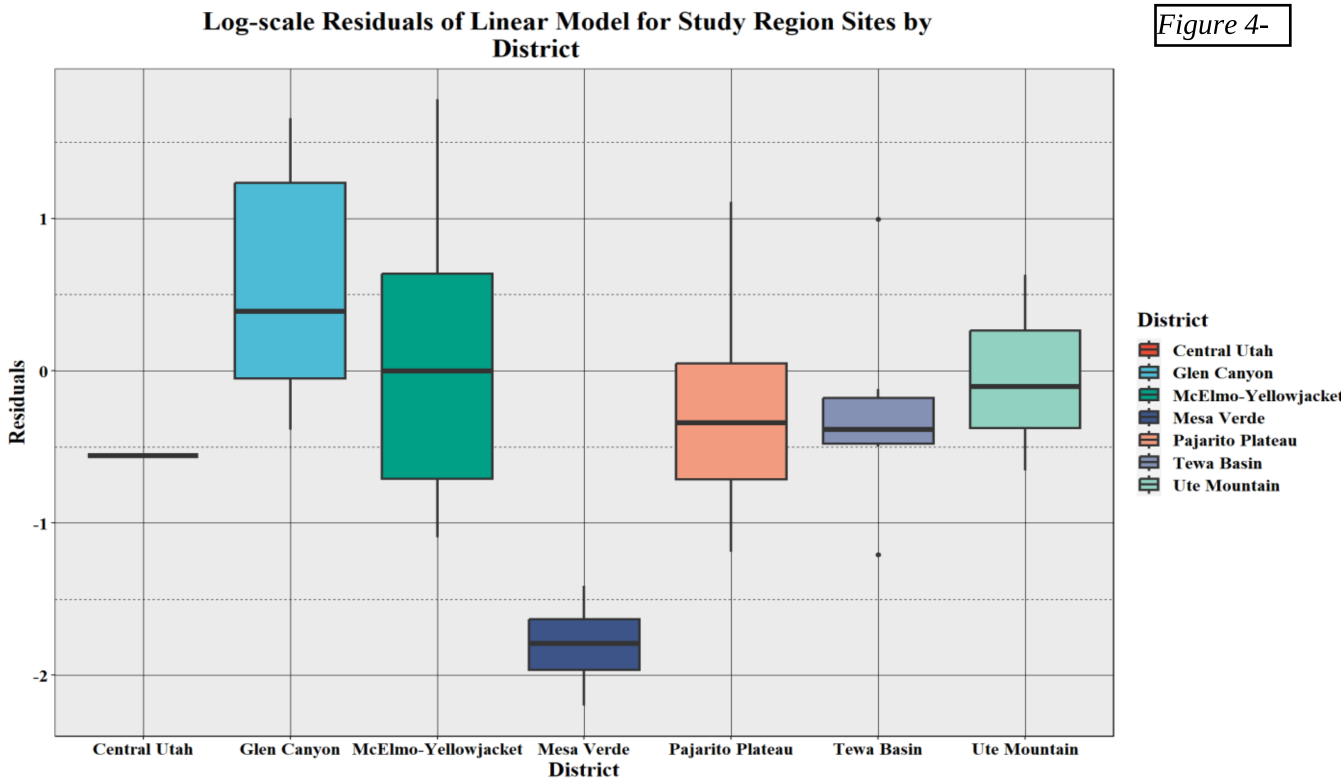

Figure 4-

B. Data Recording

This subsection describes the attributes of projectile points recorded and the justification for those attributes. I analyzed the complete projectile points from the Pojoaque Grant site thoroughly.

1. Museum Collections Analyzed in Person

This covers the attributes of the projectile points selected for analysis and the choice of those criteria. In terms of classifying the points themselves and encoding data, I adopted part of the handbook for lithic analysis from OAS staff which lay out coding procedures for raw materials and completeness (1994). These procedures provided a foundation for my data encoding procedure (see Appendix A.1). The artifacts analyzed are part of collections at the Center for New Mexico Archaeology (CNMA) in Santa Fe.

My finalized procedure for projectile analysis is as follows:

1. Weigh the point (.1g accuracy).
2. Analyze the point visually for breakage/rework patterns with a microscope up to 30x.
3. Evaluate cross-section (see Appendix A.2), completeness (OAS Staff 1994), edge curvature (see Appendix A.1), morphology/type/form (these terms are used interchangeably in this thesis following Vierra 2023, Personal Communication; Andrefsky 2008; Moore in Maxwell et al. 2020), breakage or rework (see III.1.B.a), and material (OAS Staff 1994).
4. High resolution plan view images with a centimeter scale from 18-23mm focal length using a Canon T4i and prioritizing aperture to further minimize distortion from the already minimal amount.

All data generated through this thesis are curated with the collection at ARC to benefit future research. These image files were incredibly useful for review at later times and in their use for geometric morphometrics. I proceed with elaborating on the method for data recording in each column of the spreadsheets I created that has not been covered in the procedure above, and was not a self-explanatory or curatorial part of either spreadsheet I inherited (a and b are related to the spreadsheet from ARC I added to for the collections from the Pojoaque-Tesuque area assemblages and c-g are the procedures for my extended Arakawa et al. dataset).

Projectile Point Breakage/Rework. Previous research (Dockall 1997, 1991; Fischer et al. 1984; Loendorf et al. 2018; Vierra and Heilen 2020; OAS Staff 1994; Rots and Plisson 2014; Schutt in Post et al. 2010) elucidates methods and limitations of projectile point breakage analysis and typology. This thesis applies these methods to collections in the Pojoaque and Tesuque Creeks (see *Figure 2*). The research by Dockall (1997), Fischer et al. (1984), and Rots and Plisson (2014) support the analysis of breakage patterns, see II.2.B for a review.

District. This was determined by the side of the Rio Grande for the NRG (east for Pajarito Plateau and west for Tewa Basin, and the WP and CMV data were provided by Arakawa et al. 2013).

Artiodactyl (NISP count) and Lagomorph (NISP count). I tallied artiodactyl data directly from Nancy Akins for the Pojoaque Grant site (in Maxwell et al. 2000) and thereafter in the same manner as (Arakawa et al. 2013). I included genera-level identifications such as “medium artiodactyl” in the total count.

Turkey (NISP Count). I tallied the turkey data for the available sites by including meleagris gallo. and including the more generic “large bird” as it is unlikely this category reflects any other species.

Sherds and points. These are simply numeric count totals for the numbers provided in reports and by Dr. Scott Ortman in the case of the Pojoaque Grant Site.

Projectile point and grayware proportion. All calculations and figures were produced using the software R (R Core Team 2023). The projectile point and grayware proportions were calculated in the same manner as Arakawa et al. (2013), (Projectile points) / (Projectile points + Grayware Sherds). Instead of using Bayesian methods to attempt to reduce the erroneous impacts of small sample sizes, this analysis left the data unmodified (see page 45).

Artiodactyl/turkey and grayware proportion. This calculation was made in the same manner as the proportion above. Sites with no artiodactyls were removed from the sample to remove sites with little or no faunal data.

2. Site Report Sample

I now elucidate the methods used to record data from the sites in the dataset appended to the dataset from Arakawa et al. (2013). I engaged in the same task as Arakawa et al.: recording the counts of grayware sherds, projectile points, as well as artiodactyl, lagomorph, and turkey NISP in reports (when available). In addition, I amended minor errors in the Arakawa et al. dataset when they occurred (see I.A.pp.2 for the references of the sites added and amended).

C. Data Analysis

Moving on to the larger scale of analysis, I describe the methods used to analyze the relationship between the accumulation of projectile points, artiodactyl remains, and grayware. Next, I detail the methods used to compare the relatively high and low hunting investment sites.

Picking up from II.A.1 Accumulations Research, Varien and Mills (among others, see earlier references) provided strong evidence for the use of grayware count or weight as a proxy for understanding the intensity of occupation of a site (1997). This proves incredibly useful as the denominator in proportions quantifying the relative frequency of artifacts at a site (e.g.: projectile points / (projectile points + grayware)). Proportions such as the example given are essentially the chance of picking an object of a class (in this case a projectile point) out of an imaginary pile of that artifact class mixed into all the grayware sherds from a site. Arakawa et al. used this approach to compare projectile points to artiodactyl frequency, employing empirical Bayesian methods to better account for small sample sizes (2013). Since Bayesian analysis applies prior expectations to data, thereby introducing bias, I refrained from performing empirical Bayesian analysis. Nevertheless, I apply Arakawa et al.'s approach, which uses the proportion of projectile points to utility/cooking pottery shown above to estimate the frequency of projectile point production/use compared to site occupation intensity to discuss the likelihood of hunting and warfare (2013).

Arakawa et al. likely chose to utilize the artiodactyl index because it is generally readily available (2013). They outline some of the potential problems with this index in their paper: differential taphonomic processes at sites, preservation bias, excavation/sampling methods, etc. (Arakawa et al. 2013). Ultimately, these factors were regarded as non-consequential for their analysis. However, after working with their data, it seems that the artiodactyl index is not as reliable a measure as their proportion for projectile point frequency applied to artiodactyl remains (artiodactyl NISP/ (artiodactyl NISP + grayware)). The bias towards not collecting smaller bones, the lack of screening in some cases, small samples, and differential preservation manifest in the artiodactyl index. The artiodactyl index is in essence a simple and inflexible ratio for comparing faunal assemblages that is not easily applied to understanding socioeconomic processes. Whereas this new index of relative artiodactyl abundance is fully independent of differential lagomorph bone preservation at sites or habitation in the area. The lack of integrative material analyses seems to be the only logical reason for the extensive use of the artiodactyl index. Traditionally, faunal analysts have handled faunal remains while lithic analysts focus on lithic artifacts, and so on. Using grayware as the standard denominator allows for the integrated analysis of faunal and chipped stone materials alike.

Another benefit of the artiodactyl and grayware proportion is that it allows for a direct relationship to be drawn to relative hunting investment. Essentially, the dependent variable in the model in this thesis can be interpreted as: large game processed per person-meal plotted for the x axis projectile point per person meal manufactured when both axes are log-transformed. This transformation is necessary for these axes given that they “reflect the multiplicative effects of several independent stochastic variables” (see Ortman et al. 2016). For all the effort and energy which went into crafting utility pottery and all the meals served in it, how much investment was put back into the production of projectile points? Grayware proportions of this kind may also reflect material abundance per person-year as meals and cooking are directly related to the intensity or duration of occupation. The y-axis reads as the investment in processing more large game from the perspective of points being used to procure meat from game. From this view, the residuals to a fit line for these log-transformed axes represent the degree to which a particular site experienced relatively higher or lower (than would be expected by the fit line) returns on the investment of projectile point use in the form of increased large game processing. The slope of the regression line becomes the overall trend in either increasing (>1) or decreasing (<1) returns on investment in hunting. The Coombs site in Boulder, UT and ML 1147 from Manti-La Sal National Forest are aggregated into the Central Utah category (see the original dataset, or the author).

1. Data Contributions

This research appended this data to the existing excel sheets for the Pojoaque Grant site lithic assemblage as well as the other sites analyzed. The high-resolution photos are now part of the OAS database. The publication of this honors thesis promotes the accessibility of archaeological perspectives on Ancestral Puebloan traditional knowledge and cultural materials for tribal members. The consistent interaction with THPO Bruce Bernstein lends credibility to the intentions of this research to contribute positively to the Pueblo of Pojoaque.

2. Statistical Methods

As stated, this thesis avoided Bayesian methods to retain objective interpretations of the data. All data manipulation and statistical analyses for this research were performed in the open-source program ‘R’ (build 386; R Core Team 2023) using the following packages: ‘ggpmisc’, ‘ggsci’, ‘ggpubr’, ‘RcmdrMisc’, ‘ggrepel’, ‘plyr’, ‘rstatix’, ‘geomorph’, ‘tidyverse, ‘wesanderson’, ‘mvnormtest’, and ‘ggplot2’. I performed simple tests of normality such as the Shapiro-Wilk test (univariate and multivariate varieties), analysis of qq (quantile-quantile) plots, Levene’s test, log-transformations, and variance tests. I created histograms of the residuals of linear regression models when appropriate to evaluate the validity of assumptions of normal data distributions or homoscedasticity for tests of statistical significance. I use standard T-tests, Welch’s T-tests, pairwise T-tests, ANOVA, and MANOVA tests to assess the statistical significance of the differences between means of groups. I used the Bonferroni p-value adjustment to correct issues with multiple simultaneous comparisons, which is highly conservative and effective (Jafari and Ansari-Pour 2018). Finally, this thesis uses the standard 95% confidence level for all statistical tests.

I first discuss simple tabulations of breakage, reworking, and material data from the Pojoaque Grant site. Next, I perform pairwise T-tests for the means of projectile point use rates and large game processing rates by District. I produced a scatterplot of large game processing rates for projectile point use rates to examine relative hunting investment across Districts. I demonstrate the use of this figure with inverted axes as well. I also created a density plot for the weights of points from both assemblages as well as a plot of the lengths and widths of points grouped by their form for both assemblages. Finally, I compared the projectile point assemblages from Castle Rock Pueblo and the Pojoaque Grant site using simple T-tests to evaluate differences in morphology.

Only whole points below 3.1g were included in the comparison between high and low investment projectile point assemblages based on the distributions of weight for the assemblages. Whittaker notes the difficulty in separating the use of projectile points as dart points or arrow points when they lie in between common bimodal distributions for size or weight (2012:83). Given the limited number of points which straddle this threshold in the assemblages analyzed in this thesis, it does not pose a significant issue.

3. Geometric Morphometrics

Here I detail the process for conducting geometric morphometrics on the projectile point assemblages from Pojoaque-Tesuque area sites. In order to maximize time spent analyzing assemblages I made the decision to forego taking any physical measurements aside from weight for these collections. Additionally, I found no reason to employ intense morphological study in the same manner as David Hurst Thomas (1981) as the goal of this thesis is not to evaluate potential point typologies but rather to draw meaningful comparisons across Ancestral Puebloan communities in terms of differential investment in subsistence. Thus, this analysis is limited to the measurements of length, width, and weight. After reviewing discussions of orientation in comparing bifaces and projectile points (Tibble and McPherson 1999; Costa 2010), it seems that computer aided implementations of automated orientation are substandard to those assigned by an expert (in this case Francois Bordes). In light of these results, I oriented all points manually. The procedure for geometric morphometrics largely follows Costa (2010) in its use of PAST (PAleontological Statistics software, see Hammer et al. 2001), Tpsutil (Rohlf 2006) and Tpsdig2 (Rohlf 2004).

Procedure for collecting geometric morphometric information:

1. Using Photoshop from Adobe Inc., orient projectile point with tips upwards while preserving the centimeter scale closest to the projectile point in the middle, moving the object to the right. This procedure minimizes the little distortion already present.
2. Tpsutil, Create TPS file from images (Rohlf 2006).
3. Retrieve image names from filenames of images from the TPS file in R, set that to a list that will be added in the order to the dimensions of the points later (R Core Team 2023).
4. Open TPS file in Tpsdig2 and mark landmarks at the extremes of the tip, base, and each side in the same order each time and calibrate the measurement scale to the scale in the image in Tpsdig2 (Rohlf 2004).
5. Open TPS file in PAST to save it as a '.xls'.
6. Open .xls file from step 5 in Microsoft Excel and save it as a .csv file.
7. Open the .csv file from step 6 in R and use geomorph package to calculate linear distances for the length and width as given by landmarks 1 and 3 and 2 and 4 (or any other order, as long as it is consistent) (R Core Team 2023).

8. Add the image ids back to the linear distance measurements from step 7 and integrate this back into the spreadsheet with the rest of the data from III.B.1 (R Core Team 2023).

D. Data Integrity

This section discusses potential issues with this data collection and analysis. My own difference in recording and analysis is one factor which I controlled to the extent possible by recording data in a binary Yes/No/NA format. I also had clear methods for data collection which left little room for interpretation. My own change in skill over the course of analysis also encouraged me to return to the first collections I analyzed after some time to use the same improved methodology I had created in later analyses. I had to omit many sites from data collection and site data from certain analyses due to missing data, sample size issues, or a lack of provenience. Perhaps future excavations will fill in some of the details we are left questioning following poor quality excavations from the early 20th century.

Certainly, differences in how artifacts are recorded from system-to-system also create issues down the road for researchers attempting to perform intersite analyses. This reality shows through with the significant amount of recoding which had to be undertaken just to adapt data from recent Crow Canyon datasets to my own datasheets.

Unfortunately, I engaged in significant oversight by failing to recognize the issue of only taking plan-view photos for geometric morphometric data collection for the projectile points. Omitting a profile view means that there are no thickness measurements available for any of the points I analyzed. While it is possible to use the outlines of points combined with the weight to create a weight for area measurement (g/m^2), this is not adaptable to the same degree of accuracy with other available data, rendering it marginally helpful at best. As stated, no dataset is perfect.

CHAPTER IV

RESULTS

Returning to the questions stated in the introduction of this thesis: I wonder about distinguishing between warfare and hunting uses for projectile points, examining the relationship between projectile point use rates and large game processing rates, and comparing relatively high and low hunting investment occupations. To begin, I tabulate the data for rework, breakage, and material for the Pojoaque Grant site to better understand the assemblage before proceeding. A presentation of large game processing and projectile point use rates as they relate to subsistence strategies follows with examination of patterns from the Central Mesa Verde, Western Periphery, Tewa Basin, and Pajarito Plateau Districts. Finally, I compare the relatively high hunting investment projectile point assemblage of the Pojoaque Grant Site to that of a relatively low investment site, Castle Rock. The purpose of this thesis is to examine subsistence strategies via relative investment in hunting, to compare projectile point assemblages from high and low hunting investment communities, and evaluate the possibility of distinguishing between the uses of hunting and warfare for projectile points.

A. Projectile Point Attributes for the Pojoaque Grant Site

To the right I present tabulations of rework and breakage for LA 835 in *Table 3*. Clearly, most points are not broken without being reworked. This speaks to the high reuse of lithic projectile points during their use-life at LA 835. Next, in *Table 4* I present the count of points reworked and broken by seasons. The Winter people's colors are white for snow and ice, and red for the blood of hunted animals, black and yellow are Summer colors (Ortman 2012).

Table 3- Rework and Breakage for LA 835

	Rework	
Breakage	No	Yes
No	35	46
Yes	9	34

At the Pojoaque Grant site, many Winter points were unbroken, contrasting the more even ratio of 43 to 37 unbroken to broken Summer points. Perhaps the Summer points had another purpose besides hunting; they may have been used for target practice or defense.

Table 4- Breakage and Rework for LA 835 by Season

Breakage	Summer	Winter
No	43	37
Yes	37	6
Rework		
No	26	18
Yes	57	25

The Summer and Winter points also appear to have been reworked similarly. Finally, I present the breakage of points by material for LA 835 in *Table 4*. Undifferentiated chalcedony is likely to be Pedernal Chalcedony, so it is not surprising that both materials exhibit similarly low rates of breakage in the assemblage. In contrast, Obsidian has a nearly equal ratio of 42 unbroken and 36 broken points. Naturally, Winter points are primarily made from Pedernal Chalcedony, so the breakage for Winter points is essentially that of Pedernal Chalcedony. *Table 5* provides an important perspective on the minor variation in the raw lithic source material at the Pojoaque Grant site.

Table 5- Breakage for LA 835 by Material

	Breakage	
Material	No	Yes
Basalt/Slate	2	0
Obsidian	42	36
Pedernal Chalcedony	20	2
Silicified Wood	1	0
Undifferentiated Chalcedony	12	3
Undifferentiated Chert	5	2

B. Relative Hunting Investment for Ancestral Puebloans

This section discusses artiodactyl and projectile-to-grayware proportions illustrating the relationships between the investment in hunting (the rate of projectile point use) and the rate of large game processing (the accumulation of artiodactyl remains). Having covered the subsistence trends in the literature for the NRG, CMV, Castle Rock Pueblo, and the Pojoaque Grant site, I explain the results for the large-scale analysis using the data from Arakawa et. al (2013).

I plotted the proportions on log-transformed axes to examine relative hunting investment and the returns on that investment in a very economic sense in *Figure 5* below. I implemented a fit line to evaluate the correlation between the two variables. Firstly, the slope of the fit line is difficult to interpret but means that for an amount of large game processing, projectile point use rates are consistently about half of that. More obviously, the agricultural McElmo-Yellowjacket sites are seen enveloping the Ute Mountain and Pajarito Plateau sites in the bottom left portion of the graph with low use rates for both projectiles and artiodactyl remains. On the contrary, the largely hunter-gatherer sites of Glen Canyon are seen with the Tewa Basin sites in the top right portion of the graph. This represents high proportions of both artiodactyls and projectile points.

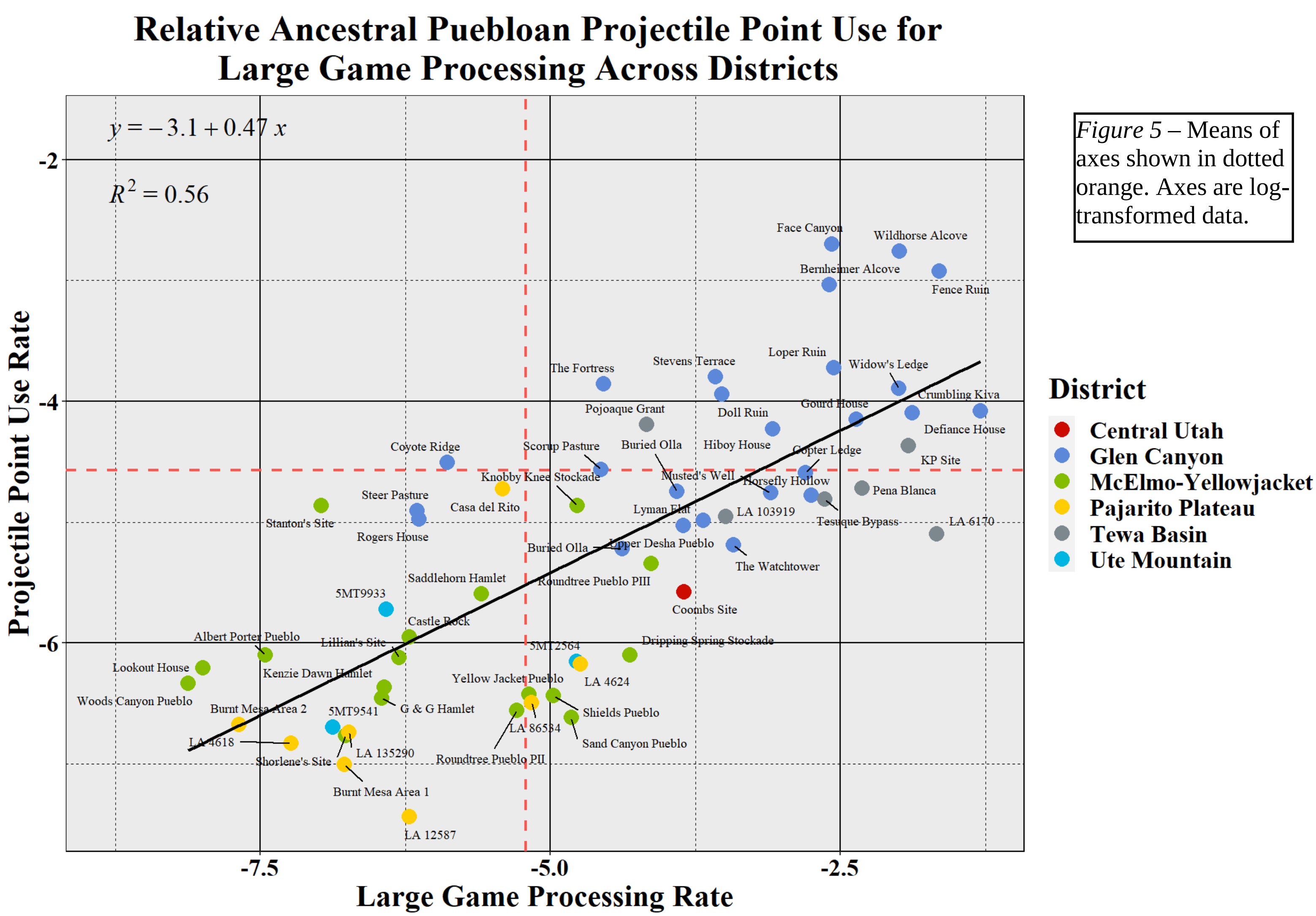

Figure 5 – Means of axes shown in dotted orange. Axes are log-transformed data.

Since the R^2 is .56, this regression can be interpreted as accounting for 56% of the variation in the data. This is also significant because the probability that there is no relationship (p-value provided for this null hypothesis) is extremely low, p = 1.433e-09, allowing a rejection of this null hypothesis at the 95% confidence interval. I note that the residuals for the two sites with known violence (Billman et al. 2000) are: -.66 for Castle Rock Pueblo and +1.52 for Sand Canyon Pueblo. The most important aspect of this plot is the interpretation of these residuals. They represent projectile point use compared to what would be expected by the fit line.

I will now explain *Figure 6* above. It is *Figure 5* with the axes switched. The R^2 and p-value for this fit line are the same as explained above for *Figure 5* given that the axes and the data

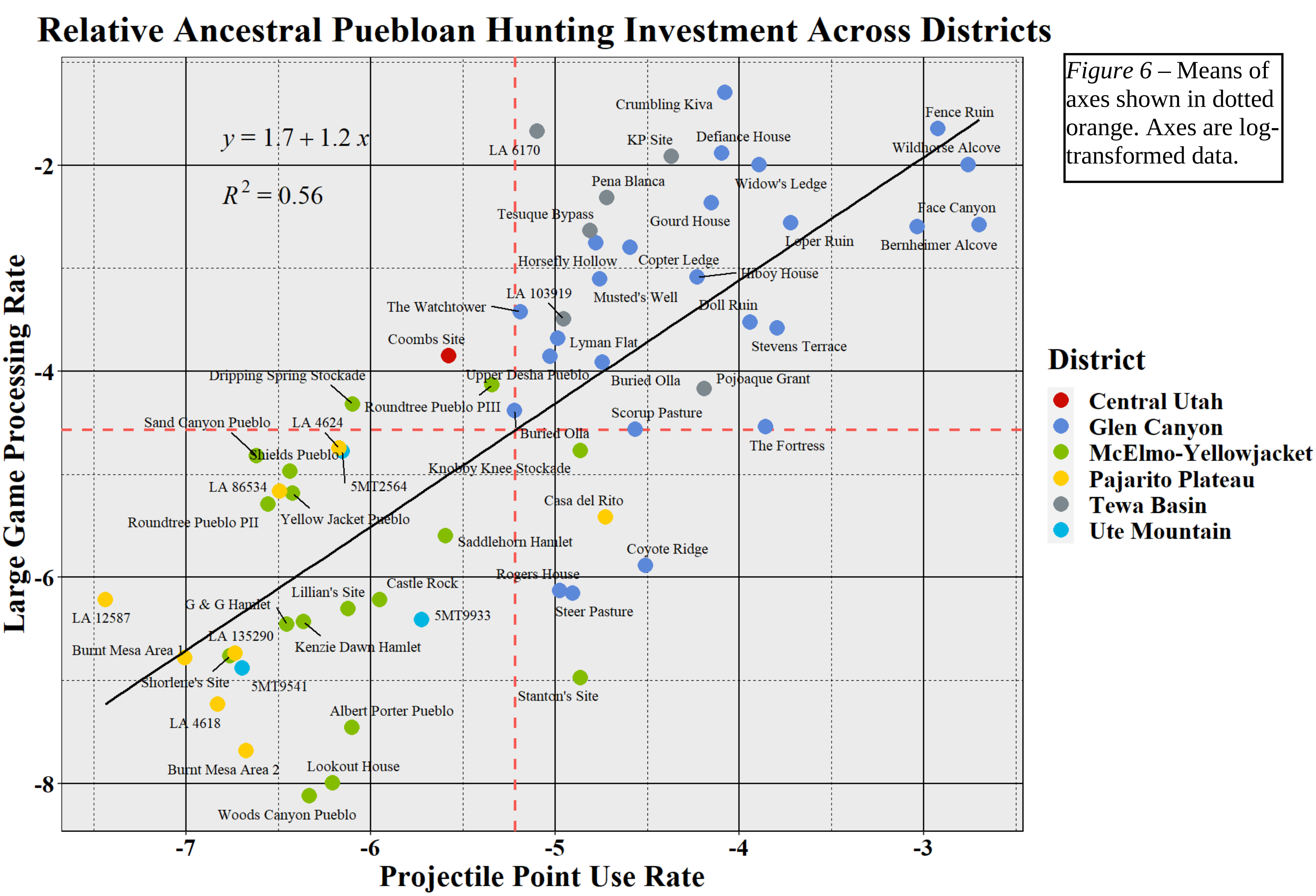

Figure 6 – Means of axes shown in dotted orange. Axes are log-transformed data.

are the same. The multiple and adjusted R^2 are the same for *Figures 5* and *6*. The general trends and grouping of the Districts are also the same. Swapping the axes allows for a more realistic examination of the relationship between projectile point use rates and large game processing rates. From a causal perspective, projectile points are made first and then used to kill, so they serve as an investment toward the result of their use.

On the other hand, artiodactyl remains accumulated as the return on investment into producing projectile points and hunting with them. Therefore, the slope of 1.2 in the regression illustrates a 120% gain in the form of large game processing for the investment of projectile points. This relationship means there are increasing returns to scale for investment in hunting. As expected (Arakawa et al. 2013 use the same procedure), the means of the axes form four quadrants on the plot, of which nearly all the sites fall into only the two quadrants along the fit line. This demonstrates the power of site-occupation-scale data. Of course, the residuals have a different meaning in this figure. Focusing solely on hunting and presuming each projectile point has an equal potential to be used for hunting, the residuals of *Figure 6* are interpreted as a measure of hunting success for hunting investment.

Next, I performed an ANOVA (Analysis of Variance) test for the residuals of Districts to the fit-line established in *Figure 6* to examine hunting return on investment. The residuals are shown in boxplot form in *Figure 7* below and it is clear that the Districts have similar ranges of variation clustered around the fit line (given Mesa Verde data are excluded). To check for normality, I performed two Levene's tests on the axes that lent p-values of 0.3559 for the projectile proportion and 0.6843 for the large game proportion. Since these are both well above .05, the null hypothesis that the data are normal cannot be rejected with 95% confidence. So, the ANOVA results for the residuals with all the same data as *Figure 7* yielded an f-stat: 1.984, and a p-value:

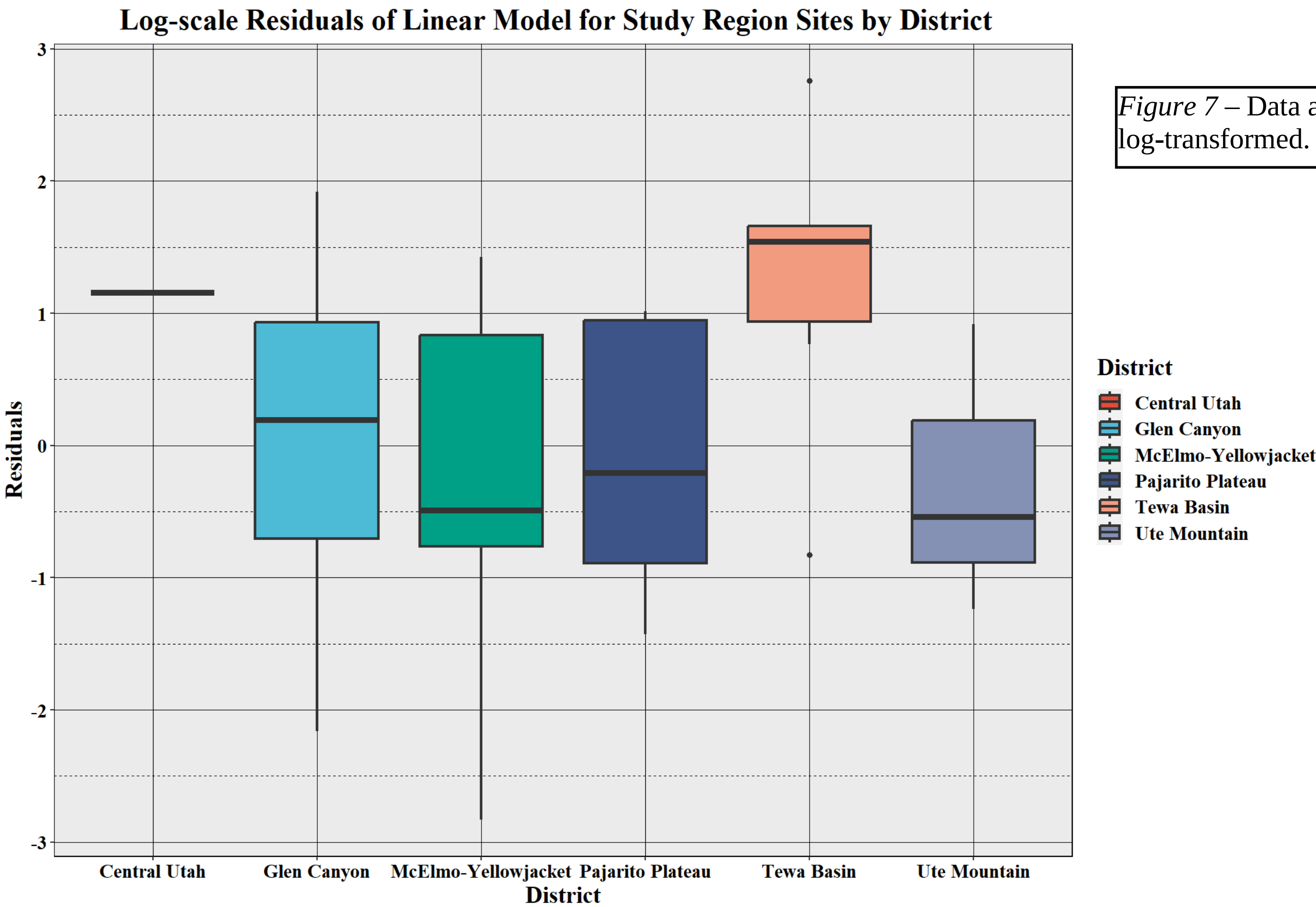

Figure 7 – Data are log-transformed.

0.0957. Being greater than .05, I fail to reject the null hypothesis that the variation in these data could be due to sampling. Considering the small sample size of Central Utah being aggregated into one datapoint I ran another ANOVA test excluding it. Levene's tests again returned values well above the .05 threshold at 0.3614 for the projectile point proportion and 0.8285 for the large game proportion. This test yielded an f-stat: 2.235, and another p-value: 0.0773, which is >.05. This means I fail to reject null hypothesis with confidence of 95%, and the sample variance may be due to sampling.

To wrap up with this model, I utilized pairwise T-tests to test if the differences between means for relative hunting investment (separately for both axes of large game processing rates and projectile point use rates) for high and low hunting investment Districts are the result of sampling.

These results are visible in *Table 6* below. The p-values between Districts tested are all much lower than .05, and thus I reject the null hypothesis that the variation between these means is due to sampling. Instead, the high and low groups are clearly and statistically significantly different from each other. The p-values are adjusted by the Bonferroni correction.

Table 6 – Pairwise Comparisons of Projectile Point Use and Large Game Processing Rates Across Low and High Relative Hunting Investment Ancestral Puebloan Site Occupations

	Proportion	District 1	District 2	n1	n2	p-value	Significance	Adjusted p-value	Adjusted Significance
1	Large Game Processing	Pajarito Plateau	Tewa Basin	8	6	2.05E-06	****	4.10E-06	****
2	Large Game Processing	Glen Canyon	McElmo-Yellowjacket	25	17	1.07E-08	****	2.14E-08	****
3	Relative Hunting Investment	Pajarito Plateau	Tewa Basin	8	6	6.86E-06	****	1.37E-05	****
4	Relative Hunting Investment	Glen Canyon	McElmo-Yellowjacket	25	17	7.76E-12	****	1.55E-11	****

I also plotted the artiodactyl and projectile point proportions examined above for log-transformed grayware sherd counts to investigate a relationship between the size or duration of occupation and investment in hunting. *Figures 8 and 9* on the following page illustrate these relationships. It is evident that hunting investment generally declines with person-years of occupation represented by the excavated samples of artifacts in the plots below. Person-years is an interpretation of the intensity and length of occupation at a site based on the accumulation of grayware. *Figure 8* supports arguments by Arakawa et al. (2013), among others, that the population of artiodactyls declines in an area given the increased presence of human occupation. *Figure 8* suggests that for double the person-years of occupation, Ancestral Puebloan communities in this sample invested slightly less than half as much in hunting (manufacturing projectile points). Based on the linear model, 57% of the variation in this plot is accounted for by the relationship between person-years of occupation and projectile point use.

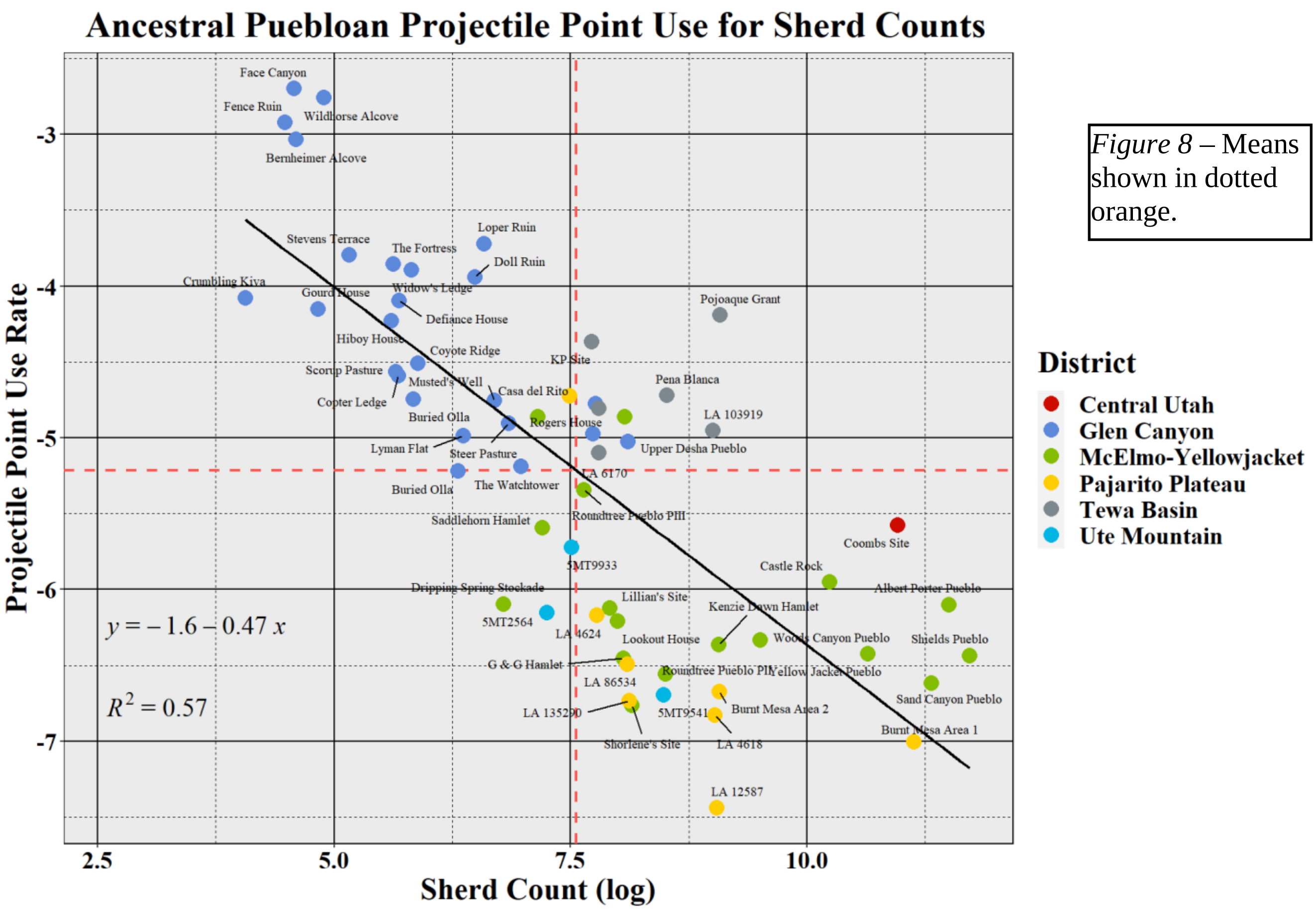

Figure 8 – Means shown in dotted orange.

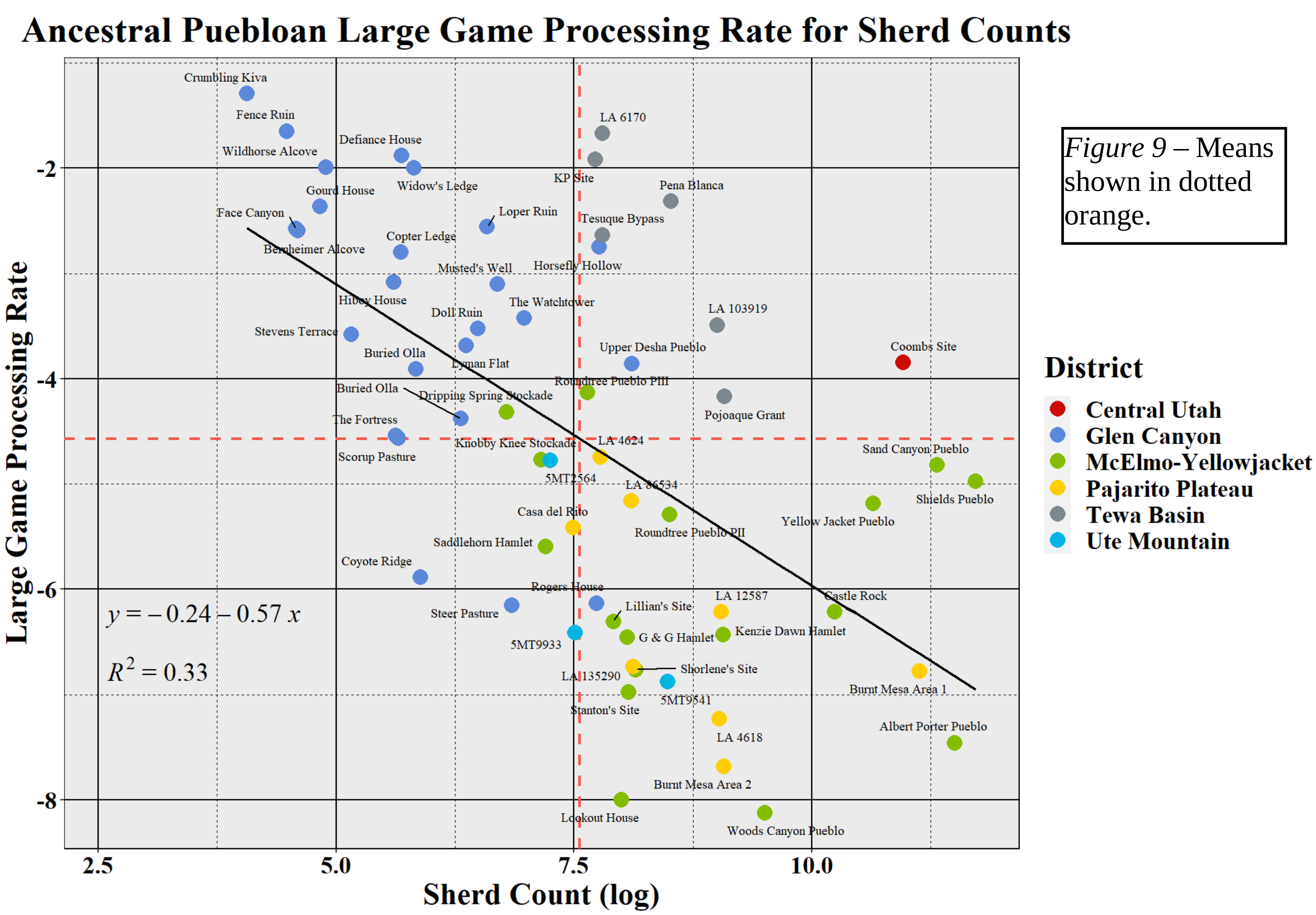

Figure 9 – Means shown in dotted orange.

In *Figure 9*, the relationship between person-years of occupation and large game processing rate is similar but more weakly correlated. The r-squared value is .33 compared to .57 in *Figure 8*. Additionally, the slope is .57, .09 greater. A glance at the plot reveals the general trend of large game processing declining for greater sherd counts at sites. Nevertheless, the sites from the Tewa Basin in grey are in the top-right quadrants of both plots. I interpret this as higher investment and higher returns on hunting investment for the person-years of occupation at those sites. Early Tewa Basin sites appear to have engaged in more hunting than would be predicted based on data from other Ancestral Puebloan sites across the Southwest. Clearly, aggregation and the duration or intensity of occupations affected the subsistence strategies of Ancestral Puebloans, as visible through hunting investment. Interestingly, projectile point use rates form a more consistent relationship with site occupation than large game processing, suggesting that different factors determine projectile point manufacturing/use than large game processing.

C. Comparing Projectile Assemblages for High and Low Hunting Investment

I used Student's T-tests to compare the projectile point assemblages from Castle Rock Pueblo and the Pojoaque Grant site. These tests evaluated the probability that sampling resulted from the differences in the means of physical metric measurements of corner-notched and side-notched projectile points from these high and low relative-hunting-investment sites. To assess the differences in variances between the metrics of the assemblages I used variance tests (var.test in R Core Team 2023). For cases where I could not determine that the variances were equal with 95% confidence, I implemented Welch’s T-test instead of a standard T-test as it does not assume equal variances. *Table 7* below presents the numerical summaries of projectiles from the two assemblages by site and type.

I first compared mean metrics for corner-notched points between sites. I report variances and then T-test results by dimension. For weight, the probability of equal variances was .0002, therefore I performed Welch's T test that resulted in a p-value of .59. For length, the probability of equal variances was .34, therefore I performed a standard T-test that resulted in a p-value of .34. For width, the probability of equal variances was .87, therefore I performed a standard T-test that resulted in a p-value of .26. None of these tests met the 95% confidence interval.

Table 7 – Numerical Summaries of Metrics by Type and Site for Complete Projectile Points from High (POJOAQUE GRANT) and Low (CR) Relative Hunting Investment

Width (cm)	Site	Type	Mean	STD	Max	Min	n	%
1	Pojoaque Grant	Basal Notched	1.67	NA	1.67	1.67	1	2.0%
2	Pojoaque Grant	Corner-notched	1.31	0.21	1.85	1.03	18	36.7%
3	Pojoaque Grant	Leaf	1.16	0.16	1.27	1.05	2	4.1%
4	Pojoaque Grant	SW Triangular	1.51	0.34	2.08	0.87	13	26.5%
5	Pojoaque Grant	Side-notched	1.10	0.11	1.33	0.98	10	20.4%
6	Pojoaque Grant	Side-notched 3+	1.32	0.07	1.41	1.21	5	10.2%
7	Castle Rock	Corner-notched	1.49	0.17	1.61	1.37	2	8.0%
8	Castle Rock	SW Triangular	1.25	NA	1.25	1.25	1	4.0%
9	Castle Rock	Side-notched	1.22	0.13	1.51	0.99	22	88.0%
Length(cm)	**Site**	**Type**	**Mean**	**STD**	**Max**	**Min**	**n**	**%**
1	Pojoaque Grant	Basal Notched	2.23	NA	2.23	2.23	1	2.0%
2	Pojoaque Grant	Corner-notched	2.53	0.51	3.87	1.68	18	36.7%
3	Pojoaque Grant	Leaf	1.82	0.31	2.04	1.60	2	4.1%
4	Pojoaque Grant	SW Triangular	2.40	0.28	2.89	2.05	13	26.5%
5	Pojoaque Grant	Side-notched	2.18	0.30	2.69	1.76	10	20.4%
6	Pojoaque Grant	Side-notched 3+	2.43	0.10	2.55	2.28	5	10.2%
7	Castle Rock	Corner-notched	2.91	0.73	3.42	2.39	2	8.0%
8	Castle Rock	SW Triangular	3.14	NA	3.14	3.14	1	4.0%
9	Castle Rock	Side-notched	2.02	0.44	2.85	1.26	22	88.0%
Weight (g)	**Site**	**Type**	**Mean**	**STD**	**Max**	**Min**	**n**	**%**
1	Pojoaque Grant	Basal Notched	1.21	NA	1.21	1.21	1	2.0%
2	Pojoaque Grant	Corner-notched	0.90	0.21	1.55	0.60	18	36.7%
3	Pojoaque Grant	Leaf	0.79	0.58	1.20	0.38	2	4.1%
4	Pojoaque Grant	SW Triangular	1.32	0.68	3.05	0.40	13	26.5%
5	Pojoaque Grant	Side-notched	0.77	0.22	1.10	0.55	10	20.4%
6	Pojoaque Grant	Side-notched 3+	0.94	0.28	1.33	0.60	5	10.2%
7	Castle Rock	Corner-notched	1.45	1.06	2.20	0.70	2	8.0%
8	Castle Rock	SW Triangular	1.20	NA	1.20	1.20	1	4.0%
9	Castle Rock	Side-notched	0.58	0.24	1.30	0.30	22	88.0%

Next, I compared mean metrics for side-notched points by site. I report variances and then T-test results by dimension. For weight, the probability the variances were equal was .80, therefore I performed a standard T-test that resulted in a p-value of **.039**. For length, the probability of equal variances was .21, therefore I performed a standard T-test that resulted in a p-value of .30. For width, the probability the variances were equal was .70, therefore I performed a standard T-test that resulted in a p-value of **.015**. The T-tests for weight and width both meet the 95% confidence interval threshold, allowing me to reject the null hypothesis and state that the means are statistically significantly different because of the nature of the assemblages.

I now present the weight distributions for the projectile assemblages from the two sites in *Figure 8* on the following page. To elaborate on the comparison of weights for the projectile points, I performed a variance test and a standard T-test to examine if the difference in the mean weights is due to sampling or is statistically significant. The numerical summaries are below in *Table 8*. For the weights of the two assemblages, the probability of equal variances was .65. Therefore, I performed a standard T-test that resulted in a p-value of **.004**. This test for weight meets the 95% confidence interval threshold, so I reject the null hypothesis and state that the means are statistically significantly different. This indicates a fundamental difference in the manufacture of the points between these sites. Raw material availability likely plays a role, though this is out of the scope of this research. The increased mean weight of the Pojoaque Grant assemblage may result from functional parameter differences for point use.

Table 8 – Numerical Summaries of Weight by Site Accompanying *Figure 8* Below

Site	Mean	STD	Max	Min	n
Pojoaque Grant	0.99	0.45	3.05	0.38	49
Castle Rock	0.67	0.41	2.2	0.3	25

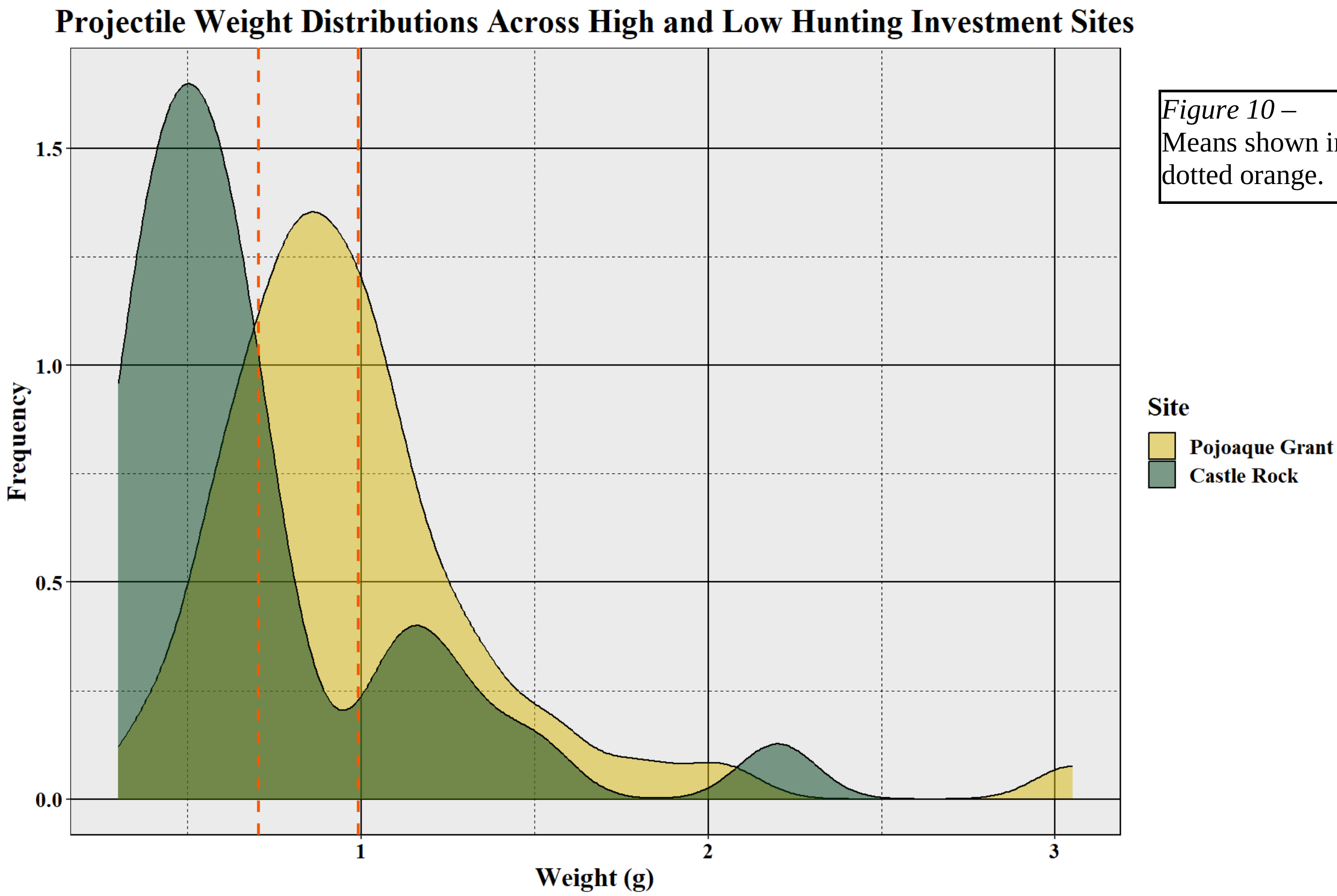

Figure 10 – Means shown in dotted orange.

In *Figure 10* above, the contrast between the means of the distributions is obvious. However, it is also important to note the differences in the shapes of the distributions. Multiple peaks appear after 1g in the Castle Rock assemblage, highlighting the effect of small numbers of points which deviate from the overwhelming majority of small, consistent side-notched points. The Pojoaque Grant assemblage, on the other hand, exhibits a fairly normal distribution, with a small rise at 3g. It is difficult to tell whether that point was used as a dart point or an arrow point. This suggests a broader overall variability in the weights of Pojoaque Grant points. However, it is interesting to return to the results of *Table 7*, which show that the standard deviations for point forms at the Pojoaque Grant site are quite low except for the leaf and SW Triangular forms. This makes sense given that some of the SW Triangular points may be misclassified and instead represent unfinished notched points (Doug Bamforth, Personal Communication 2023; Lakatos in

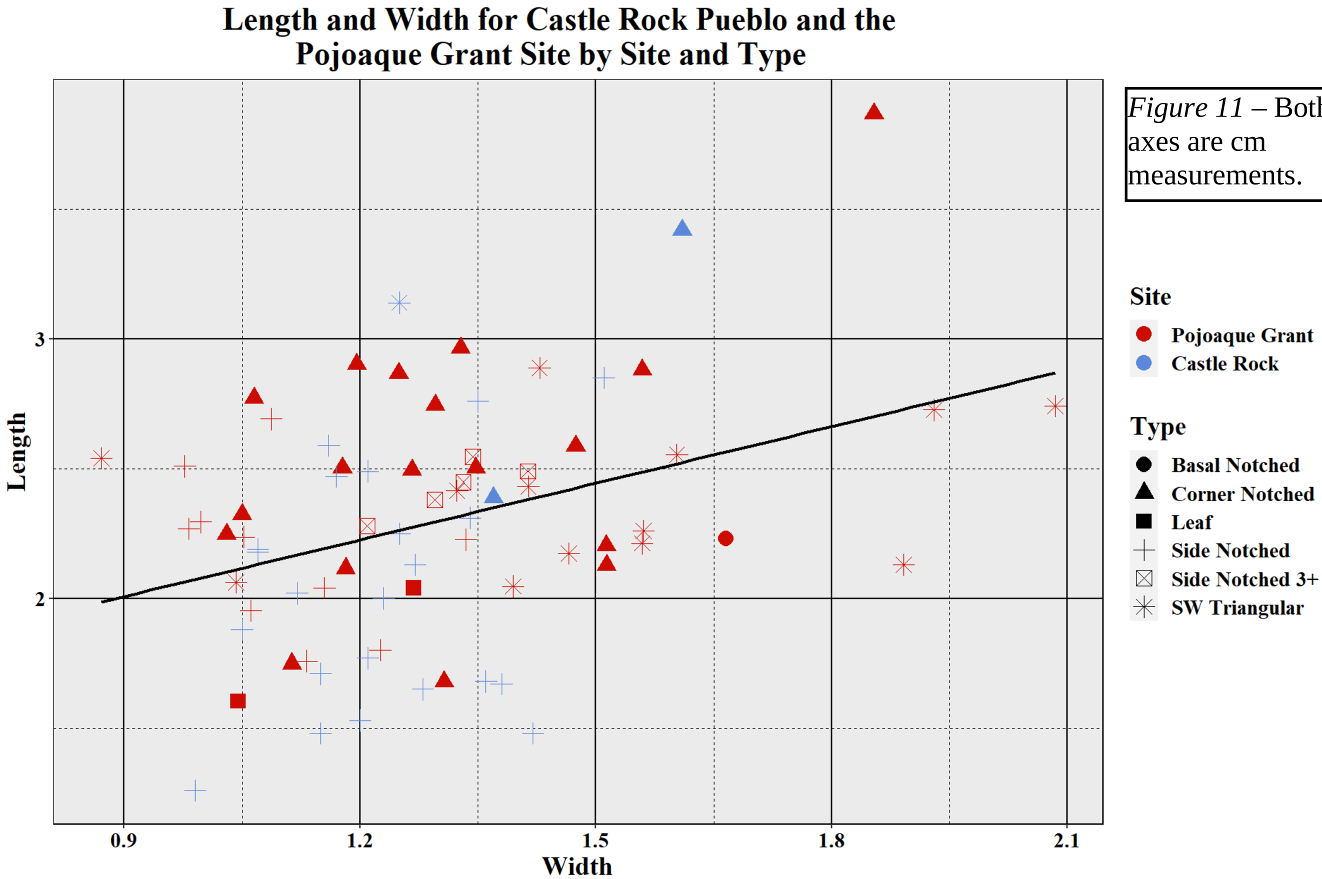

Figure 11 – Both axes are cm measurements.

Maxwell et al. 2020). However, Wiseman reported "a minimum of 42% of the chipped stone tools" from any given provenience as unnotched or unfinished (Lakatos in Maxwell et al. 2020). Observations from nearby sites show that unnotched points are a finished form on their own (Lakatos in Maxwell et al. 2020), similar to those analyzed in other regions (Bebber et al. 2017). I typed 32/84 points (38%) as unnotched. I was uncomfortable assigning notched/unnotched forms to 55/139 points from the Pojoaque Grant site (39%) due to breakage or the appearance of being unfinished. Given the conservative approaches taken to determining the form of points in this thesis, I conclude that the representation of the SW Triangular point form is not exaggerated.

Finally, I plotted the lengths and widths of all the points from the Castle Rock and Pojoaque Grant sites against each other by point form in *Figure 11* above. This illustrates the lack of morphological similarity within forms of points for both Ancestral Puebloan sites. One interpretation of these results is a low degree of cultural conformity for both sites to a set of manufacturing standards in terms relating the form of points to their size. Yet, a multivariate analysis still indicated statistically significant differences in the mean lengths and widths for the point forms. The probability of equal variances was .073, therefore I performed a MANOVA (Multivariate Analysis of Variance) test assuming equal variances which resulted in a p-value of **.0001**. This indicates that the variation in the length and width of points grouped by their form is unlikely to be due to sampling. I note that the clustering (low standard deviation of .07cm for width and .1cm for length) for side-notched points with 3+ notches may contribute heavily to this significant result.

In comparing the dimensions of side and corner-notched between the assemblages, only two measures distinguish groups significantly: weight and width for side-notched points. The small sample size of corner-notched points for Castle Rock Pueblo contributed to the lack of significance for corner-notched point dimensions. The relative frequency of corner-notched points was also significant. Furthermore, it is interesting that neither length nor width distinguish the side-notched point assemblages. A full analysis of all point forms was out of the scope of this research.

D. Comparing Point Forms Across High and Low Hunting Investment Assemblages

To examine the potential for differential design/manufacture/use for corner and side-notched points across projectile point assemblages from Castle Rock Pueblo and the Pojoaque Grant site, I used Student's T-tests as seen in the comparison above. I evaluated these point forms as they are some of the most common in the archaeological record and were present at both sites. These tests evaluated the probability that the differences in the means of physical metric measurements between corner and side-notched projectile points from these high and low relative hunting investment sites were the result of sampling. To assess the differences in variances between the metrics of the assemblages, I used variance tests as above (var.test in R Core Team 2023). For cases where I could not determine that the variances were equal with 95% confidence, I implemented Welch's T-test instead of a standard T-test as it does not assume equal variances. *Table 9* on the following page presents the numerical summaries mentioned here.

As stated, I compared the mean dimensional metrics between corner and side-notched points across sites. I report variances and T-test results by dimension. For weight, the probability of equal variances was .07; therefore, I performed a standard T-test that resulted in a p-value of **.0003**. For length, the probability of equal variances was .21; therefore, I performed a standard T-test that resulted in a p-value of **.0003**. For width, the probability of equal variances was .03; therefore, I performed Welch's T-test, resulting in a p-value of **.006**. All these tests met the 95% confidence interval indicating statistically significant differences in the means of these dimensional measurements for the two assemblages' corner and side-notched points. This suggests that the functional parameters for corner-notched points require increased durability/impact strength over side-notched points.

Table 9 – Numerical Summaries of Metrics by Form for Complete Projectile Points from High (POJOAQUE GRANT) and Low (CR) Relative Hunting

Width	Type	Mean	STD	Max	Min	n	%
1	Basal Notched	1.67	NA	1.67	1.67	1	1.35%
2	Corner-notched	1.33	0.21	1.85	1.03	20	27.03%
3	Leaf	1.16	0.16	1.27	1.05	2	2.70%
4	SW Triangular	1.49	0.33	2.08	0.87	14	18.92%
5	Side-notched	1.19	0.14	1.51	0.98	32	43.24%
6	Side-notched 3+	1.32	0.07	1.41	1.21	5	6.76%
Length	**Type**	**Mean**	**STD**	**Max**	**Min**	**n**	**%**
1	Basal Notched	2.23	NA	2.23	2.23	1	1.35%
2	Corner-notched	2.57	0.52	3.87	1.68	20	27.03%
3	Leaf	1.82	0.31	2.04	1.60	2	2.70%
4	SW Triangular	2.45	0.33	3.14	2.05	14	18.92%
5	Side-notched	2.07	0.41	2.85	1.26	32	43.24%
6	Side-notched 3+	2.43	0.10	2.55	2.28	5	6.76%
Weight	**Type**	**Mean**	**STD**	**Max**	**Min**	**n**	**%**
1	Basal Notched	1.21	NA	1.21	1.21	1	1.35%
2	Corner-notched	0.96	0.36	2.20	0.60	20	27.03%
3	Leaf	0.79	0.58	1.20	0.38	2	2.70%
4	SW Triangular	1.31	0.66	3.05	0.40	14	18.92%
5	Side-notched	0.64	0.25	1.30	0.30	32	43.24%
6	Side-notched 3+	0.94	0.28	1.33	0.60	5	6.76%

Additionally, it is important to recognize the stark difference in the composition of the assemblages from Castle Rock Pueblo and the Pojoaque Grant site in terms of form. The Pojoaque Grant assemblage has twice the number of point forms (six) compared to the three found in the Castle Rock assemblage. Along with this narrow range of point forms, side-notched points overwhelmingly dominate the assemblage from Castle Rock Pueblo. *Table 10* on the following page demonstrates the relatively high prevalence of corner-notched points in the Pojoaque Grant assemblage compared to Castle Rock. This supports the idea that the assemblages from these two sites were manufactured with different functional parameters. In other words, the populations at these sites manufactured their points with different applications for the points in mind.

Table 10 – Ratio of Corner to Side-notched Points for Complete Projectile Points from High (Pojoaque Grant) and Low (Castle Rock) Relative Hunting Investment Sites

Site	Ratio
Pojoaque Grant	1.80
Castle Rock	0.09

CHAPTER V

DISCUSSION

A. Analysis of Pojoaque Grant Projectile Points

To begin, I will discuss the results of the small-scale analysis of projectile points from the Pojoaque Grant site. As mentioned, analysis has been completed on these points by Wiseman in 1989, though this citation is available in an unpublished manuscript on file with OAS and there is no way of finding this reference (Lakatos in Maxwell et al. 2020). Given this information, I can only compare the information collected here to the broad referential statements made by Lakatos (in Maxwell et al. 2020). There are two obvious and important trends: differences in the breakage/rework patterns for obsidian and Pedernal Chalcedony and the variety of point forms. I discussed unfinished and SW Triangular points in IV.Results.

While *Tables 4 and* 5 illustrate much higher breakage rates for obsidian than Pedernal Chalcedony, this pattern raises more questions than it answers. Regardless of the precise reason for the lack of broken points made of Pedernal Chalcedony at the Pojoaque Grant site, broken points of this material were deposited in other locations on the landscape. Of course, *Table* 5 indicates that points made of Pedernal Chalcedony were used and reworked at a level similar to those made of other materials such as obsidian. Yet, broken points of Pedernal Chalcedony are essentially absent from the assemblage. In part, this may be due to the functional parameters of points manufactured from this material. The discussion from Loendorf et al. regarding the durability of various lithic materials applies here (2018). Pedernal Chalcedony is certainly more durable than obsidian given that it is a silicified quartz as opposed to a volcanic glass like obsidian. This is abundantly clear to anyone who has worked with the two materials. Therefore, it reasons that Pedernal Chalcedony be selected for uses such as the manufacture of hunting, where it is desirable for strongly hafted points to penetrate animals and be retrieved (see II.A.2.b). This interpretation falls in line with the idea put forth to me by Tribal members that "Winter" points of red or white would be associated with hunting behavior. Yet, the much-cited work of Binford described the paucity of artifacts which are actually left in the field by foraging Nunamiut (1977). This cannot be ignored, and incites more research into the deposition of Tewa projectile points, especially for sites with relatively high hunting investment.

The other material in question, obsidian, has very different use patterns. Obsidian was the most prevalent raw material for projectile points at the Pojoaque Grant site, and for a good reason: it is a closer source than Pedernal Chalcedony (Shackley 2016). Indeed, nearly all of the obsidian from the Pojoaque Grant site comes from the Jemez area (Shackley 2016; Moore et al. 2020). Wiseman concluded that obsidian was therefore the preferred raw material for biface manufacture (Lakatos in Maxwell et al. 2020). However, it is important to reflect on the discussion in II.B regarding the "quality" of material, as well as the functional parameters of points. It seems more likely that obsidian was the preferred material in terms of acquisition and day-to-day use at the Pojoaque Grant site, but perhaps not for more intensive or demanding activities such as hunting which would have occurred farther from the site. This is evidenced by the dearth of points made from Pedernal Chalcedony broken and deposited at the site, as well as Tribal knowledge regarding the design and use of points.

Finally, the simple existence of six point forms at the Pojoaque Grant site suggests a more diverse array of functional parameters for points than the three found in the Castle Rock assemblage. It is evident that the inhabitants of the Pojoaque Grant site had a wider variety of point forms in their projectile manufacturing industry, and this seems very likely related to the increased relative hunting investment at the Pojoaque Grant site. In fact, increased investment in hunting and mobility has long been linked to increasingly intricate tool complexes (Andrefsky 2010). However, these artifacts' limited provenience and sample sizes for early settlements in the Tewa Basin make this a difficult subject. Relating the complexity of projectile point manufacturing industries with relative hunting investment is also out of the scope of this work.

Of course, this analysis leaves much to be explored in terms of site-level trends and the understanding of behaviors regarding reworking and use of projectile points by material and form. In particular, the relationship between seasonality and material as it relates to use might be interesting to explore with more ethnographical or ethnoarchaeological data that may elucidate more detailed relationships.

B. Relative Hunting Investment Model

I will now return to the most clearcut portion of this study: the model from *Figure 6* which displays the correlation between relative hunting investment and relative returns on that investment in the form of large game processing. Perhaps the most surprising aspect of this relationship is the effect of economies of scale. Given the model, doubling the use rate of projectile points returns a 120% increase in large game processing rates. Essentially, the more points made, the greater the investment in hunting, and the greater the investment in hunting, the greater the return per unit effort in hunting. The more points manufactured, the more large game processed per point. Put simply, this model suggests that the efficiency of hunting increases with investment in hunting across time and space in the precolonial Southwest.

This relationship goes against the literature mentioned earlier in II.B regarding subsistence strategies in the precolonial Southwest. Many have argued for the depletion of game resources following the installation of permanent settlements (Schollmeyer and Driver 2013; Kelly 2013;

Kuckelman ed. 2000 among others). However, this model suggests the commitment to hunting investment increases long-term success as measured by large game processing rates.

To expand on the model, the projectile proportion can also be seen as points per person meal given that it is based on grayware (in a sense representing the number of meals cooked in total). So, the rate of hunting and efficiency of hunting increase as the relative rate of projectile point manufacture (per person meal) in the community increases. This is an example of the same elasticity of increasing returns to scale shown by Klassen et al. at Angkor Wat with agricultural returns on investment (2022). In fact, a similar relationship exists for many economies of scale (Ortman et al. 2016). Many further applications exist for this relationship between projectile points and artiodactyl remains in research on subsistence strategies and economies.

Since the Pojoaque Grant site has more artiodactyl remains and fewer projectile points than predicted by the fit line in *Figure 6*, this may be an example of exceptional hunters experiencing greater than expected return on investment in hunting implement (in this case projectile point) manufacture. This idea is supported by *Figures 8 and 9* where the Tewa Basin sites have relatively higher rates of hunting investment and return than would be expected given the model across Ancestral Puebloan sites. This is of course predicated on the assumption that there was little to no violence at LA 835. That assumption is grounded in the lack of evidence for such at this point, and the same assumption is true for many of the other sites in this data set as well. Archaeologists often assume precolonial societies to be peaceful, and LeBlanc makes a solid argument that it is more difficult to prove a society or occupation of a site was peaceful than proving warfare or violence existed (1999). Of course, it is possible that any of the points at the Pojoaque Grant site were used for interpersonal violence. Indeed, the very presence of unnotched obsidian projectile points would lead some to suggest their use in warfare (see II.A.4). This slight tangent leads directly into the next subsection which evaluates the original goal of this research: delineating between the uses of hunting and warfare for projectile points.

C. Evaluations of Hunting and Warfare Uses of Projectile Points

Returning to the question proposed in I.A.Topic of Study regarding the use of projectile points for hunting or warfare, the conclusions reached in this analysis were not those expected. A strong relationship between the proportions of projectile points and artiodactyl NISP was projected, and this was realized (with numerous implications in the above subsection. The precision with which the model distinguishes between relatively high and low hunting investment sites is promising.

However, it was anticipated that positive residuals in *Figure 5* would correlate with the sites that had known instances of warfare. As shown in the results, this proved inconclusive. Highly positive residuals represent projectile point use not accounted for by the modeled relationship with a given amount of large game processing. As explained in II.D, this could possibly be explained by warfare. However, given the data from Sand Canyon and Castle Rock Pueblos, the model does not seem to predict instances of violence. As explained previously, the only two sites in the dataset with certain and significant evidence for violence are Castle Rock and Sand Canyon Pueblos. Their residuals of -.66 and +1.52 to the fit line in *Figure* 5 do not suggest that sites with high interpersonal violence have higher rates of projectile points than predicted by the fit line.

D. Case for Winter People as Early Settlers in the Tewa Basin

The final implications for this research relate back to the simple conclusion provided by the relative hunting investment model: that early settlements in the Tewa Basin invested significantly in hunting. This ties into both ongoing research on early migration into the Tewa Basin (and NRG in general) and Tewa oral traditions. As discussed in II.B.2, Tewa oral tradition describes two migrations: those of the summer and the winter people. The winter people are said to have primarily hunted and foraged, arriving first from the north, and settling in areas east of the Rio Grande. The summer people are said to have followed sometime later, bringing cotton and agricultural inclinations to their settlements on the west side of the Rio Grande. Eventually these groups came together to form Tewa society as it exists today (Bernstein and Ortman 2020). As mentioned, this paper only comments briefly on this conversation as more data from spatial and temporal contexts suited to addressing these questions of migration into the NRG would need to be added. However, it is interesting to note that the turtle dance still performed at Ohkay O'Wingeh, a Tewa Village, alludes to Tsip'in (Cerro Pedernal, one of the largest sources of Pedernal Chalcedony), and signaling ancestors from the north (Ortman, 2012: 358-9). It is clear from the discussion of projectile points from the Pojoaque Grant site in IV.A, Pedernal Chalcedony is important for Tewa people, specifically winter clans (see II.B.2; Ortman 2012:358-359). Therefore, it reasons that a migration from the south, potentially collecting or otherwise procuring Pedernal Chalcedony along the way could have led this to become such an important raw material and location that it is still revered today.

CHAPTER VI

CONCLUSIONS

A. Merits of the Study

In summary, the merits of this thesis are as follows: bolstering of museum collections research, extension of Tribal knowledge, progress in delineating between hunting and warfare uses for projectile points, and implementation of innovative statistical approaches to examine subsistence strategies through relative investment in hunting.

As this project deals solely with museum collections, this is exactly the sort of project which is becoming more and more popular in light of the dire need to examine the many curated artifact collections which have never received the attention they deserve. In the Southwest, in particular, lithic analysis is often overlooked due to the prevalence of other artifact classes. This work provides evidence that lithic analysis has the potential to inform on past behavior in subsistence, hunting and warfare, economics, and cultural processes including migration.. I have conducted one instance of exactly the sort of research that uses old collections to make new insights while simultaneously improving the collection. Over the course of this project, the entire documentation of lithic artifacts in the collections analyzed have been digitized, making all of this inaccessible data from the 1950s readily available to Pueblo of Pojoaque Tribal members and other archaeologists. While preparing exhibits is certainly an extremely important aspect of museum studies, this would never be possible without the background work of documentation, provenience, packaging, and analysis. This project focused on these aspects of museum studies most simply by demonstrating the benefit of curation by returning to collections for new research.

Going further, this project is highly relevant for archaeology in the present in that it is connected directly to the interests of descendant groups. The Pueblo of Pojoaque was willing to lend collections to the University of Colorado Boulder as a result of Dr. Scott Ortman's commitment to structuring collaborative research with members of the Pueblo that also directly benefits the Pueblo. The Pueblo of Pojoaque is excited about this collection because it demonstrates the deep history and legitimacy of the Pojoaque community, an important issue given their colonial history. In other words, this project demonstrates the value of museum collections to descendant communities and, conversely, the value of descendant communities to museum collections research.

Drawing on this theme, I see this research as providing concrete evidence that collections research can directly benefit descendant communities and the museum community concomitantly. Without delving into specifics, documenting credible traces of Tewa culture as early as 900CE brings great joy to Pojoaque. I have shaped my research in response to this interest. Rather than setting oral traditions in stone (as they often are when they are not outright dismissed), I provide an opportunity for growth in meaning and interpretations by documenting evidence of social connections of Pojoaque ancestors and sharing this information with the present-day community. This outlook is incredibly important for supporting the continuation of Indigenous communities in the present and the future United States. My analysis documents the distinct backgrounds of Pojoaque ancestors through the lithic artifacts in the LA 835 collection. This work benefits the museum and descendant communities by bringing tribal members into the conversation, interpreting the new evidence for themselves. The stakeholder/community-based approach drastically improves the promise and the ethics of museum studies of extant collections. It is my sincere hope that the museum community of the future sees this as both normal and necessary and that more projects like this promote the promise of conducting research with and for descendant communities.

In short, this project demonstrates the productivity of both new and old concepts in archaeological museum studies. I have also shown the continued effectiveness of lithic analysis in the Southwest. Finally, this thesis has made headway in delineating between hunting and warfare uses for projectile points. Even though the relative hunting investment model did not predict instances of warfare, it is a successful model for interpreting subsistence strategies and economies of the past. This research has incited numerous new directions for research which I will not elaborate upon.

B. Future Research

Clearly, this thesis has branched out into several areas of archaeological research. While this has been a difficult undertaking, it has been incredibly rewarding, especially in allowing me to see numerous directions of future research. I will enumerate some of these in this section for the discerning reader or interested researcher.

The will begin with ways to improve the model for investigating relative hunting investment. In the future, other Districts could be included in later models for more a robust sample and potentially a stronger correlation. In an ideal world, more sites would also be added to the existing Districts with stricter temporal controls. The addition of other similar late Fremont/Pueblo II-III sites from Central Utah could aid significantly in understanding Fremont/Ancestral Puebloan interactions. Other sites in the Southwest where violence is known to have occurred could also be added to the dataset. It may be possible to reveal a relationship between instances of violence and negative residuals from the fit line of relative large game processing rates for relative projectile point use rates using stricter temporal controls on assemblages (though this seems unlikely). A larger dataset might also shift the position of the linear model, thereby modifying the residuals.

This would allow more insight into the idea of increasing returns on hunting investment in the Southwest more generally.

In a different vein, more data for more projectile points in the Southwest would enable more study of variability within forms of points as well as across forms, sites, regions, or time periods. Further research could also allow for improved analysis of the particular uses of forms of points. For example, one could study the morphology of side-notched points with 3+ notches, their frequency in assemblages of varying relative hunting investment, etc. The same could be done to improve the understanding of the simple triangular points, or others. It would also be fascinating to investigate if relative hunting investment correlates with variability of point forms across regions or time periods. Finally, could variation in faunal assemblages correlate with variation in point forms or variation in relative hunting investment?

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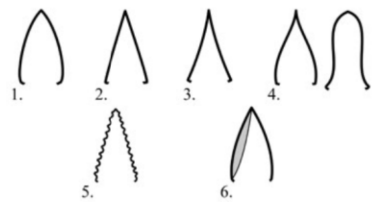
APPENDIX

A.1 **Edge coding:** Illustration courtesy of Milanich 2012, Florida Museum.

00 – indeterminate
01 – excurvate
02 – straight
03 – incurvate
04 – inward recurvate
05 – outward recurvate
10 – indeterminate serrated
11 – excurvate serrated
12 – straight serrated
13 – incurvate serrated
14 – inward recurvate serrated
15 – outward recurvate serrated
20 – indeterminate beveled
21 – excurvate beveled
22 – straight beveled
23 – incurvate beveled
24 – inward recurvate beveled
25 – outward recurvate beveled

Examples of common projectile point blade edges:



1. **Excurvate edge** – a blade whose edges curve outwardly (e.g., Itchetucknee, Tampa, Bradford, Florida Adena).
2. **Straight edge** – a blade whose edges are straight (e.g., Pinellas, O'Leno, Hernando).
3. **Incurvate edge** – a blade whose edges curve inwardly towards the center of the body of the blade. Note: None of the Bullen Projectile Point types exhibit this trait. See Bases for an example of an incurvate basal edge.
4. **Recurvate edge** – a blade whose edges curve outwardly or inwardly from the tip of the projectile point and then curve in the opposite direction (inwardly or outwardly) as it reaches the base or corner of the blade (e.g., Clay, Beaver Lake, Simpson).
5. **Serrated edge** – a blade whose edges have small flakes removed regularly resulting in a jagged, saw-like margin (e.g., Kirk Serrated, Tallahassee).
6. **Beveled edge** – a blade whose sides result from removing flakes on an angle or inclination that slopes away from either a vertical or horizontal surface (e.g., Bolen

A.2 **Cross-section coding:** Illustration courtesy of Milanich 2012, Florida Museum.

0 – indeterminate
1 - Biconvex – point is elliptical or oval in cross-section
2 - Plano-convex – point is flat on one side and rounded on the other
3 - Median-ridged – point is diamond-shaped in cross-section
4 - Flattened – Ridge of both blades has been flattened
5 - Rhomboid – Ridges of blades have been flattened and opposite edges beveled
6 - Fluted – Ridge is concave due to fluting on one or both blades

Examples of projectile point cross-section shapes:

1. **Biconvex** – point is elliptical or oval in cross-section
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