TERMINAL LATE PREHISTORIC BOTANICAL FOODWAYS AND FORAGING CATCHMENTS OF THE EASTERN TRANS-PECOS ARCHAEOLOGICAL REGION OF TEXAS

A Dissertation

by

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ABSTRACT

By combining paleoethnobotanical data from nine archaeological sites in the eastern Trans-Pecos this dissertation identified the composition of plant diet for peoples between A.D. 1250 and 1535, here-in referred to as the Terminal Late Prehistoric and influenced by the Little Ice Age. This dietary makeup was then compared between the regional sites as well as to neighboring regions to the east, west, and north. A spatial model was also developed to identify reasoning for placement of open sites to access plant foods, explicate mobility patterns, and inventory other potential floral foods based upon ethnographic data.

A total of thirty-three botanical taxa were encountered from original and previous analyses primarily from macrobotanical, but also microbotanical, assemblages. Based upon assemblages from three rockshelters it was determined that a myriad of high, mid, and low ranked resources were utilized. These included agaves, mesquite bean pods, yucca fruit, prickly pear tunas, and forb seeds, primarily from the Amaranth Family. Small cacti, such as pitaya, and other forbs, such as purslane, also contributed heavily to diet but not to the degree of those previously mentioned.

When comparing plant diets to neighboring regions the study area was considered to have high commonality with the El Paso Phase, Ochoa Phase, and hunter-gatherer groups of the western Trans-Pecos due to occupancy of the Chihuauhan Desert. When archaeologically visible diet was compared to that of historic regionally recorded groups within the eastern Trans-Pecos there was high overlap between both. The one exception were low ranked forb seeds which the Terminal Late Prehistoric peoples may have used to a higher degree than later peoples.

The novel spatial model attempted to examine the landscape complexity as well as available dietary resources. Positive results demonstrated the validity of the model though calorie dense foods, such as piñon nuts, were gathered outside of the hypothesized forging catchments, likely indicating the use of a logistical mobility strategy specifically at Tranquil and Rough Cut Rockshelters. This analysis also indicated that some campsites, such as the Fulcher Site, were specifically located in order to access a diverse landscape with an even distribution of plant community patches.

DEDICATION

For my kith and kin, archaeological and otherwise.

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INTRODUCTION

The eastern Trans-Pecos archaeological region of Texas is perhaps one of the most unique landscapes within the state. The physiographic make-up of the region resulted from the three primary orogenic events which occurred on the North American continent and the ecology of the region reflects this. Dominated by scrubland and shrubland plant communities of the Chihuahuan Desert, woodlands are found atop mountains which dot the landscape, grasslands at higher elevations, and diverse riparian communities surrounding the region's bounding rivers, the Pecos River and Rio Grande. As diverse as the experienced landscape of today, the record of human occupation within its bounds is as unique.

Stretching from the last ice age to the mid-Nineteenth Century indigenous peoples of this region utilized these landscapes to make a living whether hunting game, gathering wild plants, or practicing agriculture (Mallouf 1985). The record of these activities has been documented in a variety of archaeological investigations stretching over 100 years of effort. These studies have shown that despite being in a seemingly harsh environment, people had diverse material cultures and unique inter-cultural relationships between farmers and hunter-gatherers, primarily during the Late Prehistoric Period between A.D. 700 and 1535.

Of the five primary archaeological periods, the final period, the Late Prehistoric, is the best understood due to a focusing of archaeological studies; this study is a continuation of that research trajectory. The foundational Late Prehistoric Period work was primarily concerned with exploring a manifestation of maize (*Zea mays*) reliant agriculture in the La Junta de los Rios sub-area of the eastern Trans-Pecos, the Bravo Valley Aspect (ex. Kelley 1939, 1947, 1949). Later, research identified archaeologically distinct hunter-gatherer groups based upon lithic technology, perishable items, architecture, and mortuary practices. Thus far two hunter-gatherer archaeological phases, Livermore (Kelley et al. 1940, Kelley 1957) and Castile (Hamilton 2001), and a complex, Cielo Complex (Mallouf 1985, 1999), have been defined for the study area. Of these the Castile Phase and Cielo Complex are the two which occurred during the latter portion of the Late Prehistoric Period, here referred to as the Terminal Late Prehistoric Period (A.D. 1250/1300 – 1535) and coincided with the initiation of the Little Ice Age (Esper et al. 2002).

At present the human-produced materials of these constructs are well defined for the Terminal Late Prehistoric. The Castile Phase initiated in the Late Archaic but was based around a hunting and gathering economy in addition to some form of trade with neighboring Jornada Mogollon peoples for cotton products, marine shell, and pottery. Children and infants received great care and accoutrements for the here-after which included basketry items such as the Rustler Hills kiaha and twined grass bags not found elsewhere in the American Southwest. For unknown reasons these peoples also made comparatively little use of lithic projectile points, instead preferring hardened wood (Hamilton 2001). Cielo Complex peoples are known to have used a lithic toolkit synonymous with the Toyah Phase folks of Central Texas and included Perdiz arrow points, two- and four-edge beveled knives, end scrapers, as well as a prismatic blade core technology. Additionally, these peoples utilized boulders and cobbles as foundations for their wickiups which were perched atop mid-elevation landforms as basecamps, or rancherias, and placed much care in provisioning their deceased for the afterlife (Cloud 2002, Mallouf 1985, 1987, 1999). The Cielo Complex and Concepcion Phase farmers of the La Junta de los Rios likely formed a symbiotic relationship wherein goods and news were shared at the confluence of the Rio Grande and Rio Conchos (Arnn 2012a, 2012b, Kelley 1986, Mallouf 1985, 1989). These farmers lived in circular and square pithouses which housed multiple families and produced pottery from locally sourced raw materials. Concepcion Phase peoples also had far-ranging trade contact with areas such as East Texas, potentially via the Cielo Complex (Arnn 2012a, 2012b). Despite having an understanding about general lifeways and material culture, few studies have been undertaken specific to the dietary resources which these peoples utilized.

Comparatively speaking, the neighboring regions of the western Trans-Pecos, Central Texas, and Lower Pecos are much better understood in terms of botanical resources utilized for food in addition to how these foods were accessed. Though the Terminal Late Prehistoric record from the Lower Pecos is largely non-exisitent, or at least archaeologically visible, the use of plant foods and how they were accessed during Archaic periods is well recorded. Like the eastern Trans-Pecos the prehistory of the Lower Pecos was generated by a hunter-gatherer subsistence economy. In this region caudex producing desert plants, such as lechuguilla (*Agave lechuguilla*) and sotol (*Dasylirion* spp.), contributed a significant amount of calories to human diet. These plants likely were staple foods throughout an annual cycle with more seasonally available foods, such as tree nuts (*Carya* spp.), prickly pear *tunas* (*Opuntia* spp.), and mesquite (*Prosopis glandulosa*) adding variety to the diet (Riley 2012, Sobolik 1988, Williams-Dean 1978,).

In Central Texas a variety of foods, floral and faunal, contributed to a broad-spectrum diet of high and low ranked resources specifically during the Toyah Phase/Terminal Late Prehistoric Period. Through the use of logistical mobility and an expansive social network these Toyah Phase folk could have moved quickly and easily to access seasonal resources which had high inter-annual variation in their productivity (Arnn 2012a, 2012b, Dering 2008).

Skipping across the eastern Trans-Pecos to the western Trans-Pecos, the El Paso Phase peoples of the Jornada Mogollon raised a significant portion of their foodstuff with cultigens such as maize, beans (*Phaseolus vulgaris, P. acutifolius*), and squash (*Cucurbita* spp.). These peoples did however use wild plant resources such as desert plant caudexes, prickly pear, pitaya cacti (*Echinocereus* spp.), and mesquite (ex. O'Laughlin 2001) though to a much lower degree than the preceding early Formative Period (Miller and Kenmotsu 2004). This shift was considered by Miller and Kenmotsu (2004) to be evidence of either an increased reliance on maize or an economic shift which transitioned from wild food gathering and farming to one focused on agriculture.

Specific to the eastern Trans-Pecos some studies have contributed to the corpus of knowledge regarding plant foods within the area though not to the degree of studies in neighboring areas. Subsistence focused research for the preceding archaeological periods note, in general, that the plant portion of human diet was resource specific and focused on caudex producing plants mentioned previously. The importance of this food resource has also been noted as of increasing import through the progression of time (Mallouf 1985, Ohl 2006, 2011, Boren 2012). More direct studies have been undertaken regarding the Late Archaic portion of the Castile Phase. Based upon human coprolites the dietary remains indicated diets heavily reliant upon grass seeds. Prickly pear, hackberry (*Celtis* spp.), mesquite, and other taxa such as grape (*Vitis* spp.) and waterleaf (HYDROPHYLLACEAE) further rounded out the diet (Hamilton and Bratten 2001). My previous research (Riggs 2014) provided some generalities about plant diet for the entire Late Prehistoric Period but was lacking in detailed spatial analyses, sub-time period specificity, and only included data from four archaeological sites. In general it can be stated that the eastern Trans-Pecos is lacking in subsistence-focused studies as well as the behavioral hypotheses which result from said research.

As stated above one of the overarching issues with eastern Trans-Pecos archaeology is a lack of research which details specifics about diet, especially the floral component, beyond the generalities mentioned previously. This work seeks to change this pattern by defining not only the "what", but also the "why", "how", and "where". Or more explicitly stated:

1. What plant foods were used by Terminal Late Prehistoric peoples of the eastern Trans-Pecos?
2. Why were these foods consumed and how much did they contribute to diet during this archaeological period?
3. How were these foods accessed and where were they located on a given landscape?

The first question, and synonymous goal, is the easiest to answer based upon the paleoethnobotanical record. However, this goal is also difficult to achieve and accomplishing this is only possible by examining remains from two distinctly different archaeological site types: open and protected. The eastern Trans-Pecos is in many ways a land of extremes, and this same divergence is noted in the preservation potential of archaeological sites within the study area. Open sites have an exceptionally poor record of preserving archaeo-biological remains. This is largely due to the alkaline clay soils found across the region in addition to being in an arid environment (Braadvaart and van Brussel 2009). Being in an arid environment also does not contribute to the preservation of biological remains in that occupation events are not readily covered via pedogenesis and other sedimentary processes, allowing for the remnants of prehistoric human lifeway remains to be open to the elements for longer periods of time than other areas (Waters 1997). Protected archaeological sites, such as rockshelters and caves, are on the opposing side of the preservation potential spectrum and provide a plethora of data owing to the dry conditions in their interiors.

To answer the second question a different set of methods and data must also be used, specifically through the use of ubiquity scores, diversity indices, and multivariate statistics. From here the botanical diet of peoples in the eastern Trans-Pecos can be compared to that of other, temporally synchronous cultural manifestations which not only surround the area but which the region's groups likely had contact with (Kelley 1947, 1986). Results of this can also be used to identify which foods formed the bulk of diet versus which botanical resources were little used. With the addition of diet breadth modeling understanding why some resources were relied upon more heavily than others can also be achieved (Kelly 2013).

The final question is the most difficult to determine with absolute certainty. With the use of a spatial model specifically developed to answer this question, the spatial configuration and plant community makeup of a single-day foraging range can be determined. Other information gained from this goal extend beyond identifying the presence or absence of archaeologically visible dietary elements to what other food resources were hypothetically present. Secondary to this metric analysis of these catchments can provide even more hypotheses related to mobility strategies as well as the intentional positioning of encampments to ensure access to targeted resources.

The primary goal of this work is to identify the botanical foods consumed during the Terminal Late Prehistoric Period within the eastern Trans-Pecos. This dietary record will then be further scrutinized to identify which foods were staples and why as well as how their use compares to neighboring regions with temporally synchronous assemblages. The dietary landscapes surrounding the archaeological sites which constitute the study sample will also be reconstructed to identify the availability of these foods and decision making to access said resources.

Chapter Two provides an overview of the biotic and abiotic environs within the eastern Trans-Pecos. The physiographic and hydrographic properties of this region are described to illustrate the unforgiving elements of this landscape. A paleoenvironmental history is also provided to illustrate the dynamic nature of the ecology in response to global climate events and phenomenon, specifically the El Niño Southern Oscillation System (Lindsey 2017). The impact of the Little Ice Age on plant communities is also detailed.

Shifting into the past, Chapter Three outlines the archaeological record of the study area beginning with a brief history of eastern Trans-Pecos archaeological work. Following this the archaeological record of each major archaeological period (Paleoindian, Early Archaic, Middle Archaic, and Late Archaic) are described in terms of artifact assemblages and behavioral traits. The Late Prehistoric Period receives the most attention in this chapter. Material cultural groups defined as the Livermore Phase, Cielo Complex, Castile Phase, La Junta Phase, and Concepcion Phase are described and observations gained through recent research endeavors are presented.

The use of ethnographic analogy is an important component of archaeological research, specifically for developing questions to "ask" the archaeological record (Binford 1967, Currie 2016), and the fourth chapter reflects this. By examining the historic record compiled by the accounts of five historic Spanish endeavors the plant diet of locally indigenous groups is outlined. Because these records were lacking in subsistence related information the chapter also incorporates ethnographic information from the Mescalero Apache (Basehart 1974, Castetter and Opler 1936). Beyond diet the chapter also examines mobility strategies of all Historic Period groups noted in the text with a focus on differing uses of logistical versus residential mobility strategies. Staple plant foods are also identified based upon the combined historic and ethnographic information. These included agaves, banana yucca (*Yucca baccata*) fruits, mesquite bean pods, and piñon (ex. *Pinus cembroides*) nuts.

In order to actually address the research goals presented above Chapter Five outlines the nine archaeological sites with botanical-bearing Terminal Late Prehistoric components in the study area. The presentation is separated by site type with rockshelters and a cave presented first and the open sites second. Archaeological cultural associations are also discussed with chronometric dates, when available, and material culture.

Chapter Six describes the methods used in this study to achieve the primary research goals. Use of a given method varied in relation to the dataset at hand with rockshelter macrbotanical data being the most heavily scrutinized dataset compared to the open archaeological site macrobotanical record. A variety of methods were needed to ensure that valid interpretations, or a redundancy of results, were made based upon the botanical data. This chapter also outlines the novel spatial model used to determine landscape positioning, mobility strategies, and other plant resources which may have contributed to diet but are not archaeologically visible.

The results chapter, Chapter Seven, outlines the dietary macrobotanical record of the Terminal Late Prehistoric in the eastern Trans-Pecos. This chapter also discusses similarities of diet between the eastern Trans-Pecos and to outside groups through correspondence analysis and plant diet breadth modeling. Data recovered from rockshelters in the eastern Trans-Pecos is also detailed and the sites compared based on taxa dominance. The results of the spatial modeling are also detailed in terms of landscape configuration, likely additional plant foods, and observations of foraging behavior.

Chapter Eight, Summary and Conclusions, concludes the dissertation and summarizes the findings described therein. This chapter summarizes what plant foods were utilized by Terminal Late Prehistoric peoples in the study area and how they were accessed.

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CHAPTER II

THE EASTERN TRANS-PECOS ARCHAEOLOGICAL REGION OF TEXAS

Lying west of the Pecos River in Texas, the eastern Trans-Pecos compromises the majority of the Trans-Pecos Area. Dominated by the Chihuahuan Desert Eco-Region this Texas archaeological region remains one of the least archaeologically studied regions. This synthetic chapter is broken into three primary sections which define the eastern Trans-Pecos in time, space, and biogeography. The beginning section outlines the study area in physical space while the second section describes the region's physiography, specifically the three major physiographic provinces, and regional hydrography. The final section describes the environmental history of the study area starting from the Pleistocene and ends with the modern era. This section also provides information regarding past climatic changes, the influence of the Little Ice Age on the northeastern Chihuahuan Desert, as well as flora and fauna within the study area.

2.1 Defining the Texas Eastern Trans-Pecos

Following the separation defined by Mallouf (1985) and Miller and Kenmotsu (2004), the eastern Trans-Pecos is contained wholly within the Trans-Pecos region of Texas (Figure 2.1). Comprising the majority of the Chihuahuan Desert within the state of Texas this archaeological region is outlined by two natural boundaries, one state boundary, and two prehistoric cultural construct transitions.

The three boundaries of non-cultural affiliation include the Pecos River, Rio Grande, and modern Texas-New Mexico state border. Both natural boundaries are also the largest sources of fresh surface water available to prehistoric, historic, and modern occupants of the area. Use of the modern New Mexico-Texas state border as the northern boundary also correlates with the southern boundary of the eastern extension of the Jornada Mogollon (Leslie 1977).

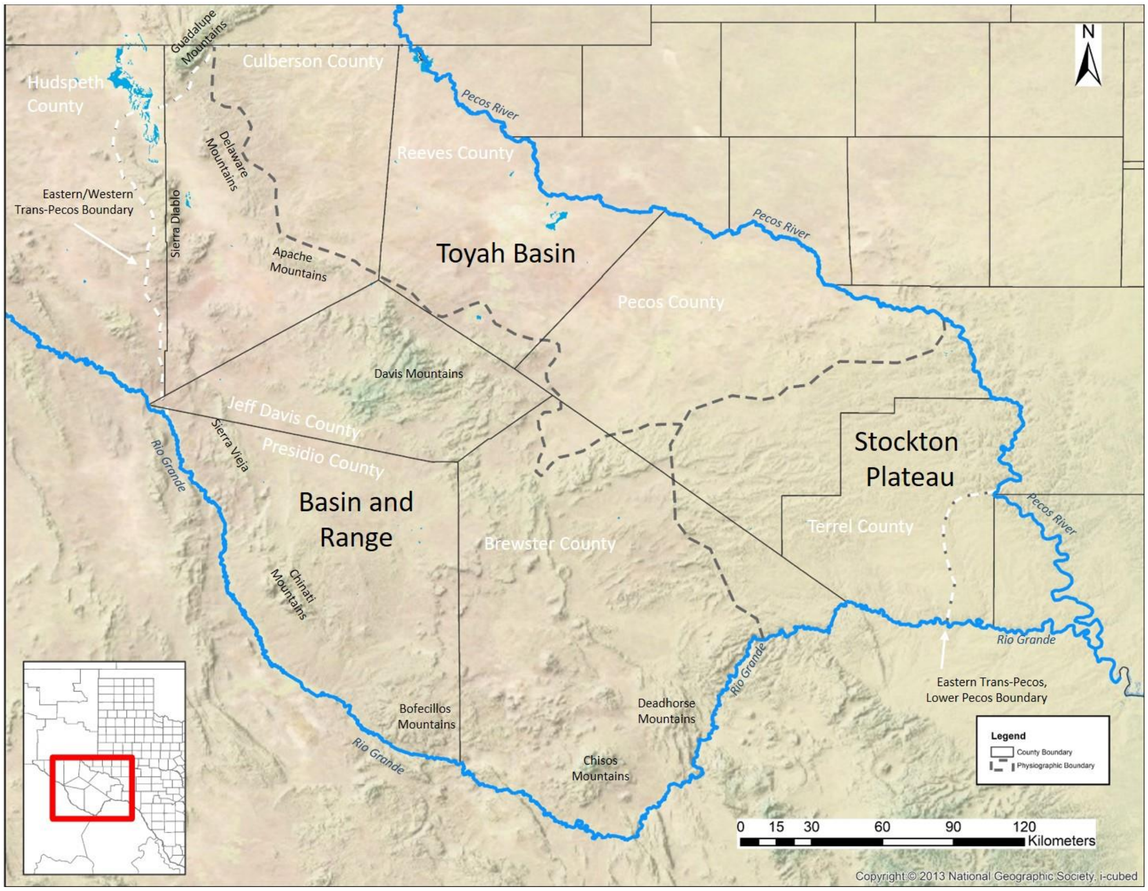

Figure 2.1. Boundaries, physiographic zones, and county names of the eastern Trans-Pecos.

The Jornada Mogollon represent the southern-most example of intensive Southwestern agriculturalists (Lehmer 1948, Miller and Kenmotsu 2004) and their cultural area delineates the western cultural area boundary of the eastern Trans-Pecos. Additionally, this is one of the two cultural areas whose extent defines the spatial area of the eastern Trans-Pecos. The second cultural area, the Lower Pecos, lies to the southeast of eastern Trans-Pecos. Though all three of these cultural areas lie within the bounds of the Chihuahuan Desert aspects of material culture are what better define the eastern Trans-Pecos.

In general, the defining characteristic for the study area is the use of a hunting-gathering subsistence pattern from the Late Pleistocene until the removal of the Mescalero Apache. Unlike the Jornada Mogollon of the western Trans-Pecos and southern New Mexico, maize-based agriculture nor year-round sedentism were common subsistence or mobility patterns except for one area. Located in the southern periphery of the eastern Trans-Pecos the La Junta de los Rios was the only portion of the study area to adopt farming and a semi-sedentary lifestyle (Kelley et al. 1940). This farming-and-foraging, or “farmaging”, entity is more fully described in Chapter 3.

To the southeast the Lower Pecos Canyonlands is also within the Chihuahuan Desert and utilized a mobile hunting-gathering subsistence pattern from the beginning of human occupation in the area. However, this area possesses a richer and more diverse rockart tradition than the eastern Trans-Pecos and is the primary material culture differentiating the two regions (Mallouf 1985).

Other artifactual indicators of the eastern Trans-Pecos include projectile points and basketry and are described in Chapter 2. Beyond the human behavioral differences that separate this region from others, the eastern Trans-Pecos is also renowned for the uniqueness and near brutality of the physical environment within its bounds.

2.2 Environmental Background of the Texas Eastern Trans-Pecos

The environment of the eastern Trans-Pecos can be summed up in two phrases: “God’s Country” and “The Devil’s Playground”; both of which can be experienced within a short, forty-five-minute drive from the communities of Alpine to Study Butte, Texas. In general, the study area can be considered a land of extremes ranging from pine forest-capped mountains to small riparian oases surrounded by the harshest desert environs of Texas. These differences result from the physiography of the region, though global climate shifts contributed to the resulting ecosystems experienced today.

2.2.1 Eastern Trans-Pecos Physiography

In general, the eastern Trans-Pecos archaeological region can be broken into three primary physiographic zones: Stockton Plateau, Basin and Range, and Toyah Basin (Bureau of Economic Geology, 1996) (Figure 2.1). Each zone resulted from unique geologic processes though all are considered local extensions of broader physiographic areas. The following sub-sections briefly describe each zone as to their age and geologic process affinity.

2.2.1.1 Stockton Plateau

The Stockton Plateau in eastern Pecos and Brewster Counties is a large tableland heavily dissected by canyons and draws. As the western extension of the larger Edwards Plateau of central Texas the primary dividing line between the two is the Pecos River. Additionally, the Stockon Plateau currently exists as an ecotone between the ecosystems of the Chihuahuan Desert to the west and the Edwards Plateau to the east, though in general it is ecologically considered part of the Chihuahuan Desert. Consisting primarily of Cretaceous age limestone this tableland is comprised of two geologic members: Fort Terrett and Fort Lancaster, both of the Edwards Formation. The Fort Terrett Member dates to the early Cretaceous and is a fossiliferous limestone with marly mudstone in the northern and western portions of the formation. Though similar to the Fort Terrett Member, the Fort Lancaster Member is more recent in age and contains more chert. This formation is what caps the mesas on the northwestern edge of the Stockton Plateau in Pecos County (Kunath and Smith, 1968).

2.2.1.2 Toyah Basin

The Toyah Basin is located in modern western and northwestern Pecos County as well as the majority of Reeves and Culberson Counties, Texas. In many ways an extension of the oil-producing Permian Basin to the north, the Toyah Basin is geologically comprised of Cenozoic alluvium which overlay Cretaceous limestones (Ashworth 1990, Uliana et al. 2007). Also considered part of the Chihuahuan Desert the Toyah Basin is another large ecotone of the eastern Trans-Pecos, though this physiographic area transitions from the Chihuahuan Desert of the south and west to the Great Plains ecosystems to the north.

2.2.1.3 Basin and Range

Wholly within the modern Chihuahuan Desert the Basin and Range physiographic zone of the eastern Trans-Pecos is located within Brewster, Presidio, Jeff Davis, Culberson, and Hudspeth Counties. This area is also the location where three (Ouachita, Laramide, and Basin and Range) of the major North American orogenic events converge.

During the Pennsylvanian Era tectonic plate collision thrust up the contemporary Marathon Basin which eventually deformed to the basin formation present today. Spanning the early Cretaceous to the Tertiary compression and volcanic activity during the Laramide Orogeny created the majority of the large mountain ranges of the Davis, Santiago, Chisos, and Bofecillos Mountains. The final major mountain building event, the Basin and Range Orogeny, was caused by tectonic expansion and resulted in the formation of the Dead Horse, Apache, and Delaware

Mountains, as well as the Sierra Vieja and Mesa de Anguilla. Later erosional processes filled the basins formed between these landforms (Urbancyzk et al. 2001).

Two unique mountain ranges, the Glass Mountains and Apache Mountains, were formed not by tectonic nor volcanic but erosion of the massive Capitan Reef Complex which manifested during the Permian period (Hill 1996). The results of these geologic processes contributed to the physiography experienced today as well as in the recent human past. These same processes also provided the basis for the development of the many ecosystems which experienced during the entirety of human occupation of the region, namely the formation and expansion of the Chihuahuan Desert.

2.2.2 Eastern Trans-Pecos Hydrography

Surface water resources, both lentic and lotic, within the eastern Trans-Pecos are largely lacking owing to the arid nature of the landscape. Only two rivers exist within the study area, Pecos River and Rio Grande, and both of these are used as boundaries to define the eastern Trans-Pecos in space (Figure 2.2). Currently only two creeks flow perennially in the study area, Limpia and Independence Creeks, but historically many of the now intermittent and ephemeral streams provided more water.

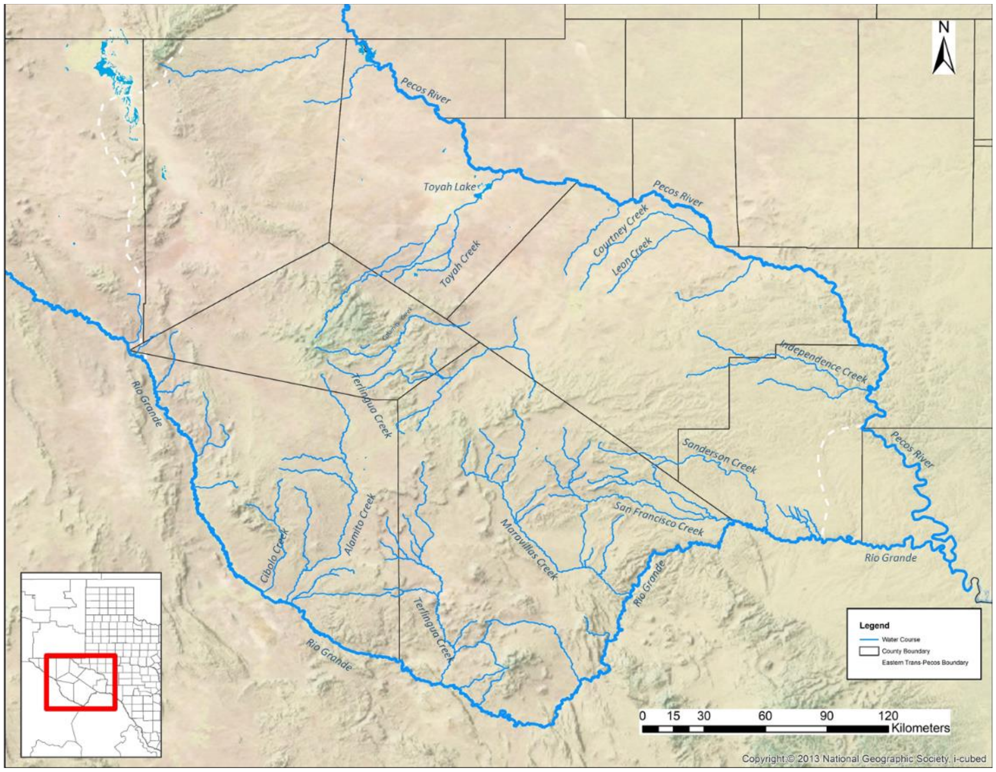

Figure 2.2. Available surface water within the eastern Trans-Pecos.

In terms of lentic water resources, springs and seeps are fairly common in some portions of the eastern Trans-Pecos, especially in the southern and central portions with histories of volcanic activity. Large springs, such as the Comanche and Leon Spring systems in Pecos County, once provided massive amounts of water though inappropriate land use and overpumping of groundwater have largely removed these once vital water sources (Brune 2002). Other ephemeral lentic water sources include playas such as Toyah Lake near Pecos, Texas, occur within the study area.

2.2.3 Eastern Trans-Pecos Environmental History and Biogeography

As the largest desert in North America, the Chihuahuan Desert Eco-Region extends from the central Mexican states of Zacatecas and San Luis Potosi north to southern New Mexico and eastern Arizona. This biologically diverse ecosystem formed fairly recently and, due to the habits of packrats (*Neotoma* spp.), insects, and well preserved pollen, how this desert formed and expanded has been studied in detail. What follows is a synopsis of the environmental history for the northeastern Chihuahuan Desert that lies within the eastern Trans-Pecos archaeological region primarily derived from a total of 220 packrat middens analyzed for macrobotanicals (VanDevender 1990), invertebrates (Elias and VanDevender 1992), and two pollen studies (Bryant and Holloway 1985, Hoyt 2000) with a focus on the Little Ice Age, the final major climate event experienced in the local prehistoric human record.

2.2.3.1 The Northeastern Chihuahuan Desert from the Pleistocene to the Present

Based on the records derived from packrat midden data and pollen studies, the earliest data dating to the late Wisconsin period (22,000 – 11,000 yBP) indicate the eastern Trans-Pecos was a much more mesic area compared to today. Xeric plant communities were largely absent with piñon-juniper-oak woodlands existing on mountain slopes and descending into their separating basins until 11,000 yBP (VanDevender 1990). Invertebrate evidence also indicates a woodland setting with much open ground, though xeric-adapted arthropods begin to arrive around 12,000 yBP within the Big Bend Region (Elias and Vandevender 1990, 1992). Pollen records also indicate piñon-juniper-oak woodlands, however Bryant and Holloway (1985) place the end of the Late Wisconsin mesic interval ending around 10,000 yBP rather than the 11,000 yBP end date from VanDevender (1990). Despite this discrepancy it can be accepted that the biological environment present at the end of the last glaciation event was a woodland setting dominated by piñon pine (*Pinus edulis*), juniper (*Juniperus* spp.), and oak (*Quercus* spp.) with an open understory.

Transitioning into the Early Holocene (11,000 – 6000 yBP) marks a time period of substantial biological and climatic change associated with the Holocene Climate Optimum, a period of increased temperatures across North America, that began around 9,000 yBP (Viau et al. 2006). Pollen data indicates an increase in grass (POACEAE), Compositae, and AMARANTHACEAE types with a decrease in arboreal pollen, demonstrating a decrease in woodland environments with an increase in grassland plant communities. Macrobotanical remains support this but also indicate replacement of the piñon-juniper-oak woodlands with juniper-oak woodlands. These subsequent Early Holocene oak-juniper woodlands included xeric scrub and succulent species in their understory (VanDevender 1990). Four xeric species (fourwing saltbush [*Atriplex canescens*], prickly pear [*Opuntia* spp.], western honey mesquite [*Prosopis glandulosa*], and sotol [*Dasylirion wheeleri*]) are also noted as rapidly increasing in number at around 8,100 yBP in the nearby Hueco Mountains (VanDevender 1995).

Arthropod populations are also noted to have undertaken demographic changes with xeric-adapted species increasing relative to temperate ones and a northward progression of these as the Chihuahuan Desert expanded north (Elias and VanDevender 1992). However, hard winter freezes likely slowed the progression of the xeric Chihuahuan Desert flora (Thompson et al. 1993, Van Devender et al. 1984). At 7500 yBP shows the appearance of the arthropod *Hellumorphoides texanus* which is widespread in the Chihuahuan Desert. This species is also an indicator of desert environs as well as desert grasslands (Elias and Vandevender 1992).

A shift in weather patterns, with summer development of low-pressure systems over the middle of North America and expansion of the Pacific subtropical high-pressure system, would have enhanced monsoonal conditions and contributed to the associated severe winters (Hoyt 2000, Mock and Brunelle-Daines, 1999, Thompson et al. 1993). This period also saw the beginnings of the El Niño-Southern Oscillation System (ENSO), a climate pattern with specific impacts to the study area.

The El Niño-Southern Oscillation System is a large scale phenomenon tied to warming and cooling of the mid-equatorial Pacific Ocean waters with a periodicity of two to seven years. Impacts from a warming phase, or “El Niño”, within the study area include below normal winter temperatures, above normal winter precipitation, and an increase in severe weather due to a southward shift of the Pacific jet stream. The opposite of this occurs during the cooling phase or “La Niña” wherein winter precipitation decreases, temperatures increase, and the Pacific jet stream shifts northward (Lindsey 2017). This highly dynamic weather phenomenon contributed not only to the vegetative communities throughout the remainder of the Holocene but also human inhabitants of the region.

The Mid-Holocene (~6000 – 2500 yBP) is represented by a shift to hotter and wetter conditions, associated with an increase in summer monsoonal rainfall and temperatures with widespread desert grasslands (VanDevender 1990, 1995). At ~4500 yBP VanDevender (1990) also noted the spread of two classic Chihuahuan Desert shrub species: creosotebush (*Larrea tridentata*) and ocotillo (*Fouquieria splendens*). One thousand years after the beginning of the Mid-Holocene saw the decline of the Holocene Climate Optimum and a return of slightly more mesic conditions to the study area. This phenomenon also correlated to an increase in annual precipitation and decline in July and January temperatures at Diamond Y Spring in Pecos County (Hoyt 2000). VanDevender (1995) also notes that this period saw a peak in summer monsoon rainfall which began at 9000 yBP ended at 4000 yBP.

The Late Holocene (2500 yBP – Present) began with enhanced mesic conditions as indicated by an increase in arboreal pollen (Bryant and Holloway 1985) though in general saw the establishment of Chihuahuan desert scrub (VanDevender 1995). Diamond Y Spring saw an increase in spring precipitation as well, though this ended around 1,000 yBP and began to decline to the modern precipitation amounts seen today (Hoyt 2000). Arthropod data from across the study area also shows a marked changed in species dynamics with total removal of temperate species by xeric species at the beginning of the Late Holocene (Elias and VanDevender 1992). It is during this period the two most recent climate events for the region, the Medieval Climate Anomaly and the Little Ice Age, were experienced by prehistoric peoples.

The biological response to the Medieval Climate Anomaly which occurred from 1050 yBP (A.D. 900) to 650 yBP (A.D. 1300) included an increase in shrub cover relative to that encountered in the Middle Holocene (VanDevender and Spaulding 1979). Climatically this episode saw dramatic warming over the study area, possibly caused by an increase in heat transport towards the Arctic by the Atlantic thermohaline ocean circulation (Mann 2002). More can be said about the increase in drought activity within the eastern Trans-Pecos though, likely due to La Niña events caused by ENSO though warming in the North Atlantic may have also contributed to these conditions (Woodhouse et al. 2010). Dendrochronological studies indicate four epochs of extreme drought at AD 936, 1034, 1150, and 1253 (Cook et al. 2004). This trend of enhanced drought frequency and intensity was quickly replaced by the last non-human initiated climate event to occur on the study area and the focus of the present work, the Little Ice Age.

2.2.3.2 The Little Ice Age and the Chihuahuan Desert

Beginning at AD 1300 (650 yBP) the Little Ice Age brought cooler temperatures to the eastern Trans-Pecos as well as most of North America until AD 1850 (Esper et al. 2002). This period also saw the establishment of the mosaic of vegetative communities described by the first European settlers to the area. Though this climate event lasted 550 years, this study is only concerned with the period from initiation of the Little Ice Age to the end of the Late Prehistoric Era at AD 1535. As such only those data and events between AD 1300 and 1535 will be examined here.

Based on the work by Neilson (1986) and Okin et al. (2009) climatic conditions coupled with shrubland-grassland dynamics resulted in the establishment of black grama (*Bouteloua eriopoda*) dominated desert grasslands. Specifically cooler temperatures coupled with enhanced rainfall in the late summer encouraged black grama seedling establishment and outpaced the mortality of adult black grama plants (Neilson 1986). Okin et al. (2009) also supports this but goes further in stating the establishment of grasses also resulted in stabilization of soils, therein creating a feedback that allows for continuation of the cycle. Both studies noted that when temperatures increase, precipitation peaks shifts from late summer to cool season, and soils are destabilized the recruitment of grasses decreases and xerophytic shrubs (i.e., creosotebush and western honey mesquite) can encroach into grass-dominated plant communities.

Despite the cooler temperatures of the Little Ice Age and mosaic pattern of the vegetative landscape this period also experienced at least two megadroughts in AD 1387-1402 and AD 1444-1481 (Stahle et al. 2007). To better understand drought activity during the Little Ice Age the work by Cook and Krusic (2004) and Cook et al. (2004) will be briefly described. Essentially these researchers utilized reconstructed Palmer Drought Severity Index values (Palmer 1965) (a measurement of dryness based on temperature and recent precipitation with a positive value indicating wet conditions and a negative value indicating drought) based on 835 annual tree ring chronologies (Cook et al. 2004). Titled the North American Drought Atlas (NADA) these studies were applied across most of North America and coupled the annual tree ring chronologies with two-degree by two-degree points to reconstruct drought over the past 2,000 years. For this study a basic exploratory analysis was undertaken with the data from points 134, 135, 149, and 150 (Figure 2.3). For the period from A.D. 1300 to 1535, the annual reconstructed PDSI values were averaged for each year. With an area-wide annual average produced a 10-year moving average was then generated from the area-wide average to aid in filtering out outliers and further identify patterning of the data. The result of this data manipulation is presented in Figure 2.4.

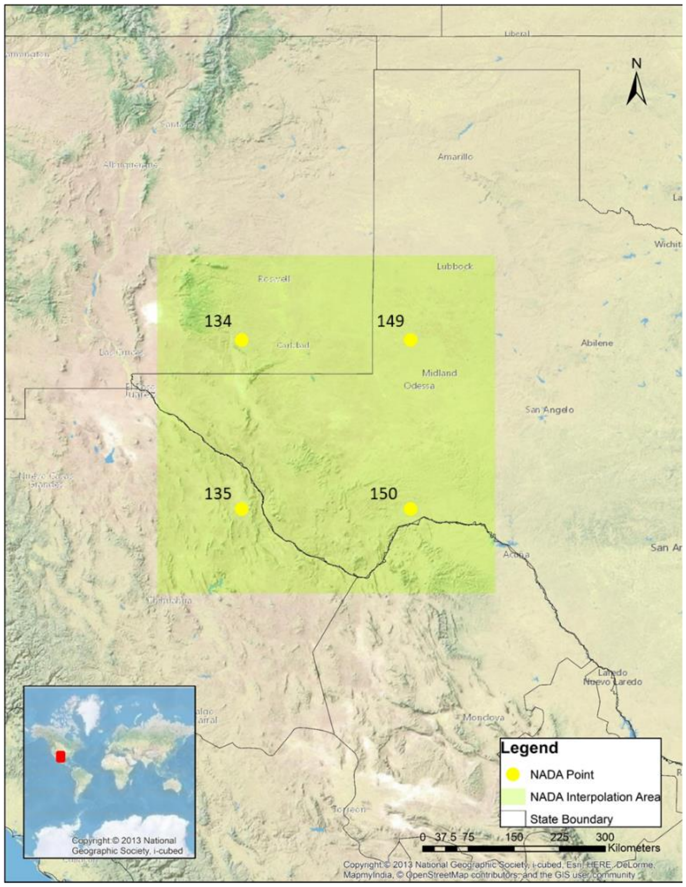

Figure 2.3. Map of Cook et al. (2004) interpolation points and area specific to the eastern Trans-Pecos.

Three periods of drought activity are noted in the dataset: AD 1300-1336, 1338-1497, and 1498-1535 (Figure 4). An overall wetter environment was experienced between AD 1300-1336 and 1478-1535 with a drought occurring on average once every three years during the former and once every 2.2 years during the latter. The intervening period of AD 1338-1497 saw wide variability in summer drought activity with a drought occurring every 1.7 years. This period saw both the driest (AD 1397, Avg. Annual Reconstructed PDSI = -4.4) and wettest (AD 1486, Avg. Annual Reconstructed PDSI = 4.16) summers during the Little Ice Age for the study area. These data further indicate that the climatic environment of the eastern Trans-Pecos was a highly variable one which had direct impacts on the plant, animal, and human communities of the area.

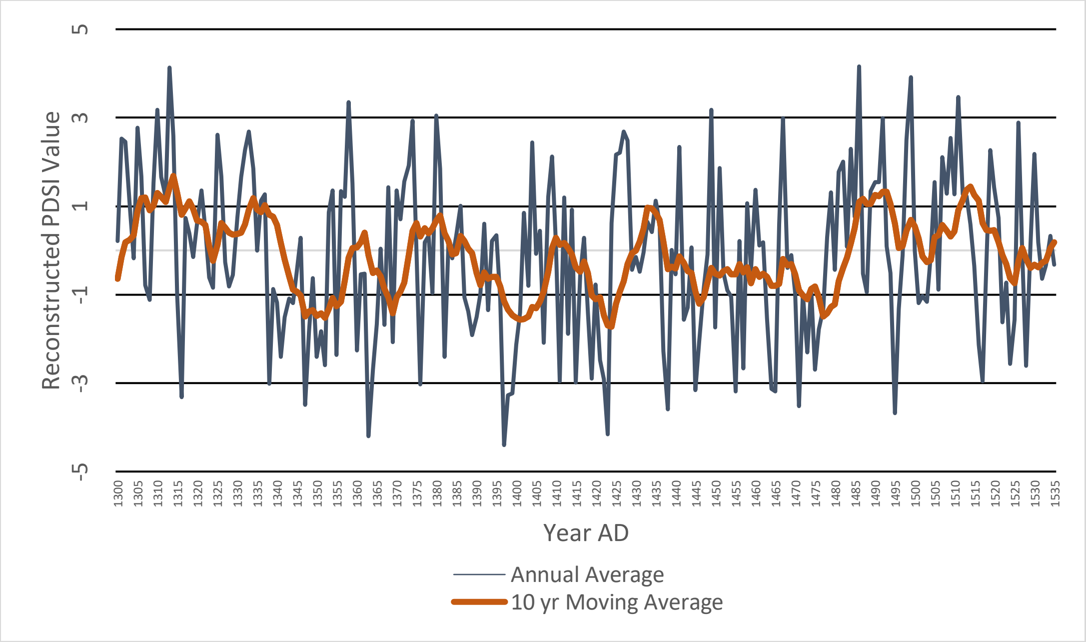

Figure 2.4. Summer annual reconstructed Palmer Drought Severity Index values for the eastern Trans-Pecos archaeological region from AD 1300 to 1535.

2.2.4 Eastern Trans-Pecos Flora

As described previously it is currently understood that cooler temperatures and late summer-focused precipitation regime contributed to the mosaic of plant communities present during the Little Ice Age (Nielson 1986, Okin et al. 2009). Though presented in greater detail in Chapter 6, the plant communities present during the study time period will be briefly described based on data from the Natural Resource Conservation Service (NRCS) Ecological Site Description (ESD) System. The NRCS describes an ecological site as "a distinctive kind of land with specific physical characteristics that differs from other kinds of land in its ability to produce a distinctive kind and amount of vegetation." (USDA-NRCS 2003:3.1-1). Ultimately this system seeks to describe and inventory the plant communities which existed at the time of European arrival and firmly within the Little Ice Age (USDA-NRCS 2003). Currently the NRCS-ESD System delineates eighty-eight ecological sites within the eastern Trans-Pecos.

For the sake of introduction and brevity the five general vegetation types of the study area will be briefly introduced. These include Chihuahuan Desert scrub, oak-juniper-piñon woodland, conifer forest, riparian communities, and grassland (Powell 1998).

Occurring in the lower elevations of the study area, the Chihuahuan Desert scrub is dominated by creosotebush, lechuguilla, soto, and yucca. Members of the FABACEAE family are also common and include acacias such as *Acacia constricta* and *A. greggii*, catclaw mimosa (*Mimosa aculeaticarpa* var. *biunicifera*), and mesquite. Other common shrubs include tarbush (*Flourensia cernua*), fourwing saltbush (*Atriplex canescens*), mariola (*Parthenium incanum*), and skeletonleaf goldeneye (*Viguiera stenoloba*). Common grass within this vegetation type include threeawns (*Aristida* spp.), gramas such as black grama, blue grama (*Bouteloua gracilis*), and sideoats grama (*B. curtipendula*), as well as fluffgrass (*Dasyochloa pulchella*) (Powell 1998).

Mid-level elevations between 1341 – 2286 meters give rise to woodlands dominated by oak, mainly gray oak (*Quercus grisea*) and Emory oak (*Q. emoryi*), as well as two species of juniper (rose-fruited juniper [*Juniperus coahuilensis*] and red berry juniper [*J. pinchotii*]). Between 1676 – 2286 meters a more common juniper species is alligator juniper (*J. deppeana*). Piñon pines within this vegetation type are primarily papershell piñon (*Pinus remota*), Mexican piñon (*P. cembroides*), and Colorado piñon (*P. edulis*). Other woody species include bigtooth maple (*Acer grandidentatum*) and Texas madrone (*Arbutus xalapensis*). Grasses present include muhlys (*Muhlenbergia* spp.), bulb panicum (*Panicum bolbosum*), and piñon rice grass (*Piptochaetium fimbriatum*) (Powell 1998).

The highest elevations within the study are dominated by conifer forests, mainly ponderosa pine (*P. ponderosa*), southwestern white pine (*P. strobiformis*), and Douglas fir (*Pseudotsuga menziesii*) though this species only grows near the New Mexico border in Culberson County. Other common tree species are quaking aspen (*Populus deltoids*) and chinkapin oak (*Q. muehlenbergii*) with the latter occurring in the Chisos Mountains. The Chisos Mountains also include relict populations of Arizona cypress (*Cupressus arizonica*). Within this vegetation type needlegrass (*Stipa* spp.) is the most common grass genus.

Grasslands within the study area occur primarily between 1067 – 1585 meters with annual precipitation between 25.4 and 38.1 cm. Common grass species include the gramas listed above, burrograss (*Scleropogon brevifolius*), bluestems (*Bothriochloa* spp., *Schizachyrium* spp.), and needlegrasses. Tobosa (*Hilaria mutica*) is also present though tobosa grasslands are frequently monotypic stands. The Trans-Pecos region as a whole constitutes some 238 species of grasses as well (Powell 1998). Scattered within the grasslands are yuccas, stool, and cacti including prickly pear (*Platyopuntia* spp.) and cholla (*Cylindropuntia* spp.) (Powell 1998).

The final vegetation type which is present in all of the above vegetation types are riparian communities. These plant species require more water than their upland counterparts and are focused around perennial surface or near-surface water. The most notable tree species is Rio Grande cottonwood (*Populus deloides* ssp. *Wislizeni*) though many willows (*Salix* spp.) and desert willow (*Chilopsis linearis*) are also present. Little walnut (*Juglans microcarpa*) is frequently associated with seasonal and intermittent waterways as well (Powell 1998). Obligate wetland plants, found around and within springs of the area, include rushes (*Juncus* spp., *Schoenoplectus* spp., and *Carex* spp.) and cattail (*Typha* spp.) (NatureServe 2009).

2.2.5 Eastern Trans-Pecos Fauna

The Trans-Pecos region of Texas hosts the most modern diverse assemblage of mammals in the state of Texas (Schmidly 2004). The three extant medium bodied ungulates include pronghorn antelope (*Antilocapra americana*), mule deer (*Odocoileus hemionus*), and white-tailed deer (*Odocoileus virginianus*). Large bodied carnivores include the American black bear (*Ursus americanus*) and mountain lion (*Felis concolor*). The grey wolf (*Canis lupus*) was present in the study area until historic times when it was hunted and trapped to statewide extinction. Small to medium-sized carnivorous and omnivorous species include the coyote (*Canis latrans*), bobcat (*Lynx rufus*), common gray fox (*Urocyon cinereoargenteus*), common raccoon (*Procyon lotor*), striped skunk (*Mephitis mephitis*), American badger (*Taxidea taxus*), and collared peccary (*Tayassu tajacu*). North American beavers (*Castor canadensis*) are also present in the study area though today their distribution is limited to the Rio Grande. Many smaller mammals, including rabbits, rodents, and bats, are also present within the study area (Schmidly and Bradley 2016).

The study area also hosts a wide assortment of reptiles and amphibians. Examples of these include the western diamondback rattlesnake (*Crotalus atrox*), Trans-Pecos ratsnake (*Bogertophis subocularis*), Mexican spadefoot toad (*Spea multiplicata*), western tiger salamander (*Ambystoma mavortium*), western ornate box turtle (*Terrapene ornata*), eastern collared lizard (*Crotaphytus collaris*), and Texas horned lizard (*Phyrnosoma cornutum*) (Dixon 2002).

Bird species frequently encountered include three species of quail (scaled quail [*Callipepla squamata*], Montezuma quail [*Cyrtonyx montezumae*], and Gambel's quail [*Callipepla gambelii*]), two subspecies of wild turkey (Merriam's turkey [*Meleagris gallopavo merriami*] and Rio Grande turkey [*Meleagris gallopavo intermedia*]). Beyond gamebirds a variety of songbirds, raptors, owls, and buzzards are also found within the study area (Rappole 2004).

2.3 Overview of Eastern Trans-Pecos Environment

The environment of the Texas eastern Trans-Pecos continues to be a diverse and, at times, harsh landscape. Three physiographic regions constitute the study area and include the Stockton Plateau, Toyah Basin, and Basin and Range. Of these the Toyah Basin and Stockton Plateau are better considered ecotones between the Chihuahuan Desert and the Great Plains for the former and the Chihuahuan Desert and central Texas shrublands with the latter. Today five dominant vegetation types are noted within these provinces and include oak-juniper-piñon woodlands, coniferous forests, Chihuahuan Desert scrub, riparian areas, and grasslands. However, the spatial dominance of these vegetation types corresponded to various climate events, though in general it is noted that since the Pleistocene the study area became increasing xeric in nature.

Beginning around AD 1300 the initiation of the Little Ice Age contributed to a mosaic of vegetation types experienced by Euroamerican explorers and settlers. Primarily composed of black grama dominated grasslands, this mosaic was caused by decreased ambient temperatures and a late-summer focused precipitation regime of the Little Ice Age which allowed for soil stabilization and enhanced grass plant recruitment. Still, data from NADA demonstrated a region with frequent, intense droughts during said climate event.

Faunal species are also quite diverse within the eastern Trans-Pecos oweing to the diversity of niches generated by the abiotic and botanical environments. Noted as having the highest diversity of mammals within the state of Texas, the assorted biotic resources of the study area contributed to the adoption and development of technologies and imagery produced by past peoples.

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CHAPTER III

EASTERN TRANS-PECOS ARCHAEOLOGY

Due to the remoteness and rugged terrain of the eastern Trans-Pecos few archaeological investigations have occurred in the region compared to those that surround it. The lack of larger public lands and few, large scale infrastructure projects have largely contributed to the paucity of studies within the area. Despite this the region has seen three waves of archaeological research during the 1920s to 1950s, late 1980s to mid-1990s, and the early 2000s to the present, 2018, though between these periods some large-scale studies were undertaken.

3.1 Prior Research in the Eastern Trans-Pecos

The first archaeological find which caught public attention was the 1895 discovery of more than 1,500 arrow points beneath a small rock cairn atop Mount Livermore in the Davis Mountains, now known as the Livermore Cache (41JD66) (Janes 1930). Fourteen years later a brief survey of the region was undertaken by Charles Peabody (Peabody 1909). After this few investigations were undertaken with the exception of those by Victor J. Smith, curator at the Museum of the Big Bend and professor at the then Sul Ross State Teachers College in Alpine, Texas. Smith would go on to undertake small scale excavations in several rockshelters which would lay the foundation for formal archaeological investigations in the area (Smith 1932). Later in the 1920s several expeditions were undertaken in the area (ex. Coffin 1932, Harrington 1928, Young 1929). Sponsored by entities such as the Smithsonian Institution and the Witte Museum in San Antonio, Texas, these endeavors primarily focused on rockshelter deposits within the area. Though most of these were concerned with identifying Basketmaker materials from the

American Southwest, which the eastern Trans-Pecos is peripheral to, the resultant reports are marginal at best largely because modern archaeological fieldwork techniques had yet to be developed.

The 1930s saw an increase in both the number of archaeological projects as well as the standardization of fieldwork techniques. This period also saw the first large scale archaeological investigation. Owing to the work of E.B. Sayles from Gila Pueblo, Sayles created the first nomenclature for the area which included the Pecos River Cave Dweller, Big Bend Cave Dweller, Edwards Plateau, and Lipan Phases as well as excavations in the northwestern eastern Trans-Pecos (Sayles 1935). The largest study in the area, which began in 1938, was a joint effort between Sul Ross State Teachers College and the Peabody Museum of Archaeology and Ethnology at Harvard University. This study would correlate Quaternary deposition, primarily in the central and southern portions of the eastern Trans-Pecos, to archaeological materials (Kelley et al. 1940). Specifically, this study would revise the cultural history and nomenclature of the area. This nomenclature would split the hunting-gathering groups, the Big Bend Cave Aspect, from the agriculturalists, Bravo Valley Aspect, of the La Junta de los Rios area surrounding Presidio, Texas. Within the Big Bend Cave Aspect two subdivisions included the Pecos River and Chisos Foci. The Bravo Valley Aspect would be broken into five foci: La Junta, Concepcion, Conchos, Alamito, and Presidio (Kelley et al. 1940). Today the Big Bend Cave Aspect has fallen out of use and the Bravo Valley Aspect has been revised to replace “focus” with “phase” (Cloud 2004, Kelley 1990, 2013, Mallouf 1990, 1999, 2013a). Kelley would continue work throughout the La Junta de los Rios area (or “La Junta”) throughout the 1930s focusing on the excavation of pithouses in several of the prehistoric villages within the area (Kelley 1939, 1985).

Work continued in the study area throughout the 1940s and 1950s, though most of these endeavors focused on the La Junta villages. Ultimately Kelley would lead several reconnaissance endeavors (Kelley 1949) and a field school (Shackelford 1951, 1955) at La Junta and would further refine the nomenclature developed in Kelley et al. (1940). Kelley's dissertation was also completed at this time which correlated historic Spanish accounts of La Junta with the archaeological resources of the area (Kelley 1947, 1986). His work would continue to expand and later refine his dissertation research while adding a significant historic perspective to the inhabitants of La Junta (Kelley 1952a, 1952b, 1953).

Between the 1950s to the late 1980s few large scale archaeological investigations were undertaken in the eastern Trans-Pecos. Those that did were largely due to the development of cultural resource laws and focused within Big Bend National Park as well as what would become Big Bend Ranch State Park (ex. Campbell 1970, Baskin 1976, 1978, Hudson 1976). A notable study was undertaken by Donny L. Hamilton in the 1970s within the Rustler Hills in the northwest portion of the study area, focusing on excavations at Granado Cave (41CU8) (Hamilton 2001).

The 1980s saw a significant departure from previous investigations in terms of technical ability and scale of investigation. Rather than focusing on rockshelters, as in the 1930s, or La Junta area villages, as in the 1940s and 1950s, most investigations were concerned with open campsites. These endeavors largely focused on Late Prehistoric hunter-gatherer campsites of the Cielo Complex, described in greater detail below, that was formally described in Robert Mallouf's unpublished Master's thesis (Mallouf 1985). Through coordination between the state archaeologist of Texas and the Texas Historical Commission, a host of surface and subsurface studies were undertaken, though focused in the southern portion of the eastern Trans-Pecos (Mallouf 1993, 1995, 1990, 1999, 2013).

The beginning of the twenty-first century saw a renewed interest, as well as breadth of endeavors, within the area. Three large scale surveys were initiated with two focused in Big Bend Ranch State Park (Gibbs 2004, Ohl and Cloud 2001) and another in Big Bend National Park which began in 1995 (Cloud 2004). The latter of which consisted of surveying 61,766 acres and took over a decade to complete (Keller et al., In prep). At this time the Center for Big Bend Studies (CBBS) at Sul Ross State University initiated the Trans-Pecos Archeological Program to develop an archaeological database further enabling archaeologists to answer questions about the past largely within the Big Bend region.

The 2000s and early 2010s also saw an increase in studies conducted within cultural resource management (CRM). Most of these studies were focused on the Stockton Plateau and initiated by wind turbine farm installations atop several mesas in the area (Anthony et al. 2015, Butler 2012, Godwin 2002).

3.2 Cultural History of the Eastern Trans-Pecos

Within the eastern Trans-Pecos seven large archaeological periods have been defined. The following section will briefly describe each period as to material culture and behavioral trends. Much focus will be placed on the Late Prehistoric Period (AD 700-1535) as it is the focus of this study.

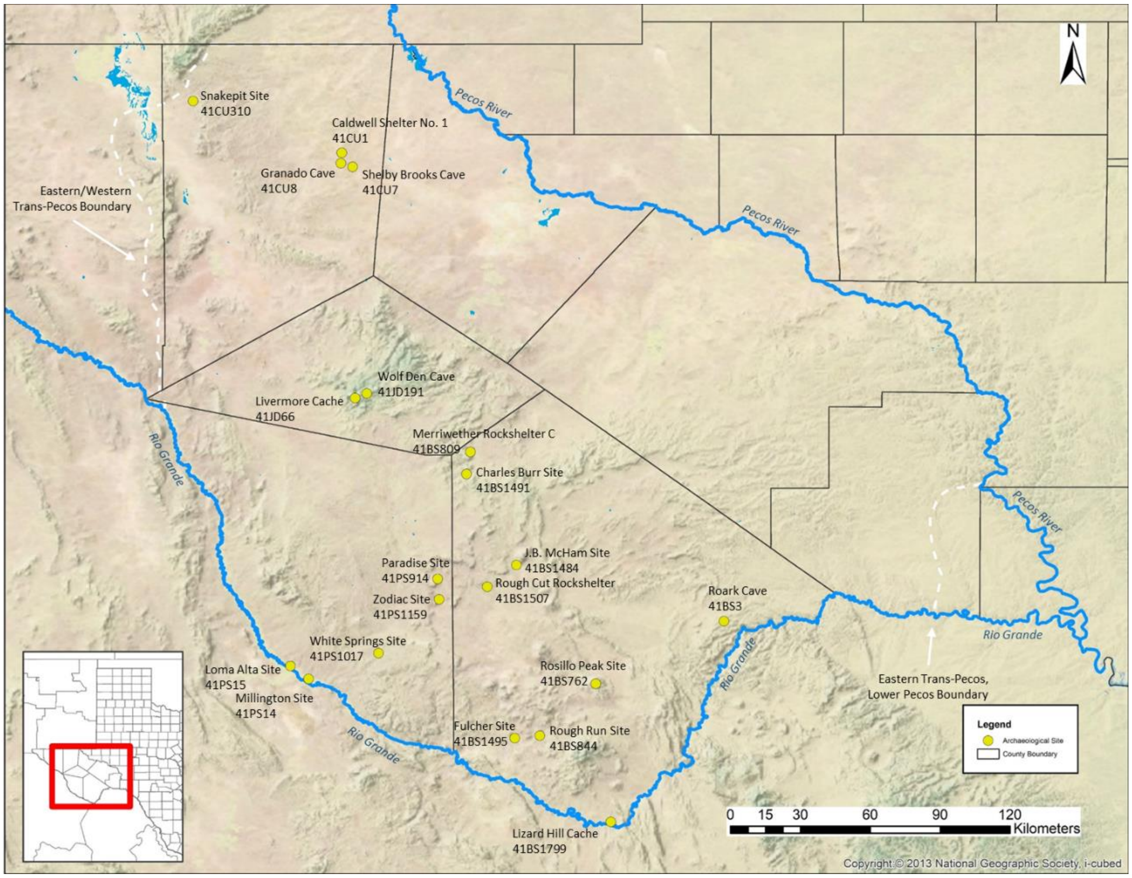

Figure 3.1. Map of archaeological sites in the eastern Trans-Pecos mentioned in text.

Major Time Period	Years Before Present (yBP)	Calendar Years BC – AD
Paleoindian	13,500 – 8500	11,500 BC – 6550 BC
Early Archaic	8500 – 4450	6550 BC – 2500 BC
Middle Archaic	4450 – 2950	2500 BC – 1000 BC
Late Archaic	2950 – 1250	1000 BC – AD 700
Late Prehistoric	1250 - 415	AD 700 - 1535
Historic	415 - Present	AD 1535 - Present

Table 3.1. Major Archaeological Time Periods in the eastern Trans-Pecos.

3.2.1 Paleoindian Period (13,500 – 8500 yBP)

Unlike other regions of Texas and areas to the west, the eastern Trans-Pecos is known for its paucity of artifacts dating to this period. All material related to these occupations indicate a highly mobile hunting and gathering subsistence pattern utilizing a broad spectrum diet with a focused use of lanceolate-shaped projectile points. Currently the earliest known Paleoindian entity was the Clovis Complex though occupations by individuals utilizing this suite of tools was likely minimal. Bever and Meltzer (2007) noted only six Clovis points recovered within the eastern Trans-Pecos, five of which were found in Brewster County and a single find in Pecos County. Gray (2014) described a fragmented Clovis point found in Jeff Davis County in 2010. In total only seven Clovis points are known for the study area. Later in the Paleoindian Period, the Folsom Complex was the focus of John Seebach's doctoral research (Seebach 2011). Seebach (2011) noted that, in general, late Early Paleoindian groups focused residential campsites within the lowlands of the region and utilized upland areas for hunting. He also notes that the majority of projectile points from the study, Folsom/Midland and Cody/Firstview, were heavily rejuvenated despite a local abundance of usable toolstone.

Work by the CBBS at the Genevieve Lykes-Duncan Site (41BS2615) in Brewster County has offered a new insight to Paleoindian hunter-gatherer resource use and diet. Composed of several buried, hot rock cooking features within Late Paleoindian components this site indicated an emphasis on the processing and consumption of desert succulents, such as lechuguilla and sotol (ex. *Dasylirion wheeleri*) (Boren 2012, Cloud and Mallouf 2011).

In terms of basketry, Adovasio (1980) demonstrated that twined objects were the first wares created by groups in the area around 9450 yBP. Coiled basketry with a single rod foundation arrived somewhat later between 8950 and 7950 yBP.

3.2.2 Early Archaic Period (8500 – 4450 yBP)

Like the preceding Paleoindian Period the Early Archaic was a continuation of a mobile hunting and gathering subsistence pattern. Hallmark artifacts of the Early Archaic in the study area included Pandale, Bell, Baker, Bandy, Early Triangular, and Zorra projectile points (Gray

2013). A recent synthesis by Boren (2012) analyzed the materials from nine archaeological sites in the eastern Trans-Pecos. This effort demonstrated that more emphasis was placed on the processing of plant foods compared to the preceding Paleoindian. Specifically, the Early Archaic saw the appearance of groundstone artifacts, such as manos and metates, used to process plant parts. Further evidence for increased use of plant foods are fire cracked rock middens associated with an intensification in the use of succulents. Additionally, Boren noted that no large-bodied game animals have been identified within the Early Archaic archaeological record, indicating that local hunters relied on small and medium-bodied game such as jackrabbits, mule deer, and pronghorn (Boren 2012).

Basketry technology begins to change during the middle portion of this period with bundle foundations and split stitching on non-work or both work sides becoming more common until 5950 yBP, although single-rod foundations were still present. After this work direction shifted from both left-to-right and right-to-left to left-to-right. Plaited mats also changed during this period to include both simple and twill plaiting (Adovasio 1980).

Perhaps the most intriguing aspect of the archaeological record during the Early Archaic is the hypothesized development of ritualism associated with mountaintops. Located atop Rosillo Peak in Big Bend National Park the Rosillo Peak Site (41BS762) was initially occupied during the Early Archaic with later occupations during the Middle and Late Archaic as well as some evidence of a Late Prehistoric occupation. During the initial occupation individuals placed an emphasis on the production of projectile points, especially diminutive Pandale dart points, as well as retooling of stone tools. This, coupled with the impressive views from the site, have lent some archaeologists to associate the Early Archaic and later occupations at the Rosillo Peak Site with ritualistic behaviors focused on mountaintops (Mallouf et al. 2006).

3.2.3 Middle Archaic Period (4450 – 2950 yBP)

The Middle Archaic Period shows little change from the preceding Early Archaic though this period is better studied owing to the presence of more archaeological sites in the area. Distinct projectile points were primarily contracting stemmed and included Almagre, Arenosa, Jora, Langtry, and Val Verde types (Ohl 2006). General observations for this period include the continuation of mobile hunting-and-gathering with a focus on the processing of desert plants not yet seen in the eastern Trans-Pecos (Mallouf 1985). Additionally, Adovasio (1980) also observed that basketry forms and types proliferated while simple plaited and twilled matting became much more elaborate.

One behavior that seems to have increased in frequency is the caching of stone tools for both utilitarian and ritual reasons. Two caches are known to this period, the Zodiac and Lizard Hill Caches. The Lizard Hill Cache from the Lizard Hill Site (41BS1799) consisted of thirteen contracting dart points (eleven Alamagre dart points and two Langtry dart points), a drilled mussel shell, and a smoothed stone cobble. The complete artifacts and a nearby large, V-shaped petroform which points to the cache likely indicate a ritualistic nature for the cache (Ohl 2007). Unlike the Lizard Hill Cache, the Zodiac Cache from the Zodiac Site (41PS1159) was considered by Mallouf and Mills (2013a) to be utilitarian in nature. Artifacts associated with this cache included two unifacial end scrapers, two bifacial end scrapers, one bifacial preform, one bifacial knife, one partial Gobernadora dart point, and a flake blank.

Other observations for this period suggest an increase in human populations (Mallouf 1985, Ohl 2006). However, based on work at the Paradise Site (41PS914) Ohl states that even though the earth oven at the site "was apparently used only a few times may mean that territorial boundaries were not strong, and any seasonality of movements were not entrenched.” (Ohl 2006: 122-123).

3.2.4 Late Archaic Period (2950 – 1250 yBP, 1000 BC – AD 700)

Late Archaic material culture dominates the archaeological record of the eastern Trans-Pecos. With the waning of the Holocene Climate Optimum the Trans-Pecos saw an increase in precipitation, arrival of new technologies, and a human population increase in the region (Mallouf 1985, 2005). During the first portion of the Late Archaic dart point styles more typical of Central Texas became increasingly common in the archaeological record (Cloud 2004, Mallouf 1985), though in general Late Archaic dart points are overwhelming common in surface collections (Cloud 2004, Mallouf 1985, 1990, 2000, 2005, 2013a). Additionally, a marked increase in the diversity of dart point styles occurred during the Late Archaic, including the adoption of the Paisono dart point which is markedly uncommon outside of the eastern Trans-Pecos (Mallouf 1985, 2005). Basketry technology was also different during this period and included coiled basketry dominated by the use of a bundle foundation and occasional false braid rims. Work direction was normally left to right while plaiting remains common with many twilled mats which incorporated painted designs (Adovasio 1980).

Potentially due to the increase in human population almost every ecological zone of the eastern Trans-Pecos was utilized during the Late Archaic. In general, most residential sites were located in the foothill zones of the region’s mountains, though activity-specific sites are common across the study area (Mallouf 2005). Despite this increase in numbers of people the mobile hunting-and-gathering subsistence pattern continued through the Late Archaic with a focus on desert succulents. Though corn (*Zea mays*) cobs are found in rockshelter deposits with Late

Archaic components the use of cultigens likely took place during the following Late Prehistoric. This mixing of materials could be due to reuse of these locales by later peoples and/or the poor documentation and excavation of rockshelters during the 1930s. Additionally if maize was consumed, and possibly grown, during the latter portion of the Late Archaic its introduction likely originated with contact with western groups. Support for this is derived from marine shell trade items which were possibly acquired via western trade routes (Mallouf 2005). Rockshelter deposits at Roark Cave (41BS3) indicated hunting of medium sized game, such white-tailed and mule deer, may have been more prominent in certain areas of the study area. Specifically, this site yielded 238 projectile points, many stylistically attributed to the Late Archaic (Kelly 1963).

Caching behavior continued during the Late Archaic owed to the presence of the McHam and Merriwether Caches in Brewster County, Texas. The McHam Cache was found at the J.B. McHam Site (41BS1484) and consisted of fifteen late stage biface preforms, one complete flake blank and one fragmentary flake blank (Mallouf 2013c). Another utilitarian cache, the Merriwether Cache, from Merriwether Rockshelter C (41BS809) originally consisted of eleven late stage bifaces. Unfortunately, only nine of these bifaces remain and Wulfkuhle (1990) posited these were dart point preforms.

Unlike the preceding periods the material culture of the Late Archaic is better described, or at least better preserved. Flaked stone tools included dart points, unifacial scrapers, expedient tools of bifacial and unifacial forms, bifacial knives, corner-tang knives, informal gouges, and bifacial drills. Groundstone artifacts varied from bedrock mortars (both oval and circular), bedrock and slab metates, oval to circular manos, atlatl weights, abrading stones, and tubular pipes. Perishable artifacts included cradleboards, rabbit sticks, bone awls and rasps, digging sticks, and cactus spine needles. Jewelry is represented by gorgets made of shell and stone, shell and kaolinite pendants, as well as beads created from bone, shell, and seeds (Mallouf 1985, 2005).

Finally, Mallouf (1985, 2005) suggested that mountain-top ritualism likely became more prevalent during the Late Archaic. Mallouf's support for this included sites atop difficult to climb landforms with extensive views and few subsistence resources nearby.

At this juncture it is worth mentioning the corpus of rockart present within the study area. Unfortunately, few rockart-focused studies have been undertaken within the region, let alone published, and those that have focused on the following Late Prehistoric Period and will be described below. Currently it is thought that the majority of rockart, and especially petroglyphs, were produced during the Archaic time periods. One particular motif is reminiscent of Late Archaic Shumla dart points and occasionally includes anthropomorphized elements (Hampson 2015). A rockart style which may have been produced in the Late Archaic, Big Bend Abstract, is primarily found in the southern portion of the study area. This style of petroglyphs includes a variety of seemingly abstract motifs dominated by wandering lines, crosses, X figures, concentric circles, vulva motifs, and handprints some of which have extended fingers (Tegarden 2005). Additionally, Tegarden (2005) posits that this style may have been produced sometime between 2950 and 450 yBP.

3.2.5 The Late Prehistoric Period (AD 700 – 1535)

The Late Prehistoric Period (AD 700 – 1535, 1250 – 415 yBP) marked the final period of prehistoric indigenous human occupation of the study area prior to the arrival of Europeans. Marked changes occurred in lithic technology, subsistence strategies, social relations, and trade ties during this period. Additionally, this era has seen the most archaeological endeavors undertaken and as such is better understood than any of the preceding archaeological periods. Because of this five distinct cultural constructs (Livermore Phase, Cielo Complex, Castile Phase, La Junta Phase, and Concepcion Phase) are defined within the study area (Table 3.2). General changes in material culture and technology will be introduced first, then each cultural construct will be described with hunting-gathering groups first and farming groups last.

Subsistence Pattern	***Cultural Construct***	***Years Before Present (yBP)***	***Calendar Years AD***
Hunter-Gatherer	Castile Phase	1800 – 450 yBP	200 BC – AD 1200
	Livermore Phase	1150 – 450 yBP	AD 800 – 1200
	Cielo Complex	700/650 – 270 yBP	AD 1250/1300 - 1680
Agriculturalists	La Junta Phase	700 – 500 yBP	AD 1250 - 1450
	Concepcion Phase	450 – 266 yBP	AD 1500 - 1684

Table 3.2. Late Archaic to Late Prehistoric Period cultural constructs of the eastern Trans-Pecos.

Unlike all preceding archaeological eras the hunter-gatherers of the Late Prehistoric Period adopted a new hunting technology which included the bow and arrow. However, this adoption was not sudden nor did it occur evenly across the region. Mallouf (2005) reports Paisano dart points continued in use in the central eastern Trans-Pecos until AD 1100 (900 yBP) at Tall Rockshelter (41JD112) and the Homer Mills Site. This mixing of atlatl-dart and bow-arrow technology suggested a cultural continuation of groups from the Late Archaic into the Late Prehistoric (Mallouf 2005).

Beyond the use of the bow and arrow, and the associated shift from dart points to arrow points, inhabitants of the study did not radically change their technological traditions. In terms of lithics beveled, or Harahey, knives began to be used at the beginning of the period (Kelley et al. 1940, Kelley 1957). Around AD 1250 (700 yBP) the Cielo Complex (described later in this section) began using a blade core technology to produce prismatic blades and arrow points (Mallouf 1985, 1990, 1999, 2013a). Basketry changed little, though the more complicated plaiting of the Late Archaic falls out of favor, bundle foundations dominate coiled items, and twined items remain scarce (Adovasio 1980). Sandal manufacture also changed little from the Late Archaic with a continuation of braided sandal pads (Taylor 1988, Turpin 2003).

Three other hallmarks of the Late Prehistoric common throughout the state of Texas are also lacking in the eastern Trans-Pecos. Agriculture, villages, and pottery-making are notably absent within the archaeological record of the area with the exception of the La Junta Phase in the Bravo Valley Aspect (Kelley et al. 1940, Kelley 1985, 1986). Otherwise the majority of individuals in the eastern Trans-Pecos continued the mobile hunting-gathering lifestyle of the Archaic periods, including a focus on the use processing of desert plants with earth ovens, with little change despite knowledge of radical social and cultural changes to the west and north (Miller and Kenmotsu 2004).

Some groups with homelands outside of the eastern Trans-Pecos did encroach on the native entities to the study area. As described in Miller and Kenmotsu (2004), Sebastian and Larralde (1989) and Miller (1994) hypothesized that agricultural groups may have briefly occupied the northern eastern Trans-Pecos for resource access. An indication of this was found at the Snakepit Site (41CU310), a small El Paso Phase (AD 1200 – 1450, 750 – 500 yBP) camp. Radiocarbon dates and El Paso polychrome sherds confirmed this occupation though a circular ephemeral hut structure is more indicative of the Mesilla Phase (AD 200/400 – 1000, 1750/1550 – 950 yBP). In sum this site, and others in the Salt Basin, indicated mobile Jornada Mogollon affiliated groups were utilizing the area but had little agricultural dependence (Miller and Kenmotsu 2004).

Rockart forms also changed during the period with the creation of pictographs defined as Big Bend Bold. Predominate motifs for this style are large-scale zoomorphs, anthropomorphic figures, and geometrics usually painted in all black with some being greenish black (Roberts 2010). Being either solid or bold-lined this style was possibly produced during the early Late Prehistoric Period though the presence of horse (*Equus caballus*) and cattle (*Bos taurus*) -like figures indicated production into the Historic Period (Roberts 2010).

Borrowing terminology from Central Texas to the east this study breaks the Late Prehistoric Period into two sub-periods: Initial Late Prehistoric and Terminal Late Prehistoric Periods (ex. Mauldin et al. 2012, Ricklis 1996). Both periods show use of the bow and arrow but other aspects of material culture differ. Here the Initial Late Prehistoric Period includes the Livermore and Castile Phases, though the latter initiated in the Late Archaic (Hamilton 2001). The Terminal Late Prehistoric Period included the agricultural peoples of the La Junta and Concepcion Phases as well as the synchronous Cielo Complex. This sub-period also coincided with the initiation of the Little Ice Age climate event (Esper et al. 2002).

3.2.5.1 Livermore Phase (AD 800 – 1200, 1150 – 450 yBP)

The earliest cultural construct for the eastern Trans-Pecos during the Late Prehistoric Era was the Livermore Phase (AD 800 – 1200, 1150 – 450 yBP). Originally defined by J. Charles Kelley (Kelley et al. 1940, Kelley 1957) this phase shows a continuation of Late Archaic subsistence practices by focusing on local, non-cultivated food resources and lack of ceramic use as well as production.

A hallmark of the Livermore Phase is the Livermore arrow point. Having a convex base, slender stem, shoulders that project at right angles, and concave lateral edges the Livermore point is quite distinct though it shows much stylistic variation (Mallouf 1990, 1999, 2013, Marmaduke 1978, Turner et al. 2011, Wulfkhule 1990). This arrow point also possesses a fairly discrete geographical range largely within the eastern Trans-Pecos, though some are found in the very northern portion of Coahuila, southeast in Val Verde County, Texas, northeast around Midland and Odessa, Texas, and north to the Guadalupe Mountains. The western extent of the range largely mirrors the western boundary of the eastern Trans-Pecos with occurrences limited to the Sierra Vieja as well as the Van Horn and Sierra Diablo Mountains (Mallouf 1990, 1999, 2013).

Other lithics associated with the Livermore Phase included the Toyah and Fresno arrow points as well as beveled knives (Kelley 1957, Kelley et al. 1940, Mallouf 1985). Recently Mallouf (2013c) formally described three more arrow points possibly contemporaneous with the Livermore Phase: Alazan, Diablo, and Means. However Mallouf (2013c) cautioned their inclusion with diagnostic artifacts of the Livermore Phase, primarily due to the lack of their presence in the Livermore Cache as well as artifact assemblages at Tall Rockshelter and Wolf Den Cave (41JD191).

Perhaps the most striking aspect of the Livermore Phase is the ritualistic caching behavior. Two large caches of arrow points have been described so far in the study area. The first, the Livermore Cache, was encountered in 1895 by T. A. Merrill and C. C. Janes atop Mount Livermore in the Davis Mountains (Janes 1930). This rock cairn-topped cache yielded over 1,500 artifacts and was comprised mostly of Livermore arrow points. The second cache, the John Z. and Exa Means Cache was discovered in 2002 in Jeff Davis County. Like the Livermore Cache the Means Cache was topped by a rock cairn, however this feature yielded over 1,250 whole and fragmentary arrow points. Livermore arrow points dominated the assemblage, but Means, Alazan and Diablo arrow points were also present (Mallouf 2009, 2013b). Other, possible cairn-topped caches which included Livermore points have been identified by Donny L.

Hamilton, Ph.D. at the Burnt Springs Site (41RV8) in modern Reeves County, Texas (Donny Hamilton, personal communication 2018).

Very little is also known regarding burial practices of the Livermore Phase. Two interments have been broadly described by Mallouf (1985) and included the Barrilla Draw Site (41RV5) and 41JD65. Both of these consisted of cairn and crevice burials in which artifacts such as Livermore and Livermore-like points were incorporated along with shell beads and bubble agate nodules (Donny Hamilton, personal communication 2018, Mallouf 1985)

Beyond the unique ritualistic behavior there has been a paucity of documentation concerning other aspect of lifeways among the Livermore Phase. Preliminary reports from Tall Rockshelter (Mallouf 2001) and Wolf Den Cave (Mallouf 2002, 2007) suggest pictographs were a part of their ritual behavior. The massive anthropomorphic pictographs from Tall Rockshelter have also been directly dated to 1280±80 yBP (AD 620 – 960) and is the only directly dated rockart imagery in the study area (Jensen et al. 2004).

In terms of cultural affiliation J. Charles Kelley suggested that the Livermore Phase may represent an incursion of hunter-gatherers from outside the study area, possibly from the Southern Great Plains (Kelley et al. 1940, Kelley 1952b, 1986). Mallouf (1990, 1999, 2013a) countered that this entity may have indigenous roots to the study area, of which his 2005 work indicated a mixing of Late Archaic Paisano and Late Prehistoric Livermore points in the central eastern Trans-Pecos and largely supports his hypothesis. Unfortunately, little else can be described of the Livermore Phase though any future research will lend much needed understanding to this unique cultural phenomenon.

3.2.5.2 Cielo Complex (AD 1250/1300 – 1680, 700/650 – 270 yBP)

Sometime between AD 1250 and 1300 the peoples of the Cielo Complex began occupying the eastern Trans-Pecos. Formally described by Mallouf (1985), this construct represents a unique hunting-gathering entity in terms of lithic tradition, mortuary practices, architecture, and social interaction.

One of the primary markers of the Cielo Complex is a unique stone tool tradition. Arrow points related to this entity are primarily Perdiz, though Toyah and Fresno are also encountered (Mallouf 1985, 1990, 1999, 2013a). Other lithics common to this complex included blade cores, prismatic blades, beveled knives, drills, unifacial end and side scrapers, pestles, manos, and notched net sinkers. In general the lithic toolkit mirrors that of the Toyah Phase primarily in Central and South Texas and termed the “Toyah Technocomplex” (Ricklis 1992). Other than lithics, specifically hunting toolkits, the Cielo Complex share little else with their pottery producing eastern neighbors.

Encampments of the Cielo Complex comprise two general types: task specific encampments and basecamps. Examples of task specific encampments include stone quarries, observation posts, hunting stations, and dietary resource collection and processing locales. Basecamps undoubtedly had many of the same activities undertaken within their bounds but possess more permanent and diverse architecture. Examples of this include stone-based wickiup rings (Figure 3.2), ramadas occasionally erected over pits, linear boulder alignments, and stone cairns (Mallouf 1985, 1990, 1999, 2013a). Additionally, these sites are located atop landforms, though within a given area are generally at mid-level elevations, with significant viewsheds. This systematic positioning is also one of the reasons for the term “Cielo Complex” with the Spanish word “*cielo*” meaning “sky” or “heaven” (Mallouf 1985).

A distinct hallmark of the Cielo Complex is permanent architecture in the form of stone-based wickiups (Mallouf 1985). These circular to oval shaped stone bases consist of cobbles and boulders stacked two to five courses tall with inner diameters of ~2.7 – 3.4 meters and entryway gaps (Mallouf 1999). Most basecamps include two to nine wickiup rings though some sites near the Rio Grande have fifty-plus wickiup rings and likely indicate occasional gathering of smaller bands. Within basecamps all wickiup rings open in the same direction, are spaced three to ten meters apart, and either loosely clustered or in linear arrangements (Mallouf 1990, 1999, 2013a). Based on the experimental reconstruction of one of these structures (Figure 3.2) at the Sundown Site (PCR205) and conversations with Samuel Cason, M.A. the use of stacked stone bases was likely due to the shallow sediments where basecamps are commonly encountered, making the excavation of postholes difficult if not impossible. Rather, this construction technique can solidly hold the surprisingly flexible ocotillo stalks utilized to construct the hypothesized superstructure (Cason and Schroeder 2016).

Figure 3.2. Hypothesized and reconstructed Cielo Complex stone-based wickiup at the Sun Down Site (PCR502), Presidio County, Texas.

Beyond the lithic artifacts previously described a few others are worth mentioning. Within Cielo Complex basecamps fragments of bone awls as well as rasps have been encountered. Unique jewelry was also present and included beads of turquoise, shell, stone, and *Olivella* shell (Mallouf 1990, 1999, 2013a).

Peoples of the Cielo Complex also included a unique burial tradition as exampled from two well-known internments within the study area. The Rough Run Burial from the Rough Run Site (41BS844) in Big Bend National Park included the extremities, cranium, clavicles, manubrium, first vertebra, and right first rib of an adult male. Based on the human remains present it is likely the burial was the result of a secondary internment (Colby and Steele 1995). Also found within the subterranean cairn atop the human remains were seventy-two Perdiz arrow points, one Harrell arrow point, and three pieces of debitage of which two show signs of utilization (Cloud 2002, 2013). Two radiocarbon dates from charcoal within the cairn dated the interment to between AD 1291 and 1681. Ultimately Cloud (2002, 2013) concluded that this individual's interment can be associated with the Cielo Complex.

Though outside of the immediate study area a second burial, the Las Hacienda Burial, is also attributed to the Cielo Complex. Located 10 miles south of Santa Elena Canyon this burial also consisted of a stone cairn atop human remains. Unfortunately, this internment was not professionally excavated but informants who looted the burial stated that a single individual was present in a shallow pit directly below the cairn, likely an adolescent. In total 194 arrow points, a kaolinite bead, and a drilled malachite pendant were recovered by artifact collectors with all artifacts being tightly clustered near the head of the individual. Of the arrow points 180 are Perdiz arrow points, one is a Toyah, two are Fresno, nine are basally notched and similar to Cienegas, Garza, and Soto points, and two are serrated side-notched points with no formal type. The Las Hacienda Burial represents the largest concentration of Perdiz points found within a single feature for the entirety of its range and, because of this, hint at a high social ranking for the individual which these were interred (Mallouf 1987).

In terms of cultural affiliation, the peoples which left physical evidence for the Cielo Complex are widely regarded as members of the historic Jumano peoples. This hunter-gatherer cultural group were described as long-distance travelers and traders and viewed by Arnn (2012a, 2012b) as the catalyst for the Toyah/Tejas Social Field. In 1535 Álvar Núñez Cabeza de Vaca potentially described this group as the "People of the Cows" who traded bison hides and dried meat for agricultural products throughout the winter at La Junta de los Rios but spent the remainder of the year on the plains to the north (Hickerson 1994, Kelley 1986, Kenmotsu 2001, Krieger 2002). The Jumano peoples figured prominently in several Spanish accounts, asking for aid and the establishment of presidios to fend off encroaching Athabascan speakers from the north as well as guiding *entradas* throughout modern day Texas (Kenmotsu 2001, Wade 2003). Members of the Jumanos also acted as information gatherers for the Spanish with the Jumano leader Juan Sabeata informing the Spanish of French activities in modern day East Texas as well as the Texas Coast between AD 1686 and 1688 (Hackett 1926, Kelley 1955).

However, Mallouf (1990, 1999, 2013a) presented four hypotheses for the cultures that make-up the Cielo Complex. These included that the Cielo Complex hunter-gatherers and Bravo Valley Aspect agriculturalists are of the same social and ethnic group, Cielo peoples were related to the agriculturalists of the La Junta area but led different subsistence patterns, both groups were not related but shared aspects of technology due to long-term symbiotic relationships, or that none of the groups which left behind these stone-based wickiups were ethnically related but did share many technologies. Regardless of ethnic affiliation more can be said about the inter-regional social networking of the Cielo Complex.

In particular the Cielo Complex were known to share a lithic tradtion of the Toyah Phase in Central Texas. Recent research by Arnn (2012a, 2012b) has defined the “Toyah/Tejas Social Field”, a network of ethnically unaffiliated hunter-gatherer and farming groups within the bounds of modern day Texas which shared regular contact and trade with one another.
Recent research from Walter (2015) indicated that extra-regional influences were greater than previously thought in the Terminal Late Prehistoric eastern Trans-Pecos though this was previously introduced by Rogers (1972). Indicators of this interaction sphere included intrusive pottery such as Chupadero Black-on-White at the Charles Burr Site (41BS1491), obsidian traced to Antelope Wells in New Mexico and El Paso Polychrome sherds at Rough Cut Rockshelter

(41BS1507), Wingate Black on Red and Toyah Phase Leon Plain at the White Springs Site (41PS1017), Rockport Black on Grey at the Jewel’s Number 2 Site (BIBE-1703) in Big Bend National Park, and a local brownware with Plains and Caddo attributes from the Fulcher Site (41BS1495). The presence of these exotic artifacts with Perdiz arrow points indicated contact with groups across prehistoric Texas and New Mexico, furthering evidence for the participation of eastern Trans-Pecos Terminal Late Prehistoric hunter-gatherers in the Toyah/Tejas Social Field (Walter 2015).

Other indicators of trade included the marine shell and turquoise mentioned previously. Currently it is believed that Cielo Complex groups acquired these items via trade with La Junta de los Rios peoples. This agricultural outpost is considered to be within the Casas Grandes Sphere of Influence and is described in more detail below (Kelley 1990, 2013; Mallouf 1990, 1999, 2013a).

3.2.5.3 Castile Phase (AD 200 – 1450, 1800 – 450 yBP)

The third material culture construct for the eastern Trans-Pecos includes that of the Castile Culture (AD 200 – 1450). This hunting and gathering group occupied the Rustler Hills and Great Gypsum Plain of Culberson and Reeves Counties. Spanning both the Late Archaic and Late Prehistoric periods, hallmarks for this group include unique burial traditions as well as distinctive basketry technology.

The basketry tradition of the Castile Phase includes two geographically unique forms, the Rustler Hills kiâhâ and Rustler Hills twined grass bags. Though burden baskets are present throughout the American Southwest and western Texas, those from the Rustler Hills only use a weaving technique where a cordage warp element fully encircles two cordage weft elements

(Hamilton 2001). Twined grass bags are unique artifacts found solely within the Rustler Hills at Caldwell Shelter No. 1 (41CU1), Shelby Brooks Cave, and Granado Cave. Constructed of a retted grass fiber warp and 2-ply *Yucca* spp. cordage weft, these items are noted as sturdy utilitarian wares as well as the beginning containers for infant burials (Hamilton 2001). Additionally, the Rustler Hills basketry assemblage includes one of the most complicated edge finish techniques in Texas as well as western North America. This is based on a fragment of plaited matting recovered from Shelby Brooks Cave (41CU7) as well as a second mat with the same execution at Granado Cave (Adovasio et al. 1975, Hamilton 2001).

Sandals from the Rustler Hills offer a stark technological difference from the surrounding areas as well. Whereas other regions utilized multiple types through time those from the Rustler Hills are a single type described as “two-warp fishtail scuffer toe” (Hamilton 2001:151). Dimensions indicate these were likely constructed for children with their construction being two warp bundles of unmodified soaptree yucca (*Yucca elata*) leaves tied at what would be the heel with the warp elements protruding past this and creating a fishtail appearance. The body of this sandal type is a weft bundle of unmodified soaptree yucca leaves.

A variety of tools have been recovered and associated with the Castile Phase which include hearth boards, bone awls, rabbit sticks, and gourd container fragments. Arrow fragments and sharpened hardwood arrow foreshafts have also been recovered from the Rustler Hills. The latter artifact type likely indicates that stone arrow points may not have been as readily used as in other areas. Stone tools include edge modified flakes, unifaces, drills, and a few projectile points (Dockall and Shafer 2001). From Granado Cave, one flake is comprised of Caballos novaculite which occurs around Marathon, Texas (Baker and Bowman 1918) and 13.8 percent of the debitage is basalt, the closest source of which is the Davis Mountains in the very southeast corner of Culberson County (Dockall and Shafer 2001). The presence of these raw materials indicated that the peoples of the Castile Phase either directly accessed these resources or came upon them via contact with outside groups.

Based on research by Sayles (1935), Jackson (1934a, 1934b, 1937), Tanner (1949), Ward (1992), and Hamilton (2001), one of the most striking behaviors of the Castile Phase are the burial goods associated with infants and children. These interments were typified by the remains being placed in Rustler Hills twined grass bags and/or wrapped in successive layers of matting, usually twined, and rabbitskin blankets. These bundles were then placed within Rustler Hills kiâhâs or had them broken/"killed" over them. In some instances, such as Burials 2 and 3 at Granado Cave (41CU8), coiled basketry vessels were placed atop and within the burial bundles. Burial 1 at Granado Cave also included musical instruments, including deer hoof tinklers and a rattlesnake-rattle rattle (Hamilton 2001). Uniquely the diverse grave goods dedicated to children and infants was not transferred to adults who were interred with a paucity of tools.

Other indications of outside contact include pottery, items of cotton (*Gossypium* spp.), and marine shell. Hamilton (2001) posited that ceramics were not produced within the Rustler Hills but rather were trade items obtained from groups to the north and west. Pottery recovered at Granado Cave which originated from the Casas Grandes area include Mata Red-on-Brown, Mata Red-on-Brown Textured, and Chihuahuan Brownware. Chupadero Black-on-White and Jornada Brownware indicate contact with groups in modern New Mexico. Several shell beads present within the Rustler Hills are from *Olivella* and a serpulid marine worm (*Protula superba*), both of which are found on the North American West Coast. Cotton lint, seeds, cordage, ropes, and a belt have all been encountered within the Rustler Hills and, as Hamilton (2001) hypothesized there is little likelihood these were grown within the vicinity of the site. Rather it is more likely these items were procured from agricultural groups to the west and north which the Castile Phase appear to have had much trade contact with.

Shifting from the hunter-gatherer to agricultural groups in the southern eastern Trans-Pecos two hypotheses have been presented for the adoption of agriculture within the study area. Both of these hypotheses will be briefly described below.

3.2.5.4 Bravo Valley Aspect

Beginning around AD 1200 Southwestern agricultural activities began expanding down the Rio Grande Valley (Kelley 1949). Regional archaeologists agree on this view though differ significantly on who was bringing these activities into the eastern Trans-Pecos. Kelley (1990, 2013) hypothesized that those who settled the river valley, specifically the La Junta de los Rios, were an El Paso Phase Jornada Mogollon colony. Counter to this Mallouf (1990, 1999, 2013a) proposes that the farmers at La Junta were instead local indigenous peoples who took on a bastardized form of the agricultural practices and village building from Jornada Mogollon and Casas Grandes groups. Further research by Cloud and Piehl (2008) and Piehl (2009) has lent credence to Mallouf's hypothesis for local adoption of cultural practices outside of the area based on human bone chemistry analyses. Specifically, these two studies note a lack of maize within the diet, probably contributing only 25% of the total diet. What follows are brief descriptions of the two Terminal Late Prehistoric Period phases associated with agriculture which occurred at La Junta de los Rios, the La Junta Phase and Concepcion Phase.

La Junta Phase (AD 1250 – 1450, 700 – 500 yBP) The first manifestation of agriculture and a sedentary lifestyle within the La Junta de los Rios was the La Junta Phase (AD 1250 – 1450, 700

– 500 yBP). Hallmarks of this phase are pithouses with jacal superstructures as well as the importation of ceramics from the west and northwest. In terms of cultural affiliation three hypotheses have been presented in the literature.

In total three types of structures are noted from La Junta Phase villages: unit pueblo room block, rectangular pithouse, and circular pithouse. The oldest structure at the Millington Site (41PS14) was a unit pueblo room block with five contiguous rooms arranged in an east-west orientation. This structure was unlike the other structures from the La Junta area in that the room block was originally on the surface and constructed of adobe walls. The finding of this structure led Kelley to hypothesize that the agricultural founders of the area were originally Jornada Mogollon, owing to the similarities between this structure and those in the western Trans-Pecos (Kelley and Kelley 1990).

The two other structural forms associated with the La Junta Phase include rectangular and circular pithouses. Unlike pithouses from the Jornada Mogollon, those at La Junta were quite deep (up to 2m) and possessed superstructures of jacal rather than adobe. Additionally rectangular pithouses were associated with residential activities while circular pithouses considered to be granaries or sweat houses (Kelley et al. 1940). These structures usually had well-made adobe floors with a single firepit. Similarities with Jornada Mogollon villages included altars on south facing walls and the linear arrangement of pithouses (Kelley and Kelley 1990).

Ceramics associated with the La Junta Phase are dominated by El Paso Polychrome and indicate strong trade relations with the Jornada Mogollon. Other styles encountered included Playas Red, Chupadero Black-on-White, and Chihuauhan polychromes. One very unique aspect of the La Junta Phase peoples are the reliance on imported ceramics wherein no pottery was produced locally (Cloud et al. 1994, Kelley et al. 1940). Other artifacts encountered at La Junta Phase sites included pestles, stone bowls, basin mutates, notched pebbles, and arrow points such as Toyah, Perdiz, Fresno, and Garza (Cloud et al. 1994, Miller and Kenmotsu 2004).

Burial traditions during the La Junta Phase are also different from the greater eastern Trans-Pecos. Usually individuals were interred beneath residential structure floors or middens in small pits, with the individual placed in a supine flexed position with few to no grave goods. Interred individuals were also oriented in a manner differentiated by sex, with males oriented with their heads directed north and females to the south (Piehl 2009). Markers for grave locations consisted of small stones, usually placed directly atop the interment but occasionally located on the edge of the burial pit (Piehl 2009).

In terms of subsistence patterns recent analyses have indicated that a maize-intensive diet was not practiced among La Junta Phase groups. Though maize did account for approximately twenty-five percent of the total diet, desert succulents likely contributed to the majority of the diet. Evidence for this is found in bone chemistry analyses as well as the presence of fire cracked rock middens within several of the village sites (ex. Kelley et al. 1940, Kelley and Kelley 1990, Cloud and Piehl 2008) indicating intensive processing of desert succulents. Work by Seebach (2007) suggested that La Junta Phase peoples may have been far ranging foragers while Cloud (2004) demonstrated that local procurement of wild foodstuffs also occurred. As such a more appropriate term for these part-time agriculturalists may be “farmagers” rather than “farmers” or “foragers”.

Currently it is unclear whether the first villagers at La Junta were from Jornada Mogollon colonizers (Kelley et al. 1940), locally indigenous peoples who adopted the lifestyle of their western neighbors, or Antelope Creek Phase affiliated peoples of the Texas Panhandle (Mallouf 1990, 1999, 2013a).

Concepcion Phase (AD 1500 – 1684, 450 – 266 yBP) Owing to the collapse of the Casas Grandes Sphere of Influence and abandonment of the Jornada Mogollon region, Kelley (1990, 2013) hypothesized that the La Junta colonizers abandoned the area briefly before communities were re-established around AD 1500. Mallouf (1990, 1999, 2013a) has hypothesized that in the intervening decades the La Junta Phase folk took-up a foraging lifestyle with the Cielo Complex, however data supporting this is slim. Ultimately it is beyond the scope of this work to understand the origins of the Concepcion Phase, though whatever the impetus the Concepcion Phase possessed different architectural and artifact manifestations than the preceding La Junta Phase.

One of the marked differences from the La Junta to Concepcion Phase is the lack of Southwestern ceramics and manufacture of local wares. Typical wares for this period include Chinati Plain, Chinati Filleted Rim, and Chinati Scored, as well as Capote Red-on-Brown, Capote Plain, and Paloma Red-on-Gray. One of the most unique wares is Patton Engraved, a sherd of which was found at the Loma Alta site (41PS15). This ceramic was produced among the Caddoan peoples of eastern Texas and indicates some form of contact between the two areas (Hickerson 1994, Kelley 1947, Kelley et al. 1940).

Architecture does not experience a significant change from the preceding La Junta Phase. Rectangular pithouses continued to be constructed, though these are substantially larger with approximate dimensions of 7.3 x 8.8 m with multiple firepits. The increase in size as well as increase in number of firepits led Kelley and Kelley (1990) to hypothesize that more than a single family would occupy each residential structure as compared to the preceding La Junta Phase.

Ultimately this phase included the first contact with the Spanish with Alvar Nunez Cabeza de Vaca, Andres Dorantes de Carranza, Alonso del Castillo Maldonado, and Esteban/Estevanico briefly visiting the La Junta area villages in AD 1535. Over the next 149 years the Concepcion Phase peoples only had intermittent contact with successive entradas travelling through the area until the establishment of Spanish missions during the Mendoza-Lopez expedition of 1683 (Kelley 1952b).

3.2.6 Historic Period (AD 1535 – Present, 415 yBP – Present)

The Historic Period marked substantial cultural changes within the Texas eastern Trans-Pecos. Continued contact as well as colonization by the Spanish allowed for a view into the historic native peoples of the area. The general trend during this period is the gradual demise and displacement of indigenous peoples from the area, removal of hunting-gathering subsistence patterns, and introduction of industry.

Regarding culture names, the peoples of the eastern Trans-Pecos were typically described within two categories: agriculturalists and hunter-gatherers. Agriculturalists were only encountered within the La Junta de los Rios area and broadly identified as Patarbueye. This single term does not reflect the ethnic diversity of the La Junta agriculturalists with ten distinct groups named by the Trasvina-Retis entrada of 1714 and the 1747 Ydoiaga entrada (Kenmotsu 1994). These groups included the Conejo, Cholome, Posalme, Tecolote, Pulique, Pescado, Concho, Mesquite, Tapacolme, and Cacalote (Kenmotsu 1994). Hunting and gathering groups encountered throughout the early portion of the Historic Period included the Chisos whose homeland was southeast of the La Junta area and the Cibolo originally from the mountains east of La Junta. One foraging group frequently encountered in Spanish records of both the eastern Trans-Pecos and the remainder of Texas were the Jumano, whose homeland lay between the Pecos and Conchos Rivers of western Texas. Still another, small group encountered by the Mendoza expedition in 1684 along the Pecos River in current Crockett County was the Gediondo (Wade 2003).

Beginning in the early 1600s Plains Apachean groups began arriving within the study area. Until this time groups such as the Jumano attempted to limit their contact with the Spanish, though continued fighting with the new Athabascan speakers led the Jumano and others to convince the Spanish into establishing *presidios* at La Junta and near the modern day city of San Angelo, Texas. Ultimately these efforts, largely undertaken by the Jumano leader Juan Sabeata, proved futile as the term “Jumano” is replaced by terms alluding to a combined Apache-Jumano group in 1720. By the end of the eighteenth century the term Jumano is never mentioned again in Spanish documents (Kenmotsu 1994, Kenmotsu and Wade 2002).

After this Spanish-Apache relations improved, and Spanish followed by Mexican colonists began taking up residence in the La Junta area. Continued colonization by Euroamericans began in the mid-1800s with the final Apache groups being forcibly removed during the 1880s. At this point the hunting and gathering subsistence pattern and lifeway that had been utilized for millennia within the study area was removed. After this all groups who would come to call this area home would rely upon agricultural pursuits as well as the import of various goods, a trend that continues to today.

3.3 Overview of Eastern Trans-Pecos Archaeology

The archaeological record of the eastern Trans-Pecos is both diverse but little studied, specifically in terms of large-scale excavations. The year 1895 marked the first significant archaeological find in the study area with the recovery of the Livermore Cache in the Davis Mountains. Between then and the time of this writing three waves of archaeological investigations occurred and have outlined a continued use of a hunting and gathering subsistence pattern from the time of initial human occupation to the removal of native peoples in the mid-Nineteenth Century.

In general, the archaeological record notes a continually increasing reliance on desert succulents beginning in the Late Paleoindian. Through time differences in lithic hunting tools, settlement patterns, caching behavior, and fiber technologies differentiated the Early, Middle, and Late Archaic periods. Mountain top-focused ritualism also became prominent throughout the Archaic periods and culminated in the Late Prehistoric Period.

This last period of prehistory also incorporated the highest diversity of archaeological cultures known in the study area. Three hunting-gathering cultures are recognized and included the Livermore Phase, Cielo Complex, and Castile Phase, though the Castile Phase was noted to have originated in the Late Archaic. The Late Prehistoric Period also saw the adoption of agriculture and construction of permanent villages as evidenced by the La Junta and Concepcion Phases of the La Junta de los Rios District. It was this sub-region which also saw the highest relative amount of contact with the Spanish, whose reports described not only ethnic identifications but also technologies, architecture, and plant foodways as presented in the following chapter.

Another aspect of behavior during the Terminal Late Prehistoric was the high degree of interactions between the eastern Trans-Pecos and neighboring areas to the west, north, and east. Exotic pottery from east Texas, the Texas Gulf Coast, northern Mexico, and the American Southwest, obsidian sources from modern day New Mexico, marine shell from the Pacific Ocean, and turquoise items from as yet unprovenanced locales serve as markers for the inter-connected nature of peoples during the Terminal Late Prehistoric. Shared flaked lithic technologies between the Cielo Complex and the Toyah Phase also signal a high level of contact between said archaeological groups. Additionally, these items provide physical evidence of participation in the Toyah/Tejas Social Field and suggest trade economies focused on the procurement of hunted products for grown and manufactured goods. Direct "membership" of this alliance may also be presented in the Perdiz points utilized by the Cielo Complex, La Junta Phase, and early Concepcion Phase as identified by Arnn (2012a, 2012b). A possible indicator of this was also noted from the Castile Phase occupants of Granado Cave wherein hickory/pecan (*Carya* spp.) pollen was recovered from human coprolites (Hamilton 2001). Uniquely this genus is likely not from vicinity of the site and possibly obtained via trade with groups from more mesic locales to the east, though this hypothesis is more detailed in Chapter 7 (pg. 230).

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CHAPTER IV

EARLY HISTORIC FOODS AND FORAGING IN THE EASTERN TRANS-PECOS

This chapter will describe the native groups known to have called the study area home from the first Spaniard to describe the area to the detailed ethnographies of the historic Mescalero Apache. Rather than serve as a synthesis of cultural and ethnic descriptions within the study area the following information will focus solely on groups for which ethnobiological relevant information was recorded. It should be noted that much of the information presented originated from the accounts of Spanish travelers and explorers; as such, the data which was gathered is fairly course. Because of this, data regarding plant use gathered from the Spanish accounts will be presented first and then the more detailed ethnographic data from the Mescalero Apache will be presented second. The chapter will conclude with a discussion and model of the recorded and inferred mobility patterns as well as foraging practices of historic native peoples within the eastern Trans-Pecos region of Texas.

Information gained through the investigation of historic and ethnographic accounts will also provide baseline and comparative data for the research questions posited in Chapter 1, which included:

4. What plant foods were used by Terminal Late Prehistoric peoples of the eastern Trans-Pecos?
5. Why were these foods consumed and how much did they contribute to diet during this archaeological period?
6. How were these foods accessed and where were they located on a given landscape?

Via comparison of wild and cultivated plant foods of ethnic groups which bracketed the Terminal Late Prehistoric and Historic periods, an inventory of botanical dietary taxa can be indexed and staples identified. Seasonal preference as well as spatial and inter-annual dependability will also be described, primarily from Mescalero Apache ethnographic data. Said ethnographic data can then contribute to the final question in terms of how floral foodstuffs were accessed based upon mobility strategies.

4.1 Native Peoples and Food Resources of the Historic Period

Five encounters and expeditions by the Spanish from A.D. 1535 – 1748 are considered within this analysis. These expeditions included:

- Narváez Expedition- Survivors, 1535 (Krieger 2001)
- Rodríguez-Chamuscado, 1581 (Bolton 1916)
- Espejo, 1582-1583 (Bolton 1916, Hammond and Rey 1929)
- Mendoza-Lopez, 1683 (Bolton 1916, Wade 2003)
- Ydoiaga, 1747-1748 (Madrid 1992)

It should be noted that this area was in a state of considerable cultural flux from the 1500 to 1700s, largely a result of migrating Apachean groups from the north, contraction of European diseases, colonization efforts by the Spanish government, mission building activities by the Holy Roman Catholic Church, and slave raids (Arnn 2012, Kemotsu 1994, 2001). All of the Spanish accounts refer to the La Junta de los Rios area in greater detail compared to the remainder of the study area, primarily because of the proclivity for using that area to then explore the greater American Southwest. Because of this the following discussion will first focus on these La Junta groups before shifting to the Jumano, which were the only foragers that historic ethnobiological information was recorded.

4.1.1 Plant Foodways of the La Junta de los Rios Farmers

The total number of distinct cultures within the La Junta de los Rios cultures from a single one from the account by Cabeza de Vaca (Krieger 2001) to at least five (Madrid 1992). Of these only six of the groups have specific descriptions for plant use. In two other instances the Spanish descriptions serve as more a generalized description of plant foodways within the La Junta area, specifically in the descriptions provided by Álvar Núñez de Cabeza de Vaca (Krieger 2001) and Diego Perez de Luxán (Hammond and Rey 1929) in his account of the Espejo expedition (Table 4.1).

Year (A.D.)	**Expedition**	**Account Author**	**Source**
1535	Narváez Expedition- Survivors	Álvar Núñez de Cabeza de Vaca	Krieger (2001)
1581	Rodriguez-Chamuscado	Pedro de Bustamante	Bolton (1916)
		Hernando Gallegos	Bolton (1916)
1582, 1583	Espejo	Antonio de Espejo	Bolton (1916)
		Diego Perez de Luxán	Hammond and Rey (1929)
1683	Mendoza-Lopez	Juan Domínguez de Mendoza	Bolton (1916), Wade (2003)
1747, 1748	Ydoiaga	Joseph de Ydoiaga	Madrid (1992)

Table 4.1. Expeditions, recorders, year, and sources of five Spanish expeditions in the eastern Trans-Pecos.

Likely one of the southern-most La Junta farming groups on the Rio Conchos, the Pazaguate were described by Antonio de Espejo, organizer and leader of the Espejo expedition, as utilizing maize (*Zea mays*), gourds (*Laegenaria* spp.), Castilian melons, watermelons, and lechuguilla (*Agave lechuguilla*) in November of 1582. Here it can be also be assumed that the Pazaguate utilized a mixed subsistence pattern, relying on self-raised crops as well as wild plant foods, specifically lechuguilla. Further downstream of the Rio Conchos another group was encountered and known as the Jobosos who consumed the same plants as the Pazagautes (Bolton 1916).

In the Espejo account, at the confluence of the Rio Conchos and Rio Grande the members of the Espejo expedition encountered the Xumarias which lived in settled pueblos and had beans (*Phaseolus vulgaris*), maize, and gourds. The name of this group has been questioned by many scholars (ex. Kenmotsu 1994), but agree this name was associated with the Jumano later encountered by the expedition on the return through La Junta. It is likely Espejo confused the names due to him writing his account after the return of the expedition party (Bolton 1916, Kenmotsu 1994). Because of this the account by Diego Perez de Luxán, who kept a daily journal, is considered more accurate and explored below.

When arriving at the La Junta de los Rios, Luxán identified the settled Otomoaco who consumed maize, calabashes, beans, and mescal. Additionally, this group is noted as travelling up to thirty leagues (203.52 km) to hunt bison (*Bison bison*) primarily for their meat and hides (Hammond and Rey 1929).

Four days later Luxán identified the Abriache as living at the actual confluence of the two rivers and, upon arriving at one of the Abriache pueblos, were presented with an assortment of items, including beans and maize. Luxán makes mention of other vegetables being a part of the Abriache diet though discrete identifications are not detailed (Hammond and Rey 1929). Later in August of 1583, on their return route, the Espejo expedition briefly stopped at the Abriache occupied Pueblo of San Bernaldino and were given beans, ears of green corn, raw and roasted calabashes, pods of screwbean mesquite (*Prosopis pubescens*), as well as various types of fish (Hammond and Rey 1929). Considering the timing of this event (i.e. late summer) it is in the view of this researcher that the green corn identified was not a variety of green kernel corn but rather fresh corn akin to the sweet corn consumed in many locales today.

A third group with documented plant foods was the Julimes. The account by Juan Domínguez de Mendoza of the Mendoza-Lopez expedition in 1583 noted wheat (*Triticum* spp.) and maize being raised by these peoples, indicating that Old World crops had entered the study area by this time (Bolton 1916, Wade 2003).

The final five groups for which botanical diet composition are briefly described within the La Junta area come from the 1747 expedition of Ydoiaga to the confluence of the Rio Grande and Rio Conchos. Domesticated plants dominated the recorded taxa with the Puliques, Pescados, and Cibolos/Sibolos of Pueblo de los Puliques making plantings of pumpkins as well as maize. At the Pueblo of San Cristobal wheat, maize, and *tunas* of prickly pear (*Opuntia* spp.) were identified as foods, as was *atole* made from unidentified plant seeds. It is also from the pueblo that inter-cultural trade is noted, specifically that when a surplus of crops was grown it was possible to trade with the foraging Apache for tanned deer hides (Madrid 1992). Near the Pueblo of El Mesquite, small fields of pumpkins, corn, and other unidentified vegetables were planted by the Conejos/Conexos and Cholomes inhabitants of the pueblo (Madrid 1992).

Beyond this little else can be said regarding cultural group specific plant diet, though three accounts from two Spanish visits to La Junta should be mentioned. Both of these described plant foods of the La Junta area as a whole rather than a given entity. In 1535 Álvar Núñez de Cabeza de Vaca identified the People of the Cows as inhabitants of the La Junta area. The five Spanish visitors consumed and/or were given cultigens including beans, calabashes, maize, and dried gourds to be used as canteens. While in the pueblos of the La Junta District the locals identified and prepared for them the only edible plant available on the next leg of the journey up the Rio Grande, a fruit called "*chacan*", which was processed with two stones and considered inedible by the Spaniard as it "cannot be eaten because of its roughness and dryness" (Krieger 2001, pg. 223)."

Describing the La Junta rancherías/pubelos as a whole, the Luxán account of the Espejo expedition indicated a large feast was held in honor of the returning explorers. It was during this reception the Spanish received raw as well as cooked calabashes, whole ears of green corn (or fresh, sweet corn), as well as catfish.

The final, district level food plants mentioned in historic texts comes from the Ydoiaga visit to La Junta. Though he does not identify a specific group or pueblo, Ydoiaga is informed about a mountain range referred to as the *Sierra Rica*. It was given this native name "by the Indians, meaning that there are *piñones* [piñon nuts], turkeys, javelinas, many tunas, and *mescal*" (Madrid 1992, pg. 59) to be found within the mountain range southwest of the La Junta area. Though it is not explicitly stated whether or not the plants mentioned were consumed, all can be consumed and as such are considered here a part of the La Junta District diet.

In total the Spanish description indicate a broad spectrum plant diet for the inhabitants of the La Junta de los Rios area. Of the plant foods described eight are cultivated (maize, beans, and members of the genus *Cucurbita*). Five gathered plant taxa are also described and include mescal as well as lechuguilla, prickly pear cactus, honey mesquite, screwbean mesquite, and piñon. This combination of plant foods suggested that despite being farmers and large portion of the diet included wild foods.

4.1.2 Botanical Diet of the Jumano

The Jumano were a highly nomadic hunting, gathering, trading, and news sharing group frequently mentioned in Spanish accounts from the 1500s (ex. Arnn 2012, Hinkerson 1994, Kelley 1982, Kenmotsu 1994, 2001). Though their homeland is considered to have been between the Pecos and Conchos Rivers of western Texas a significant portion of the Texas Trans-Pecos is considered to have been within their larger domain (Arnn 2012, Hinkerson 1994, Kenmotsu 1994, 2001). The account by Luxán described the only reference to plant diet within the study area while Juan Domínguez de Mendoza of the Mendoza-Lopez expedition provides reference to plant diet in the Jumano homeland.

On their return from the pueblos of modern day New Mexico, the members of the 1582-1583 Espejo expedition happened upon Jumano individuals near what is now Pecos, Texas (Bolton 1916, Kelley 1982). At this time the Espejo expedition were attempting to follow the Pecos River to its confluence with the Rio Grande thinking the juncture would place them near La Junta de los Rios. Being familiar with the region the Jumano convinced the expedition members that a much faster route should be taken south through the Davis Mountains, primarily by following Toyah Creek to its headwaters and then south beyond that (Kelley 1982).

On August 8, 1583 likely moving up Toyah Creek “We found many Jumana [Jumano] people from the ranchería of the people who were guiding us. They were on their way to the river to the mesquite trees. We stopped on this stream where the ranchería was situated.” (Hammond and Rey 1929, pg. 124). Given the date it is likely this entry by Luxán is referring to a logistical group of the Jumano travelling to harvest mesquite (likely western honey mesquite [*Prosopis glandulosa*]) pods along the banks of the Pecos River.

The second mention of Jumano diet was three days later on August 11, 1583 where another Jumano ranchería, probably within the Davis Mountains, received the Espejo expedition. At this location the Spaniards were given raw and roasted calabashes as well as prickly pear *tunas* (Bolton 1916).

During the Rodriguez-Mendoza expedition one hundred years later a few more taxa are mentioned by to have been consumed, at least by the Spaniards of the group but likely all members of the party. Reaching the Middle Concho River of west central Texas on February 2, 1684 the group was relieved to find tree nuts, likely pecan trees (*Carya illinoisensis*). Between nine and ten days later Juan Domínguez de Mendoza lists edible tubers, "*camoyes*", as being present though no attempt has been made at a taxonomic identification for these (Wade 2003). Despite lying outside of the study area, this account provides some supplementary information regarding plant use of these peoples during the early Historic period.

Based on these three descriptions it can be noted that the plant diet of the Jumano peoples was primarily wild, gathered foods. At this point it is not possible to determine if the calabashes to which Luxán mentions are wild gourds (ex. buffalo gourd [*Cucurbita foetidissima*]) or a domesticated squash species such as *Cucurbita moschata* or *C. mixta*. If these were domesticates it is also not mentioned whether these were grown by the Jumano or if they were a product traded for. As such this researcher only considers their identification at the genus level and not at the species. Finally, the last entry, regarding likely pecan nuts and wild tubers, indicates the ability for Jumano groups to forage in the winter months, at least when in their homeland.

4.1.3 Mescalero Apache Plant Diet

Owing to the advent of ethnographic fieldwork the plant diet of the Mescalero Apache, formerly of western Texas and southern New Mexico, has been described in greater detail than other historic inhabitants of the study area. Focusing on the publications by Castetter and Opler (1936) and Basehart (1974), the general floral diet of this historic group will be described below. For clarity the four most important plant taxa for diet will be described first, then the remaining taxa described on a season by season basis. Here spring is defined as the months of March, April, May, summer as June, July, August, fall as September, October, November, and winter December, January, and February. It should be noted that the naming conventions for the following taxa have been updated, when necessary, to reflect contemporary taxonomic nomenclature.

The most important plant utilized by the Mescalero Apache was the mescal plant (*Agave parryi*) and was also the plant from which the Mescalero Apache were given their name by other groups (Castetter and Opler 1936). Despite having a limited distribution to the southern reaches of their territory (Basehart 1974), the caudexes of these plants were baked in earth ovens and then consumed after baking and either pounded and immediately consumed or dried for future use (Castetter and Opler 1936). Though this plant could be gathered throughout the year, spring and fall were considered the main harvesting seasons with the former preferred due to the higher moisture content in the plants (Basehart 1974). Mescal was also the most dependable, in terms of productivity, dietary plant for the Mescalero and possessed the highest storage capabilities (Basehart 1974).

Second in importance, and also having a high storage potential, were the processed fruits of banana yucca (*Yucca baccata*), also referred to as *datil*. Ripening in the summer within the foothills of the Mescalero Apache range, the fruits of banana yucca were noted as having variations in productivity but evenly distributed across the Mescalero's range (Basehart 1974). Processing steps for this plant including roasting of whole fruits, removal of seeds, grinding of pulp, and then the forming of cakes, all by women (Basehart 1974, Castetter and Opler 1936).

Both mesquite pods and piñon nuts were gathered in the fall, with the latter primarily collected in October. Like the banana yucca fruits the productivity of both had annual fluctuations in productivity while mesquite plants had a more limited geographic distribution (Basehart 1974).

Switching to plant taxa grouped in a seasonal collection and processing time, mescal received the highest emphasis compared to other taxa. The plant bases of cattail (*Typha latifolia*) and Fendler's flatsedge (*Cyperus fendlerianus*) were gathered and either eaten as-is or cooked with meat (Castetter and Opler 1936). Caudexes of sotol (*Dasylirion wheeleri*) were gathered and processed like mescal, though this plant was considered inferior to mescal as large portions of the caudex were inedible (Caster and Opler 1936). The flowers of banana yucca and soaptree yucca (*Yucca elata*) were boiled and eaten, though the latter was preferred (Castetter and Bell 1936). Flower spikes of mescal, sacahuista (*Nolina microcarpa*), and soapweed yucca (*Yucca glauca*) were all collected upon formation and then either eaten raw, roasted or boiled. Once flower bud development initiated on these same taxa the spikes would be peeled, cut into smaller pieces, boiled, dried, then stored for future use. Finally, the stem/trunk of soaptree yucca would be harvested, pit baked, broken into pieces, and then softened with water before consuming. This portion of the plant was utilized from the middle of March until the end of the summer. Greens also became of importance during the summer with nine taxa either processed via boiling or consumed without. These included the introduced Mediterranean amaranth (*Amaranthus* *graecizans*), purslane (*Portulaca oleracea*), pigweed (*Amaranthus retroflexus*), lamb's quarters (*Chenopodium alba*), wood sorrel (*Oxalis violacea*), fetid marigold (*Dysodia papposa*), shepherd's purse (*Capsella bursa-pastoris*), and osha (*Ligusticum porteri*).

Summer saw an expansion of the plant part of the diet for the Mescalero Apache compared to the spring. Juniper berries from one-seeded juniper (*Juniperus monosperma*) were roasted and used in gravies while those of alligator juniper (*Juniperus deppeana*) were eaten fresh or roasted and ground with the onset of fruit ripening in July. Sumac berries from three-leaf sumac (*Rhus trilobata*) and littleleaf sumac (*R. microphylla*) were used from midsummer into the fall primarily to make preserves. The fruits of the cacti genus *Echinocereus* as well as *Neomammillaria* were also heavily utilized during this season. Fruits of white evening primrose (*Oenothera albicaulis*), lavender-leaf primrose (*Calylophus lavandulifolia*), and balloonbush (*Epixiphium wislizeni*) were either eaten raw or cooked and then consumed. Black chokecherries (*Arronia melanocarpa*) were also harvested in the summer and eaten or dried, ground, made into cakes, and then reconstituted as a jelly for the winter. The flowers of New Mexico locust (*Robinia neomexicana*) were gathered and boiled, when in abundance, and occasionally stored. Wild potato (*Solanum jamesii*) would also be gathered at ate the end of summer, in August, and boiled without peeling.

Fall plant collection focused on mesquite, though the tunas of prickly pear were also widely collected upon ripening in September (Basehart 1974). The small seeds of Mediterranean amaranth, pigweed, common sunflower (*Helianthus annuus*), prairie sunflower (*H. petiolaris*), fetid marigold, and shepherd's purse were commonly collected. Less frequently seeds from littlepod false flax (*Camelina microcarpa*), tansy mustard (*Sophia incise*), and pale thistle (*Cirsium pallidum*) were also taken. The reproductive parts of sweet vetch (*Vicia pulchella*) and wild pea (*Lathyrus leucanthus*) further expanded the forb component of diet. Grass seeds from the *Muhlenbergia* genus, sand dropseed (*Sporobolus cryptandrus*), bulb panicgrass (*Panicum bulbosum*), and vine mesquite (*Panicum obtusum*) contributed to the edible seeds.

Besides piñon nuts, usually gathered in October, and mesquite, other trees utilized for food included screwbean mesquite, walnuts (*Juglans major*), New Mexico locusts, grapes (*Vitus arizonica*), as well as acorns from grey oak (*Quercus grisea*) and Gambell's oak (*Q. gambelli*). The fruits of three shrub taxa also matured in fall, which included red barberry (*Berberis haematocarpa*), Wood's rose (*Rosa woodsii* var. *woodsii*), and netleaf hackberry (*Celtis reticulata*).

Based on these ethnographic accounts it is noted that with the onset of winter women's collection activities ceased though two genera, *Agave* and *Allium*, could be collected in any season. Though Basehart (1974) gives physical descriptions of three wild onion "types" no specific taxonomic identifications are presented in the text and no identification is attempted here.

In summation an annual round with a Mescalero Apache plant collector could include fifty-two different species and plant genera. Though several of these had only a single use, especially with nut mast and small seeds, some taxa presented multiple uses throughout the year. Of the fifty-two described above those of the genus *Yucca* stand-out with the parts of the plants to be utilized, which included the fruits, flowers, flower spikes, and trunks.

One trend noted which stands when comparing the historic and ethnographic accounts is a distinct overlap between the La Juntan and Jumano wild foods and those of the Mescalero Apache. The Spanish accounts list three of the primary plant foods outlined by Basehart (1974), which included mescal, mesquite, and piñon. It should be noted here that the Spanish accounts never occur during the spring season and may be the reason the pods of banana yucca are not mentioned in the lists of plant foods. Still, the fact that the Spanish accounts only mention the three most important plant foods of the Mescalero Apache, despite not having an entrenched regional presence until the 1600s is unlikely due to happenstance. Rather, it is in the opinion of this researcher that the early Historic native peoples of the eastern Trans-Pecos possessed a plant diet as varied and seasonally driven as that of the historic Mescalero Apache due to a shared environment in as well as absorption of native cultures, such as the Jumano, and their foodways in the early historic period (Riggs 2014).

4.2 Ethnohistoric Subsistence Patterns

Much like the differences in specificity of the ethnographic versus explorer accounts regarding plant use, little is known about subsistence patterns and annual ranges of the eastern Trans-Pecos native peoples compared to the Mescalero Apache. What follows is a discussion of the known subsistence patterns, first describing those from the Spanish accounts, then of the Mescalero Apache.

4.2.1 La Junta District Subsistence Patterns

Subsistence pattern data from for the historic La Junta District is poorly known. The first Spanish account by Cabeza de Vaca indicated a settlement within the La Junta District was abandoned for some part of the year to hunt bison, though the specific season is not mentioned (Krieger 2001). Other Spanish accounts suggest that the La Junta people themselves spent a portion of the year hunting bison north of the La Junta District, or at least bison hunting was an option (Hammond and Rey 1929, Madrid 1992).

From the Espejo expedition hides of bison and deer are frequently mentioned while in the company of the Otomoacos in the area. Additionally, Luxán states that the bison hides were tanned by villagers and that bison are hunted about thirty leagues (203.52 km) from the La Junta area (Hammond and Rey 1929). Upstream from La Junta along the Rio Grande the same hides are also described as are items made of cotton (*Gossypium* spp.) and brightly colored feathers, indicating an economy with some trade emphasis (Bolton 1916, Hammond and Rey 1929). Fishing was also an important food producing activity with Luxán stating the various types of fish given to the returning expedition upon their arrival in August of 1583 (Hammond and Rey 1929).

Foraging and trading activities are not described again until the arrival of Ydoiaga in November of 1747. While visiting Pueblo de los Puliques, which consisted of Puliques, Sibolos, and Pescados, Ydoiaga was informed about a water source 20 leagues (135.68 km) from the pueblo which was encountered while hunting deer. Other gathered foods were also described at this pueblo, or at least their gathering place: *Sierra Rica*, which was southwest of the pueblo and included javelina, turkey, prickly pear tunas, mescal, and piñon nuts. Additional economic information related to trade is shared with him at this time. Specifically, Apache individuals would visit the pueblo at an unspecified time of year to trade tanned deer hides for rawhide horse bridles, tamed horses, maize, as well as beans. Trade with Apache groups was also mentioned on December 2, 1747 while visiting the Pueblo of San Christobal, where Ydoiaga was informed that when a good farming year was had the pueblo inhabitants would have a year’s worth of food supplies in addition to a surplus for trading hides.

It is also worth a brief mention here of the farming practices related to the La Junta District, with the best source being that of Ydoiaga. Briefly, most fields were located atop sandbars within the Rio Grande and Rio Conchos and relied upon intermittent flooding for irrigation and known as *humedades* (Madrid 1996). However, this field location made farming quite risky and prone to loss from floods. Other field locations include classic dryland plantings, termed a *labor*, which relied solely upon precipitation and *temporalis* which divert water from arroyo mouths for irrigation (Madrid 1992, 1996). Ydoiaga also briefly mentions the number of harvests each year for maize, usually one or two. Harvest was also dictated by geography with the pueblos upstream of the confluence requiring two crops per growing season as a single crop would not have a high enough yield to sustain the inhabitants for the remainder of the year (Madrid 1992).

Based on this it can be generally assumed that the peoples of the La Junta District possessed a mixed subsistence pattern, relying on both cultivated and wild plants to sustain themselves throughout the year. Though maize appears to have been of primary importance, wheat, calabashes, and beans also contributed to the farmed plants. No mention is made to gendered subsistence activities, timing of wild plant gathering or hunting, nor the logistics required to intercept and gather these foods. In general, economic activities suggest the peoples of La Junta were involved in far reaching trade networks, as evidenced by the cotton goods and likely parrot feathers seen during the Espejo expedition (Bolton 1916, Hammond and Rey 1929). Trade was also important during the 1700s with Apache groups, though transactions focused on exchange of the farmed La Junta foods and other durable goods for buckskins provided by the Apache. In summation the historic peoples of La Junta had a broad diet comprised of both wild and farmed plants, fish, wild game, and participated in inter-regional scale trade networks though durable goods were the primary gain from this activity.

4.2.2 Jumano Subsistence Patterns

Turning now to the pre-Apachean hunting and gathering groups, slightly more is known about their subsistence patterns though much has also been lost to time. The subsistence pattern and economy of the Jumano is largely considered to be hunting and gathering with some use of fish (Arnn 2012, Hicherson 1994, Kelley 1986, Kenmotsu 1994).

Subsistence activities for the Jumano were first reported on August 7, 1583 when the Espejo expedition happened upon three Jumano hunters on the banks of the Pecos River, though the sought after game is not mentioned. On August 8, 1583 the same expedition was also presented with fish, likely caught in Toyah Creek or surrounding *cienegas*, as well as passing a group of Jumano travelling to the Pecos River likely to gather mesquite pods (Hammond and Rey 1929).

During the Mendoza-Lopez expedition deer were a focus of hunting activities by the Jumano and the expedition party while travelling through the mountains of central Trans-Pecos, Texas (Bolton 1916, Wade 2003). A unique hunting event occurred on December 29, 1683 when a surround hunt was organized by the Jumano to provide meat for the travelling party. Hunting again is mentioned on January 11, 1684 in the vicinity of modern Fort Stockton, Texas where three bison bulls were killed and provided enough meat for all members of the expedition.

Outside of the Trans-Pecos, but within the Jumano homeland, the Juan Domínguez de Mendoza account states that mast producing plants were gathered, for which Wade (2003) suggests that two species may have been used though pecan is most likely. Though not explicitly stated as consumed Mendoza also indicates a tuber of some sort could also be eaten. While along the Middle Concho River fish, turkeys, and bison were also mentioned though only the last was readily identified as an immediate food source.

This location along the Middle Concho River is likely the location the Jumano leader Juan Sabeata mentioned in a previous interview with the Spanish in modern day El Paso, Texas. During his request for the Spanish protection from the south-pushing Apache, Sabeata lists some thirty-six groups besides the Jumano which gather nuts at this location (Wade 2003). In several Spanish accounts the Jumano are mentioned being with many other groups in their travels, with the best example from the Mendoza-Lopez Expedition where eighteen groups (Ororosos, Beitonijures, Achubales, Cujals, Toremes, Gediondos, Siacuchas, Suajos, Isuchos, Cujacos, Caulas, Hinehis, Ylames, Cunquebacos, Quitacas, Quicuchuabes, Los que Hasen arcos, and Hanasines) were listed in January, 1584 (Wade 2003). Some researchers believe this to be evidence of landscape sharing wherein outside groups allied with the Jumano would have access to food resources during difficult times in reciprocation for the same gesture by the Jumano. Arnn (2012) postulated this means of buffering against environmental stresses was key to the success of the Jumano, in addition to their far-ranging trading and news sharing activities which allowed access to otherwise closed landscapes surrounding their homeland.

Still other researchers, specifically Kelley (1986), hypothesized that trade would have directly contributed to the diet of the Jumano. Because the Jumano homeland was centrally located between agricultural groups, tanned bison and deer hides could have been used to trade for consumables (such as maize) with agriculturalists in the Texas Trans-Pecos, eastern New Mexico, and east Texas. Other goods possibly traded for included pottery, raw materials for bows, turquoise, marine shell, copper bells, and cotton items. As the Spanish expanded north other items potentially included were horses, cloth, and metal implements (Kelley 1986). It should be noted though that no Spanish account specifically states the items traded, let alone if those directly contributed to the diet of the Jumano.

4.2.3 Mescalero Apache Subsistence Patterns

More specifics are known about the hunting and gathering activities of the Mescalero Apache thanks largely to the work of Basehart (1974). In general, Basehart (1974) noted there was a somewhat equal emphasis on hunting and gathering for these peoples, though plant collecting contributed to the bulk of the diet. Additionally, each activity was largely gendered with women performing the plant collecting while men were the active hunters, though children in general are documented as collecting specific plants. Basehart (1974) also states that all moves, whether logistical or residential (Binford 1986) required the presence of water to maintain a camp indicating a practice of tethered nomadism (Taylor 1964). Because the preceding discussions included both the hunting and gathering activities for the various groups the same themes will be discussed below, first with men's hunting activities, then women's gathering practices, and followed by the inter-group interactions recorded between Apache groups and the La Junta de los Rios area and others.

Basehart (1974) reports that Mescalero Apache hunting focused on three primary taxa: pronghorn antelope, mule deer, and bison. All were hunted in similar fashion by either chance encounter, stalking, surrounds, or relay while horseback, with the hunting done only by men. Another overarching practice was butchering wherein the hunter to take the animal could not possess the hides nor could participate in the butchering of his kill. Rather, the hide usually went to the first visitor and his companions divided the meat between the hunting party members. Group mobility for these activities were always residential moves with entire families being included, though moves for bison needed much preparation and could take a month to complete the actual movement.

From a logistical standpoint women's resources were the complete opposite and used a logistical movement rather than a residential one. In general, gathering parties consisted of four to ten women with a few men to assist with camp duties, provide hunted meat, and protection. Unlike resources gained from hunting, an individual woman had control over the distribution of her gathered products which mainly stayed within her family unit. For mescal an attempt was made to undertake the baking in the main camp as much as possible, though if the resource patch was too far the baking would take place there. Because banana yucca fruits were not uniform in their productivity at the landscape level, collecting trips could take up to six days in duration and several needed to gain enough for storage. Much was the same for piñon nuts, though if it was a scarce year a woman and her husband may quietly go collect from a given patch without others joining. The gathering of mesquite bean pods and prickly pear tunas was usually not a multi-day task with collecting parties leaving and returning to the main camp within a single day (Basehart 1974).

A brief mention should be made regarding the agricultural activities of the Mescalero Apache though these never contributed much to their historic diet. With seedstock procured from either trade or raiding, maize was the primary crop though squash and pumpkins were also grown. Though there seems to be disagreement over the segregation of activities, groups would either spend an entire year with their fields or would plant, leave during the growing season, then return for the harvest (Basehart 1974). Based on the paucity of accounts it can be assumed that agriculture activities contributed little to the diet or subsistence activities of the Mescalero Apache.

Trade also figured into the economic pattern of the Mescalero Apache, or at least the early Apache who visited the La Junta area. While visiting Pueblo de los Puliques, Ydoiaga was informed of an Apache ranchería under the leadership of a leader called El Lijero which consisted of approximately 100 families. This group actively traded with the pueblo's inhabitants, primarily providing tanned deer hides in exchange for tame horses, rawhide bridles, maize, and beans. However, the entire ranchería would not join in the trading event which would last two to three days, rather a few families at a time would congregate near the pueblo (Madrid 1992). Other Apache groups were located farther from La Junta than those of El Lijero but would trade at the pueblo, bringing bison hides and dried meat rather than deer hides (Madrid 1992). This same trade relationship is also mentioned at the Pueblo of San Cristobal where the locals stated that when a surplus of crops were had these products would be traded for hides with the Apache, though which group and the kinds of hides is not documented (Madrid 1992).

Raiding also figured into the subsistence patterns of the Mescalero Apache in at least a minimal form. Based on Basehart (1974), most raiding activities were focused on settlements associated with Europeans, whether Spanish, Mexican, or American. However, the raids most likely to contribute to subsistence were American affiliated and included the capture of cattle, hides, slaves, horses, and other riding stock (Basehart 1974).

In summation it can be understood that the Mescalero Apache practiced a more or less balanced subsistence pattern. Men focused on hunting game though most of these endeavors were multi-family events which required residential mobility, especially when hunting bison. Additionally, the returns from these events were shared between those who participated in the hunting. Women's plant gathering were more or less the opposite of this using logistical mobility to gather from appropriate patches which did not require the entire movement of families or entire main camps. The products of women's subsistence activities were almost never shared, though in the case of mescal emphasis was placed on the generosity of those who gathered the raw produce. Some maize-based agriculture was practiced though its importance appears to be negligible compared to hunting and gathering. As such the Mescalero Apache possessed a mixed residential strategy of both residential and logistical mobility, though tethered nomadism was also incorporated into these decisions.

Trade and raiding activities also contributed to the subsistence patterns of the Mescalero Apache and their Apachean ancestors. In the mid-18th Century Apache trade with peoples in the La Junta de los Rios area provided access to farmed crops such as corn and beans as well as mounts and other durable goods. Entire Apachean groups did not visit the pueblos, rather groups of two or three families would visit a given pueblo for two to three days. Raiding of outside groups also contributed to the economy of the Mescalero Apache primarily through the procurement of rising stock in addition to durable goods.

4.3 A Model of Eastern Trans-Pecos Human Foraging

By combining the information above it can possible to develop a testable model in terms of archaeological group use of plant resource and general subsistence patterns within the eastern Trans-Pecos. It should be noted that this model is based solely upon the written record with the archaeological record being used to test this model. In general, both hunter-gatherers and foraging agriculturalists are considered here to utilize similar plant procurement strategies as well as tethered nomadism based on similarities between Spanish accounts, ethnographic data, and inhabiting the Chihuahuan Desert. The primary differences between subsistence strategies are considered within this model to be hunting-gathering and farming, with hunter-gatherers not practicing maize, bean, and cucurbit production but relying more heavily on game procurement, mainly bison and deer.

For this model it is hypothesized that a wild plant food-based diet principally composed of agaves, banana yucca fruits, mesquite bean pods, and piñon nuts was used by Terminal Late Prehistoric peoples of the area. Historic data from Spanish accounts as well as ethnographic data from the Mescalero Apache demonstrated a significant overlap in diet between the known groups. It is not possible to test whether logistical mobility was utilized by prehistoric peoples within the study area as it was by Mescalero Apache women at this time. However, it is posited here that central place foraging was utilized, specifically that plant gathering was undertaken from a given campsite and/or pueblo, and the contributing members returned to this place for processing, consumption, and possible storage (Kelly 2013). As such, the archaeological record will be used to identify plant foods utilized by these peoples.

Specific to the agriculturalists it is also hypothesized that wild plant foods contributed to a significant portion of the plant diet. As stated above, this hypothesis is based upon the fragile nature of recorded agricultural activities within the La Junta de los Rio area.

In order to model landscape use other assumption are needed, specifically regarding travel time to plant food resource patches. Working under the assumption that most plant foods were gathered and the collectors returned to their central place within a single day, Kelly’s (2013) six kilometer effective foraging radius is assumed here. To test this a separate model will be generated in a geographic information system and then compared to historic plant community distributions within the study area. Here the hypothesized focus would be upon the procurement of the four primary plant foods mentioned previously, with archaeological sites focusing in locations where patches of these foods could be procured within a distance of less than six kilometers.

Due to the complexities of the archaeological record as well as difficulties in modeling, the importance of hunted, fished, and traded foods will not be included within the model. Rather, the proposed model is solely concerned with the procurement and processing of plant foods. However, it is assumed that faunal food sources contributed to diet with hunting being of primary importance.

4.4 Overview of Plant Foods and Foraging in the Eastern Trans-Pecos

Within the study area, early Historic Period peoples were noted as utilizing both grown and wild plant foods. Accounts from five Spanish encounters spanning from 1535 to 1747 identified corn, beans, and squash as the primary agricultural products, though plant foods such as mesquite and tornillo beans, agaves, and piñon nuts contributed to local diet. Ethnographic studies of the Mescalero Apache identified a diet focused primarily on agaves, yucca fruits, mesquite beans, and piñon nuts, though each of these varied in inter-annual and spatial dependability. Another forty-eight plant taxa contributed to plant diet, of which women were the primary plant gatherers who used a logistical mobility strategy to access said resources. Mobility strategies of the La Junta peoples as well as the Jumano are currently unknown, though trade of foodstuffs (i.e., non-La Junta mammal products for La Junta cultivated and durable goods) did contribute to dietary diversity. As such this information can be combined into a model for assessing Terminal Late Prehistoric plant diet breadth, staples, and food resource access.

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CHAPTER V

BOTANICAL BEARING TERMINAL LATE PREHISTORIC PERIOD SITES OF THE EASTERN TRANS-PECOS ARCHAEOLOGICAL REGION

For this study nine archaeological sites are included from the eastern Trans-Pecos, four of which are protected sites and five open campsites. The majority of these are in the southern and western portions of the study are (Figure 5.1). These were chosen as they are the only Terminal Late Prehistoric Period (TLP) archaeological sites for which modern paleoethnobotanical procedures were utilized in their analysis. Through earlier studies (ex. Holden 1941, Kelly and Smith 1963, Smith 1934) did recover macrobotanical remains these are excluded as the recorded remains were chance finds while excavation and not from systematic botanical sampling. Inclusion of these sites has the potential to skew resultant analyses when compared with studies which included appropriate botanical sampling and processing procedures which were incorporated into archaeological investigations more recently.

Of those sites included in this study only materials related to TLP occupations are considered. Several of the sites include materials which pre- and post-date the TLP and those associated plant remains could be influenced by other climatic events (i.e., the Medieval Climate Anomaly) and enculturation processes which occurred with Spanish and Mexican colonization efforts. As such the following descriptions will focus on TLP-related materials from the nine archaeological sites within the study sample, though brief descriptions will be provided for other occupation materials. It should also be noted that all radiocarbon dates described in-text calendar years, though radiocarbon years are provided in the radiometric dating tables from each site (Table 5.1 – 5.6).

It should also be noted that the reported radiocarbon dates were recalibrated by this researcher using OxCal version 4.3 (Ramsey 2009) with IntCal 2013 (Reimer et al. 2013). Eight of the sites within the study sample had reported radiocarbon dates. A single site, Arroyo de las Burras (41BS194), does not have radiocarbon date data at the present. However, the architecture and artifact assemblage reported by Mallouf (1995) place it firmly within the TLP (Mallouf 1995).

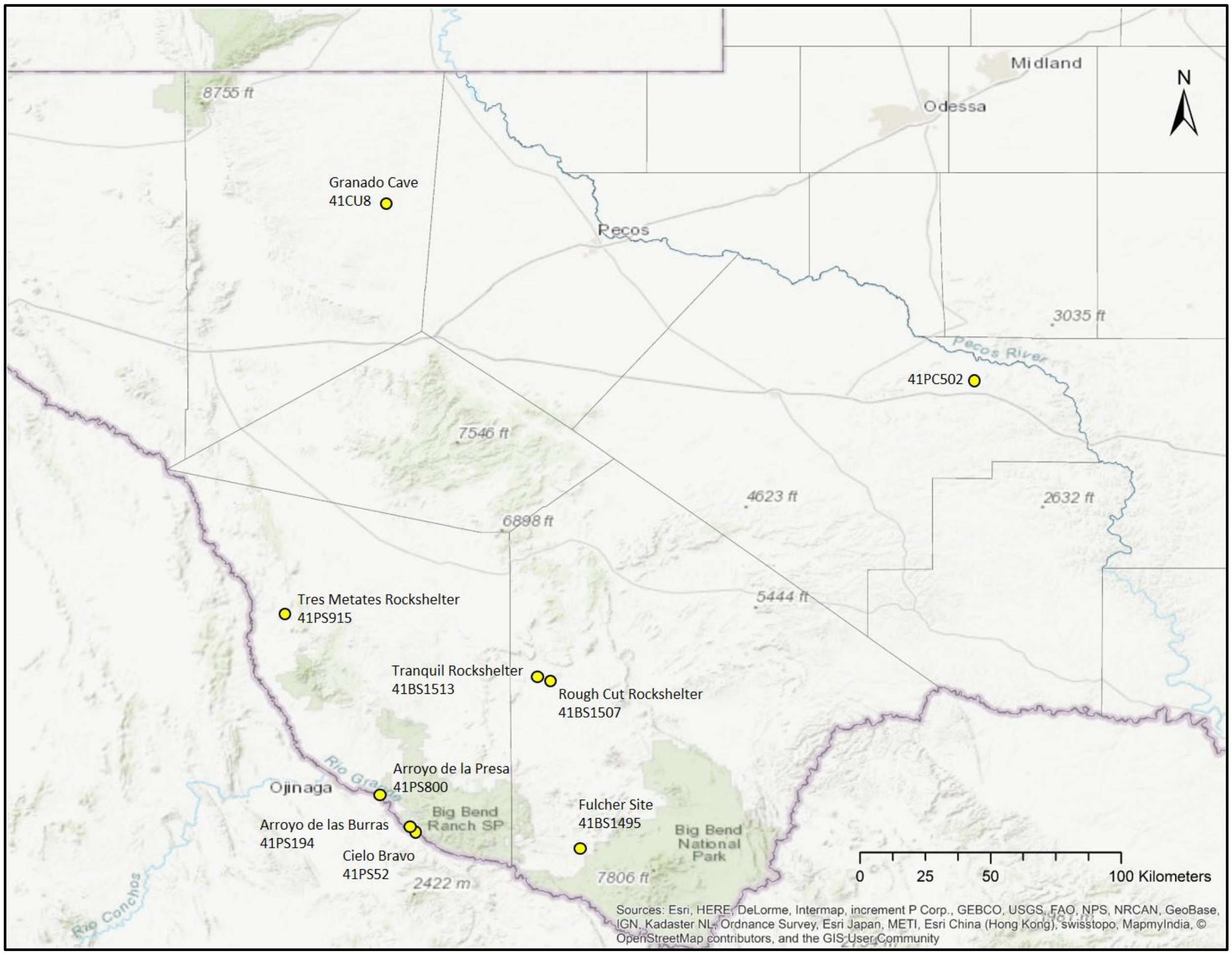

Figure 5.1. Map of sites within the study sample.

5.1 Terminal Late Prehistoric Period Protected Sites of the Eastern Trans-Pecos

Three rockshelters and a single cave will be briefly described. As depicted in Figure 5.1, the rockshelters are located in the southern eastern Trans-Pecos while the only cave, Granado Cave (41CU8) is located in the northwest portion of the study area. All of these sites yielded excellent preservation and likely reflect all aspects of floral resource use to a higher degree than that of the open sites within the study sample. The dietary botanical assemblages will be discussed in great detail in Chapter 7, though the site and feature descriptions below are presented to introduce general site-level occupations and artifact assemblages.

5.1.1 Tranquil Rockshelter (41BS1513)

Tranquil Rockshelter (Figure 5.2) measures approximately 36 m east-west and 15 m north-south and has a D-shaped plan outline with a thin talus slope extending down the south-facing opening of the rockshelter. Beginning in 2007 the Center for Big Bend Studies at Sul Ross State University initiated field investigations with staff members. Worked was continued in 2008 which included the 2008 Sul Ross State University Archeological Field School. A trench (Figure 5.3) consisting of seventeen units was excavated across the east-west, long axis of the shelter with a secondary, north-south block composed of a 2 m wide by 3 m long block excavation intersected this trench and extended to the back, north wall of the shelter (Cason 2018).

Figure 5.2. Tranquil Rockshelter (41BS1513).

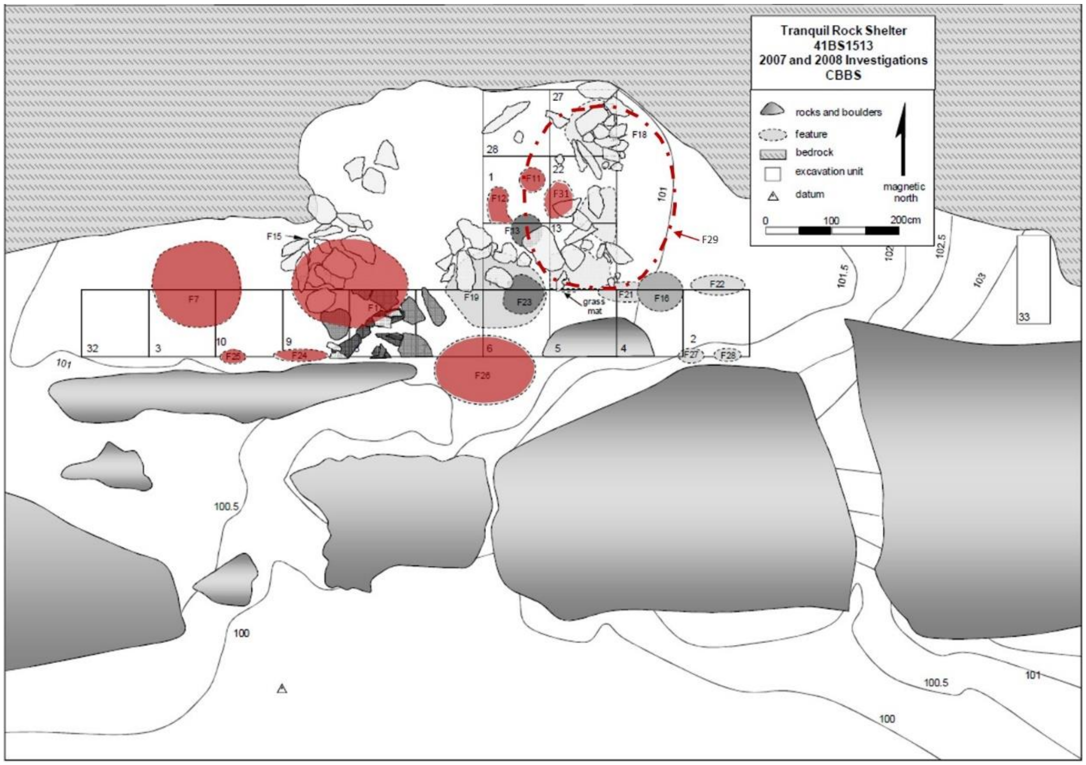

Figure 5.3. Tranquil Rockshelter site map with features and excavation units. Features in red are considered in this study. Figure modified from Cason (2018).

Occupations date back to 4,950 yBP though most occupation events covered the time between A.D. 890 and 1620 (Table 5.1). Currently Cason (2018) posits that a variety of subsistence activities were undertaken at Tranquil Rockshelter as well as ties to the La Junta de los Rios area based on the Feature 29 which is described in more detail below.

Feature No.	*Sample No.*	*Age, ^{14}C BP*	*Age, cal BP (1σ range)*	*Age, cal AD (1σ range)*
Feature 7	PRI 09-88-74	640 ± 20	656 – 564	1295-1387
Feature 7	Beta 248499	460 ± 60	546 – 340	1404-1610
Feature 17	Beta 248500	620 ± 40	653 – 557	1298-1394
Feature 26	Beta 248501	510 ± 40	547 – 509	1250-1295
Feature 29	PRI 09-88-504	635 ± 15	653 – 563	1298-1387
Feature 29	PRI 09-88-36	650 ± 15	659 – 566	1292-1384
Feature 29	Beta 248497	780 ± 40	728 – 679	1223-1271

Table 5.1 Terminal Late Prehistoric Period radiocarbon dates from Tranquil Rockshelter features. Table reprinted from Cason (2018).

5.1.1.1 Tranquil Rockshelter TLP Feature Descriptions

Within Tranquil Rockshelter twenty-six features were documented and excavated during the field investigations. Of these, nine (Features 7, 11, 12, 17, 24, 25, 26, 29, 31) are considered within this work as dated materials and/or provenience fall within the Terminal Late Prehistoric Period in addition to samples being gathered for macrobotanical analyses (Figure 5.3). The remaining seventeen features pre-date the TLP and as such are excluded from this discussion. Table 5.1 presents the uncalibrated and calibrated dates for Terminal Late Prehistoric Period features.

Feature 7 is a basin-shaped earth oven and is located in the western portion of the rockshelter with approximately half of it being excavated during field investigations. Two radiocarbon samples were submitted for dating and yielded 1-sigma calibrated dates of A.D.

1295-1387 and A.D. 1404-1610. Cason (2018) interprets this as likely two use episodes separated by approximately forty years. Artifacts recovered from Feature 7 include 71 pieces of mammal bone, a Toyah arrow point, and eight pieces of unmodified debitage (Cason 2018).

Located in Unit 1, Feature 11 is a weakly defined basin shaped depression which rests directly atop the bedrock floor of the rockshelter. At approximately 45 cm across the feature has a high amount of plant remains including five prickly pear (*Opuntia* spp.) pads. Artifacts recovered included eight pieces of debitage, a single biface fragment, and twenty small mammal bones of which 40% are burned. Feature 11 is in close proximity to an upright ocotillo stalk which forms the outline of Feature 29 and placing it within Feature 29 (Figure 5.3). At this juncture it is unknown if Feature 11 is directly associated with the use of Feature 29, but its vertical positioning is coeval with that of Feature 12 (discussed below), which is directly associated with the use of Feature 29. As such Feature 11 is considered to reflect human occupation of Feature 29 (Cason 2018).

Near Feature 11, Feature 17 also constituted a buried thermal feature having a maximum thickness of approximately 25 cm. For dating a radiocarbon sample from above and within the feature were submitted for dating and yielded a 1-*sigma* calibrated date of A.D. 1298-1394. With the completion of fieldwork the feature yielded 750 stone artifacts (724 pieces of unmodified debitage, one core, one uniface, a single spokeshave, and seven non-arrow point bifaces), of which three are definitively Toyah arrow points and a fourth is likely a Toyah. Mammal bones were quite common within Feature 17 with 2,163 bone fragments recovered. The majority of these are rabbit/hare (Leporidae) with 33% of these burned. Large mammal bones (n=29) were also recovered with sixteen showing evidence of burning. This feature is also close to Feature 29 and may be an interior feature within it or it could have been used prior to the building of the *jacal* (regional term for wattle-and-daub construction) superstructure (Cason 2018).

Feature 12 was another accumulation of organic materials much like Feature 11 and likely associated with subsistence activities of the Feature 29 occupation. This feature yielded a corncob (*Zea mays*), ten pieces of debitage, nine pieces of small mammal bone, and occasional fire cracked rock (FCR). The general matrix was a 10 cm thick layer of burned and unburned grass leaves and culms with intermixed lechuguilla (*Agave lechuguilla*) parts, some of which have evidence of burning (Cason 2018).

Likely associated with Feature 17, Feature 24 is a basin-shaped depression primarily composed of carbon stained sediment with several pieces of FCR. Feature 25 was a series of charcoal and ash lenses and possibly represented cleanout episodes from the oven which comprised Feature 7 (Cason 2018).

Feature 26 was a poorly defined basin shaped pit with evidence of thermal properties based on the presence of charcoal and ash laden microstratigraphy. This feature was not discernable during excavations and was only noted while profiling the south walls of Units 6 and 7 (Cason 2018).

The largest and most complex feature within Tranquil Rockshelter, Feature 29 represents a possible *jacal* superstructure which sectioned off a portion of the shelter. Stratigraphically the feature is defined by an ash deposit, though microstratigraphic layers of organic material, ash, carbon, and charcoal were noted. The central thickness of this deposit is 20 cm and the feature in its entirety was shallowly buried. Other defining aspects for the delineation of Feature 29 are five ocotillo (*Fouquerqia splendens*) stalks on the exterior of the feature's deposits, two of which have pieces of lashing material. Thirty fragments of daub with ocotillo-size impressions were recovered 30 cm away from the feature in Unit 14 and demonstrate that the superstructure had some appearance of a *jacal* structure.

The artifact assemblage from Feature 29 was also quite diverse yielding 484 pieces of unmodified debitage, a spoke shave, a single uniface, split antler tool, 663 pieces of bone, a possible sandal fragment, two fragments of sotol (*Dasylirion wheeleri*) matting, and three bifaces of which one is a Toyah arrow point. Three botanical samples were submitted for dating with resultant calibrated 1-*sigma* dates of A.D. 1298-1387, 1292-1384, and 1223-1271 and indicates construction and use during the Terminal Late Prehistoric Period (Cason 2018).

Feature 29 also included features within itself, with Feature 31 being a basin-shaped depression measuring 72 cm x 42 cm. Cason (2018) considers this to be a storage or refuse pit used during the occupation of Feature 29 based on the construction and contents of the feature. Briefly, the top of Feature 29 consisted of a layer of grass, beneath which three prickly pear (*Opuntia* spp.) pads were encountered across the upper portions and the bottom portion of the pit lined with more prickly pear pads. Atrifactual contents within the feature included ten pieces of debitage, one sotol mat fragment, two pieces of cordage, two pieces of knotted fiber, a heavily used sandal, and eleven pieces of small mammal bone (Cason 2018).

5.1.1.2 Tranquil Rockshelter- General Findings

For the site as a whole twenty-three cores, 6,994 pieces of unmodified debitage, forty-nine unifacial tools, and ninety-seven bifaces, including forty-two are projectile points, were recovered. Of these twenty-seven were arrow points and the remaining fifteen dart points. Arrow point styles include Perdiz (n=2) and Toyah (n=15), and an untyped contracting stem type (n=3). A single untyped arrow point preform and six untyped arrow point fragments were also recovered. Various other lithic tools including gravers (n=5), a spoke shave, and a chopper were also excavated. Artifacts of clay balls, a burned clay cone, arrow fragments (n=5), possible stick-and-cordage trap trigger sets, etched stones, beads, and groundstone artifacts were recovered through the course of investigations. Red pictographs are also present along the north wall of the rockshelter (Cason 2008, 2018).

5.1.2 Rough Cut Rockshelter (41BS1507)

Also located in west-central Brewster County, Texas, Rough Cut Rockshelter (41BS1507) was investigated in 2007 by staff members from the Center for Big Bend Studies. The maximum dimensions of the rockshelter are 15 m wide by 7 m deep and include a stacked stone structural feature remnant. Across the entrance a talus slope extends down the slope leading up to the rockshelter (Figure 5.4). Rockart present within the shelter include positive and negative handprints colored with a red pigment as well as a few red abstract linear motifs (Gray 2008).

Figure 5.4. Rough Cut Rockshelter (41BS1507). Photo by: CBBS.

On the initial discovery of the rockshelter eight artifacts were collected and included three Perdiz arrow points, one Livermore point, a biface fragment, a single retouched flake, and two sherds of El Paso pottery. For the pottery sherds one was an El Paso Polychrome ware and the second an El Paso brownware (Gray 2008).

During the 2007 investigations six 1 x 1m units were excavated as well as a 0.5 x 0.5 m unit. A total of 20,000 artifacts were recovered from the small shelter with a significant portion of these being bone. Of 7,000-plus faunal remains collected so far 1,000 have been identified with approximately 500 identified as rabbit. Other notable aspects of the artifact assemblage from Rough Cut Rockshelter were another 91 Perdiz point and point fragments recovered as well as four pieces of obsidian, an excruciatingly rare lithic material for the eastern Trans-Pecos (Gray 2008).

Within the rockshelter two features, Features 1 and 2, were noted. Feature 1 was likely the stacked stone base of a wickiup with the disarticulated remains of a single individual intentionally placed beneath the walls. Feature 2 includes the remnants of a hot rock cooking feature (Gray 2008).

Context	***Sample No.***	***Age, ^{14}C BP***	***Age, cal BP (1 σ range)***	***Age, cal AD (1 σ range)***
Ash Layer	Beta-237123	610 ± 40	650 – 553	1300 – 1397
Hearth	Beta-237121	490 ± 30	534 – 510	1417 – 1440
Charcoal enriched zone	Beta-237122	490 ± 40	540 – 506	1411 – 1445
Disturbed Burial	PRI-09-123	370 ± 15	486 – 334	1465 – 1616

Table 5.2. Radiocarbon dates from Rough Cut Rockshelter (CBBS unpublished).

After excavation four radiocarbon samples were analyzed to date occupation events as well as the age of the disturbed burial. One sigma dates indicate repeated occupations between A.D. 1300 and A.D. 1445 (Table 5.2). The burial post-dates the main occupation with the 1- σ dates of A.D. 1465 – 1498 having the highest probability (42.6%) with the later two date ranges from the sample being less likely (A.D. 1506 – 1512 at 5.3% and A.D. 1601 – 1616 at 20.4%). Still all dates point to a series of TLP occupations in addition to the recovery of several Perdiz arrow points which assist in defining the TLP.

5.1.3 Tres Metates Rockshelter (41PS915)

Of the three rockshelters included in this study Tres Metates Rockshelter (41PS915) has the largest evidence of looting activities. This rockshelter has a 10 m long axis, 6 m short axis, and a ceiling height of almost 6 m and was investigated by Center for Big Bend Studies staff in 2004 (Figure 5.5). The site receives its name from the presence of three metates found on the shelter's floor (Seebach 2007).

Figure 5.5. Entrance to Tres Metates Rockshelter (41PS915). Figure reprinted from Seebach (2008).

A total of six, 1m x 1 m units were excavated within Tres Metates Rockshelter, three along the west portion of the shelter (M26-2, M25-22, M25-17), a single one towards the front of the shelter (M25-8), and the remaining two (M25-18, M25-13) near the eastern side (Figure 5.6).

All units recovered evidence of Late Prehistoric Period (A.D. 700 – 1535) occupations and none of preceding time periods (Seebach 2007).

The site as a whole was considered to have experienced two large occupation events. The first of these likely occurred around A.D. 1200 with a focus being on the use of an earth oven (Feature 2) as well as activities possibly related to hunting activities. Evidence for the latter is based on the recovery of two definitive Toyah arrow points, a possible Livermore point, and a possible Garza point. Of these the Garza stands out as an outlier due to its later use (A.D. 1540 – 1665) compared to the earlier used Livermore (900 – 1200 A.D.) and Toyah (1230 – 1380 A.D.) points (Corrick 2000, Kelley 1957, Johnson et al. 1977, Seebach 2007, Turner et al. 2011).

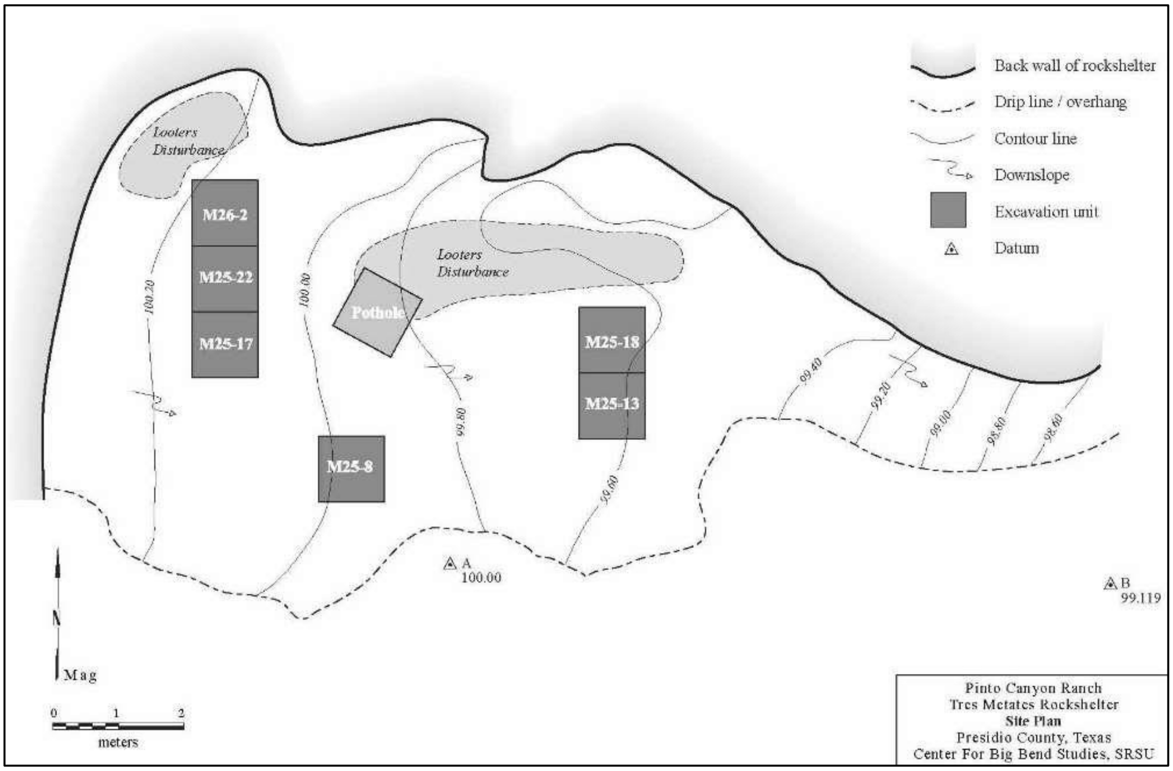

Figure 5.6. Excavation map of Tres Metates Rockshelter. Figure reprinted from Seebach (2007).

Because this study is concerned with the Terminal Late Prehistoric, a more in-depth discussion of related materials will be presented here. Most activities identified through excavation are related to the construction and use of Feature 1 (Figure 5.7), a prickly pear pad and brush storage pit encountered while excavating in Unit M26-2. This storage feature measured approximately 85 cm x 70 cm and was around 30 cm in depth, if not slightly deeper (Seebach 2007).

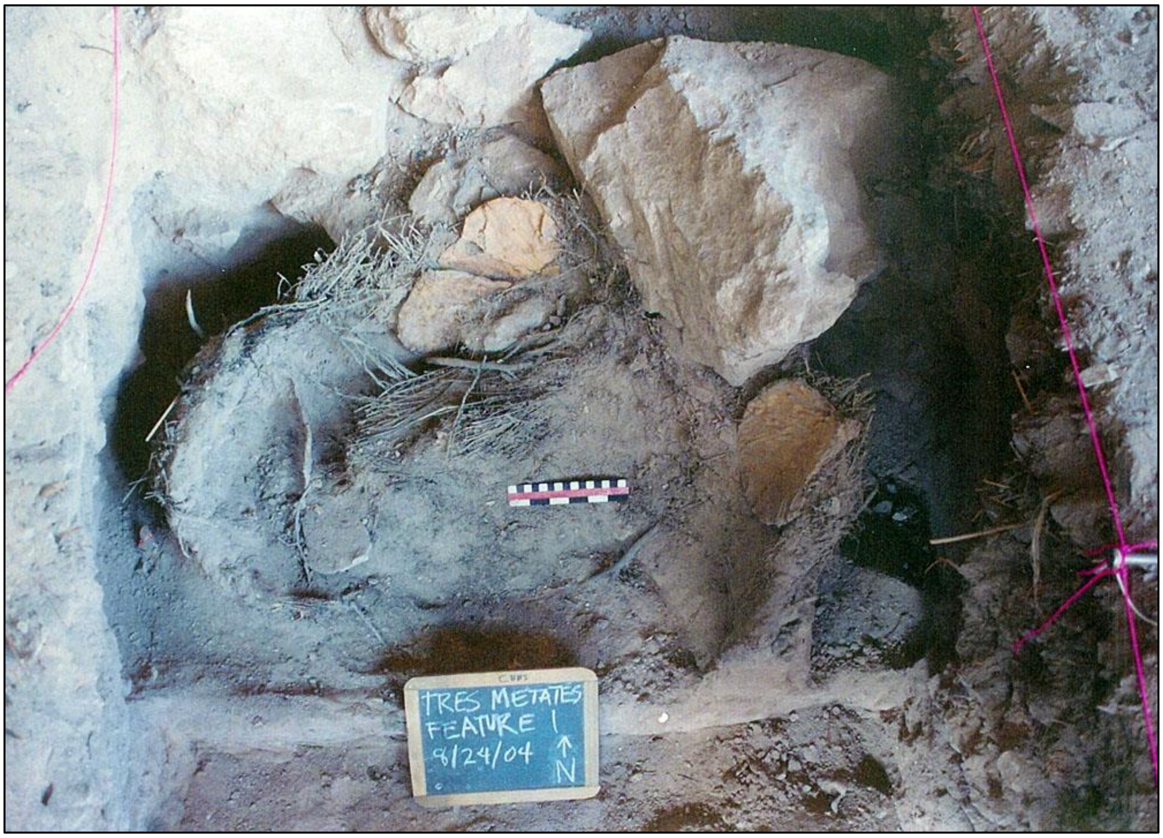

Figure 5.7. Base of Feature 1 from Tres Metates Rockshelter. Figure reprinted from Seebach (2008).

From Feature 1 a series of artifacts were recovered and included two wooden stakes, two pieces of FCR, two pieces of untwisted cordage, two pieces of groundstone, and a single bead. In terms of diagnostic artifacts two arrow points were recovered, one of which was identified as a Perdiz preform. One unique faunal remain was the undressed skin of a mouse at the bottom of the pit, something which Seebach (2007, 2008) hypothesizes is a cultural marker. Additionally, an El Paso Brownware sherd was also recovered during excavation of Feature 1. A large amount of botanical remains were also recovered (including one corn corb and four common beans [*Phaseolus vulgaris*]), those these are discussed in more detail later in Chapter 7.

A single date for this storage facility was obtained from the prickly pear pad fragment from the top portion of the feature. This yielded an uncalibrated date of 360 ± 40 B.P. and a calibrated 1-*sigma* date of A.D. 1440 – 1640, indicating a use in either the Terminal Late Prehistoric or the following Protohistoric.

In summation Tres Metates Rockshelter contributed significant meaning to the Late Prehistoric Period within the study area. Two primary occupations occurred within this rockshelter, with the second related to plant gathering and storage activities for which the dry nature of this rockshelter makes it will accustomed to. For this second occupation a single radiocarbon date, Perdiz point preform, and El Paso Brownware pottery sherd from Feature 1 all confirm a Terminal Late Prehistoric occupation. Further evidence of use during this time period is a Carretas Polychrome sherd recovered from the surface and hypothesized to be in relation to the second, major occupation of the rockshelter.

Seebach (2007, 2008) also hypothesizes that the second occupation of Tres Metates Rockshelter was most likely associated with La Junta Phase peoples. Evidence for use by these peoples are the Perdiz preform, imported pottery, and cultigens present within the rockshelter. The radiocarbon date for the feature also falls within the timeframe for the La Junta Phase (A.D. 1200 – 1450) (Seebach 2008). Seebach (2007, 2008) also utilized ethnohistoric accounts to bolster his hypothesis, focusing on the tenuous nature of agricultural activities and foraging patterns recorded by Ydoiaga (Madrid 1992) and discussed in Chapter 3 of this work.

5.1.4 Granado Cave (41CU8)

The only true cave within the study sample, Granado Cave (41CU8), is located in eastern Culberson County, Texas within the Rustler Hills. Comprised of a large sinkhole within a limestone hill (Figure 5.8), the site is predominately associated with Late Archaic and early Late Prehistoric Period burial activities, though Terminal Late Prehistoric Period occupations have also been noted. The site consisted of a sinkhole cave within a limestone hill with three ring middens atop the hill as well as three bedrock mortars. The general understanding of the site is one of mixed use and repeated occupations with the cave itself being used for the processing of wild foods as well as a burial location. Additionally, this site, as well as other cave sites in the immediate area, are used to define the Castile Phase, a Late Archaic and Late Prehistoric hunting and gathering culture which occupied the Great Gypsum Plain and Rustler Hills beginning around A.D. 200 and continuing until at least A.D. 1450 (Hamilton 2001).

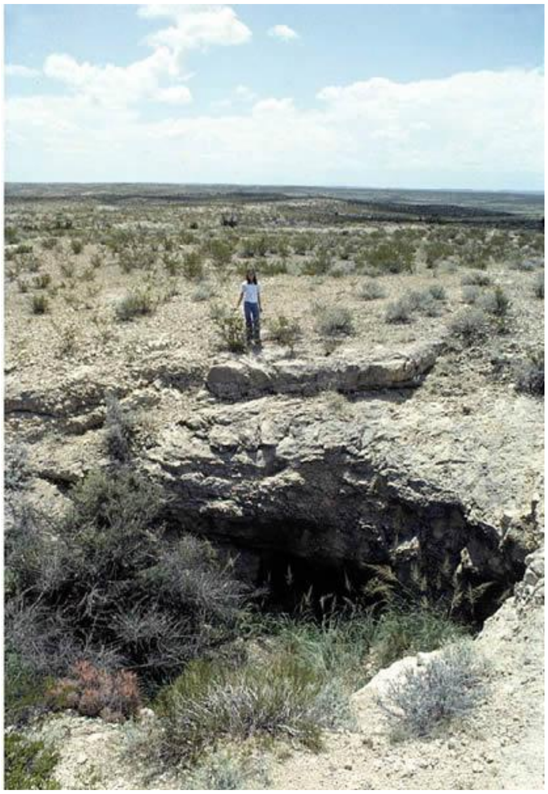

Figure 5.8. Entrance to Granado Cave (41CU8). Figure reprinted from Hamilton (2004).

Granado Cave was found by local surveyor Frank Granado in 1976 who, along with several family members, removed eight burials from within the cave. From August through November of that year Donny L. Hamilton and others conducted a research visit, initial mapping, and preliminary testing of deposits within the cave. In 1978 Hamilton led a field crew and conducted formal excavations of the cave deposits through the excavation of six excavations units ranging in size from a single 1 m x 1m unit (Excavation Unit 6) to block excavation units (ex. Excavation Unit 1) as shown in Figure 5.9 (Hamilton 2001).

Figure 5.9. Plan, profile, and excavation map of Granado Cave. Figure modified from Hamilton (2001).

In total ten human burials were recovered via artifact collector activities and formal archaeological investigations. Burials 1 through 4 are the most elaborate of the ten within the cave and included the remains of children and infants, all of which were collected by Granado and others. Burial 1 constituted a Late Archaic partially mummified child, probably female, wrapped in a series of mats as well as a tanned deer hide; two Rustler Hills kiahas (burden baskets diagnostic of the Castile Culture) were found ceremonially killed over the bundle. Burial 2 included a Late Prehistoric Period infant placed within a Rustler Hills Twined Grass Bag (another diagnostic artifact of the Castile Culture). Burial 3 was placed atop Burial 2 and included the remains of another infant within a Rustler Hills Twined Grass Bag. Atop both of these burials a large coiled basketry tray was placed as were several sherds of a Matta Red-on-

Brown Textured from a jar “killed” atop the burials. Burial 4, a likely female 16 month-old Late Archaic child, was placed within a Rustler Hills Twined Grass Bag which was then wrapped in twined grass mat, rabbit skin blanket, and then a twined rush (*Scirpus* spp.) mat. The last non-adult burial, Burial 9, consisted of the left scapula, right parietal, occipital, and a few small skull fragments in addition to a coiled basket, cotton belt, twined sacahuista (*Nolina texana*) mat, and numerous *Lithospermum* seed beads; in possible association with this burial were fragments of a single Rustler Hills kiaha (Hamilton 2001).

For the adult burials recovered, Burial 5 contained the cranial and post-cranial remains of two Late Archaic individuals while the only remains recovered from Burial 5 was of a skull recovered from a packrat (*Neotoma* spp.) nest. Burial 7 consists of a skull and various post-cranial remains date to the initiation of the Terminal Late Prehistoric Period (Table 4.3) and described in more detail below. Only a single parietal bone can be associated with Burial 8 while Burial 10 included the remains of a 30+ year old female placed in a loosely flexed position (Hamilton 2001).

Despite the fantastic aspects of material culture recovered from Granado Cave only a small portion of the artifact and feature assemblage can be attributed to the Terminal Late Prehistoric Period. Four radiocarbon dates were obtained from this cave and the materials associated will be discussed briefly here and presented in Table 5.3.

5.1.4.1 Terminal Late Prehistoric Materials from Granado Cave

Layer 2 in Excavation Unit 4 includes the remains of an earth oven or hearth and associated living surface in the anteroom portion of the cave. For units with a definite association with Layer 2, quids from the order Agavoidea were the most common artifact type with a total of forty-four recovered and lithic debitage the second most common artifact type with thirty-six found. From Unit 1 a single metate fragment, three Granado Cave Two-Warp Fishtail Scuffer Toe Sandals, and five coprolites were also collected during excavation. The only diagnostic artifact besides the sandals was a single body sherd of a Chupadero Black-on-White vessel (Hamilton 2001).

Dated to the beginning of the Terminal Late Prehistoric, Layer 2 from Excavation Unit 5 consisted of an FCR midden within the entrance of the cave. The excavation unit itself was composed of 3, 1 m x 1 m units. Yielding a 1-*sigma* calibrated date of A.D. 1224-1285 (Table 4.3), the feature as a whole consisted of a powdery dark gray and ashy matrix with numerous limestone spalls as well as FCR. Bioturbation caused by plant roots was also quite common within this feature. Of the artifacts directly associated with this midden deposit, 142 pieces of debitage were recovered, a single projectile point, a single metate fragment, and 228 grams of faunal bone were recovered. Six pottery sherds were also found within one being assigned as a general Chihuahuan ware, two Mata Red-on-Brown, two Convento Vertical Corrugated, and one Jornada Brown (Hamilton 2001).

Feature No.	***Sample No.****	***Age, ^{14}C BP***	***Age, cal BP (1 σ range)***	***Age, cal AD (1 σ range)***
EU 5, Layer 2	Tx-3104	750 ± 50	727 – 665	1224 – 1285
EU 4, Base of hearth	Tx-3105	550 ± 40	630 – 525	1321 – 1426
EU 1, Surface	Tx-2829	510 ± 60	626 – 503	1325 – 1447
Burial 7	Tx-2828	600 ± 100	657 – 538	1293 – 1412

Table 5.3. Terminal Late Prehistoric Period radiocarbon dates from Granado Cave (41CU8). Table reprinted from Hamilton (2001). *Laboratory sample numbers not provided.

The surface of Excavation Unit 1 is associated with Terminal Late Prehistoric Period activities as evidence by a broken burden basket hoop yielding the most recent date for the site at a 1-*sigma* date range of A.D. 1325-1447 (Table 4.3). Excavation Unit 1 was excavated primarily to identify remains associated with Burials 1 – 4 and as such the recovered artifacts are attributed to earlier portions of the Late Prehistoric Period and the Late Archaic. Working with an assumption that Layer 1 may slightly predate the dated burden basket and is separated by Lens A in Layer 2 from Burial 1, artifacts recovered included animal and human coprolites and a Chihuahuan ware basal sherd. Sixteen sherds from a single "killed" Mata Red-on-Brown vessel were also recovered but these are associated activities with Burials 2 and 3 (Hamilton 2001). Though Burials 2 and 3 from Excavation Unit 1 may date to the Terminal Late Prehistoric Period the wide dispersion of dates associated with the grave goods precludes them from this analysis.

Of the ten burials known from Granado Cave only Burial 7 is attributed to the Terminal Late Prehistoric Period. The remains of this probable 25 – 30-year female were placed in a crevice 58 m east of the entrance in an area lacking sunlight. Compared to the general burial patterns at the site, Burial 7 is quite unique in placement as the other nine burials were along the west wall near the center of the cave, an area which received light during the morning hours. Additionally, the other adult burials were interred along the north portions of the cave. Recovered remains within the burial crevice included a skull, right innominate, and a proximal phalanx of the left foot. Two other human bones were associated with Burial 7 with a right scapula found 3 m north of the burial crevice and a left humerus 7.5 m to the north. Artifacts associated with the burial include a possible weaving tool constructed from a modified and polished deer rib bone, seed or rush culms from a twined mat, eleven pieces of 2-ply, Z-twisted cordage potentially from the weft of a twined mate, a piece of 2-ply, Z-twisted cordage tied in a sheet bend knot, two possibly juniper (*Juniperus* spp.) berry beads, and a modified cottonwood (*Populus* spp.) branch fragment (Hamilton 2001).

5.2 Terminal Late Prehistoric Period Open Sites of the Eastern Trans-Pecos

For this study five open archaeological sites are included for comparison to the protected sites described above. Four of these are located in the southern area of the eastern Trans-Pecos with the fifth, 41PC502, located in presented day Pecos County, Texas and within the Stockton Plateau biotic geographic province. The site descriptions will first focus on those associated with the Cielo Complex (Cielo Bravo [41PS52] and Arroyo de las Burras [41PS194]), then Concepcion Phase (Arroyo de la Presa Site [41PS800]), and finally two archaeological sites which lack an archaeological material culture affiliation (41PC502 and the Fulcher Site [41BS1495]).

5.2.1 Cielo Bravo (41PS52)

The Cielo Bravo Site (41PS52) is located in southern Presidio County, Texas on a ridgeline overlooking the valley of the Rio Grande (Figure 5.10). One of the four type sites for the Cielo Complex, a hunting and gathering group focused in the Big Bend region of the study area which utilized the Toyah Technocomplex lithic toolkit, stone-based wickiups, and lacked pottery. Features from Cielo Bravo included twelve stacked stone wickiup rings, a large pit feature, four possible *ramada* structures, two cairns with linear associated linear alignments, numerous hearths or earth ovens, and several concentrations of FCR. Generally the external hearths are located on the opposite of the wickiup structure’s entrances (Mallouf 1995, 1999).

Figure 5.10. Site overview of Cielo Bravo (41PS52).

Research endeavors at Cielo Bravo were undertaken by the Texas Office of the State Archeologist in the 1980s under the leadership of then Texas State Archeologist Robert J. Mallouf. Through surface and subsurface investigations four major occupations of the site were identified and dated to A.D. 1335 – 1690 (Table 5.4). The first occupation focused on the construction of wickiups as well as *ramadas* and occurred between A.D. 1335 and 1375. Two occupations occurred between A.D. 1440 and 1450 though these are not as well represented. The artifact assemblage from these occupations included lithic tools such as Perdiz arrow points, unifacial end and side scrapers, beveled knives, flake drills, expediency tools made from flakes and blades, pestles, manos, and end-notched sinker stones. Other items encountered include bone awls and rasps, as well as beads made from stone, shell (including *Olivella*), bone, and turquoise (Mallouf 1999).

Feature Info.	***Sample No.***	***Age, ^{14}C BP***	***Age, cal BP (1 σ range)***	***Age, cal AD (1 σ range)***
E-10 living floor	Beta 21790	580 ± 130	673 – 505	1288-1460
E-10 int. hearth	Beta 21797	410 ± 80	520 – 323	1444-1607
E-10 ext. living surf.	Beta 21794	200 ± 60	305 – Present	1662-1907
E-11 ext. posthole	Beta 21791	430 ± 70	535 – 331	1434-1598
E-11 ext. posthole	Beat 21793	820 ± 90	898 – 672	1081-1259
Pit ramada posthole	Beta 21795	555 ± 80	644 – 517	1317-1426
Ext. ash pit	Beta 21796	150 ± 60	281 – Present	1699-1910
Pit ramada posthole	Beta 26707	480 ± 40	535 – 505	1415-1446
Pit ramada posthole	Beta 26709	260 ± 40	427 – 153	1540-1782
Ext. hearth	Beta 26711	150 ± 50	281 – 6	1703-1912

Table 5.4. Terminal Late Prehistoric Period radiocarbon dates from Cielo Bravo (41PS52). Table reprinted from Mallouf (1999).

The final occupation at Cielo Bravo occurred between A.D. 1650 and 1690 and possessed a few dissimilarities to the three preceding occupations. For the lithic tool assemblage Garza-like arrowpoints replaced Perdiz, triangular end scrapers and beveled knives became more common, the frequency of groundstone decreased, and end-notched sinker stones were absent. Decorative items also shifted with the appearance of tiny trianguloid pendants made of freshwater mussel shells and have a striking similarity to Garza Complex pendants from the Texas Southern Plains. Based on the shift of artifacts Mallouf postulates the final occupation is associated with Apachean groups rather than the locally indigenous peoples of the Terminal Late Prehistoric Period (Mallouf 1999).

5.2.2 Arroyo de las Burras (41PS194)

The second Cielo Complex site within the study sample, Arroyo de las Burras is also located in southern Presidio County, Texas on a well elevated mesa near the Bofecillos Mountains (Figure 5.11). Arroyo de las Burras is also one of the four types sites for the Cielo Complex in the Big Bend region of the study area (Mallouf 1985). In total the site consisted of thirty-six stacked stone wickiup rings as well as 130 associated features which included two ring middens, 14 clusters of unaltered boulders, two rock alignments, seventy-eight hearths, and nine piles of stone thought to be of modern or historic origin. Unlike the Cielo Bravo site the wickiup rings from Arroyo de las Burras are arranged in a linear arrangement (Mallouf 1995).

Figure 5.11. Site overview of Arroyo de las Burras (41PS194). Figure reprinted from Cloud et al. (2007).

Arroyo de las Burras was originally encountered in the mid-1970s and partially excavated in 1992 with by an archaeological field school from Sul Ross State University. Two general areas were excavated during the field school and consisted of Collection Block C, a 10 m x 20 m block excavation adjacent to Structures 1 and 2, a 7 x 7 m surface collection block focused on Structure 16 as well as two 1 x 1 m excavation units which bisected the west wall of the structure (Mallouf 1995). Because Structure 16 received such focused exploration said feature will be described in greater detail below.

5.2.2.1 Arroyo de las Burras – Structure 16

Structure 16 is composed of a stacked stone ring with approximate, maximum diameters of 4.5 m externally and 3.2 m internally (Figure 5.12). The wall widths range from 80 to 100 cm and the encircling wall has a south-southwest entrance gap with an average width of 50 cm. Thirty-three artifacts were recovered from the surface and included one Perdiz arrow point preform, a distal fragment from an arrow point, a mano fragment, utilized flakes and chips (n = 8), and lithic debitage (n = 22). Within the walls one core fragment and eight pieces of debitage were recovered. Outside of Structure 16 a single Perdiz arrow point fragment, one core fragment, and seventy-six pieces of utilized and unutilized lithic debitage and flakes were encountered with most of the these on the west side of the structure. Through excavation a Perdiz arrow point stem, Perdiz arrow point preform, depleted cores, utilized flakes, and a mano fragment were found. In total 749 debitage and tools make-up the subsurface artifact assemblage of the feature (Mallouf 1995).

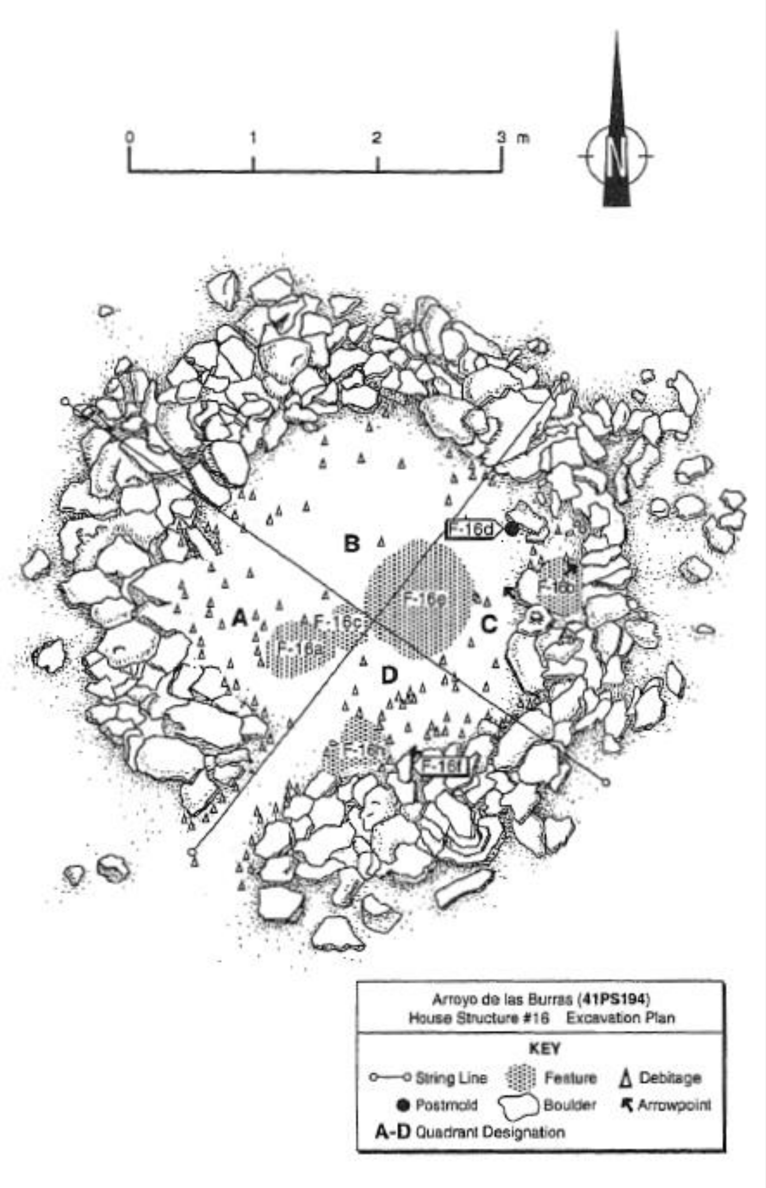

Figure 5.12. Excavation map of Structure 16 from Arroyo de las Burras. Figure modified from Mallouf (1995).

Within Structure 16 at least eight sub-features were also recorded (Figure 4.8). Features 16a and 16c were small hearths which rested on the original sediment of the landform. Feature 16e was a roughly circular pit with a maximum depth of 19 cm and was excavated into the landform's sediment while Feature 16b was the result of floor sweeping events or a weatherproofing attempt for the structure’s wall. Within the enclosing wall, Feature 16f was a wall niche which consisted of two thin, flat stones vertically placed beneath a protruding boulder from the wall. Two possible postmolds, Features 16d and 16g, were also found with the former in the interior of the structure and the latter within the stacked stone wall. An oval pit, Feature 16h, has no hypothesized use but was ash filled (Mallouf 1995).

General findings from Arroyo de las Burras include that house structures were spaced an average of 3.8 m apart with structural entrance gaps oriented to the south and south-southwest and external hearths placed behind the rings to the north. Additionally, these hearth areas appear to have been a primary location for stone tool fabrication. The site is considered to be of a single occupation event by a group of 80 to 150 persons or repeated occupations by smaller groups which did not stone rob from earlier structures. The structures themselves were constructed by arranging a circle of vertical superstructure supports, outlining the structure with a single course of boulders, and then a double row of boulders placed to form the primary foundation. After this, subsequent layers of boulders were dry laid until the preferred wall height was achieved. The lithic tool assemblage for the site is attributed to late stage reduction of high quality raw materials (Mallouf 1995). Non-lithic artifacts were exceedingly rare for the site as well. No radiocarbon date is currently known from this site though the artifact assemblage and architecture all indicate assignment with the Cielo Complex and as such occupation between A.D. 1250 – 1680 is likely.

5.2.3 Arroyo de la Presa Site (41PS800)

Located quite close to the Cielo Bravo and Arroyo de las Burras sites, the Arroyo de las Presa site (41PS800) was a multi-component site on a secondary terrace of the Rio Grande and also in southern Presidio County, Texas (Cloud 2004). The site was recorded (Kenmotsu and Hickman 2000) and tested in 2000 (Cloud 2001) with an extensive excavation occurring in 2001 under the leadership of William “Andy” Cloud of the Center for Big Bend Studies (Cloud 2004). Excavation procedures included four backhoe trenches (BHT 1-4), an “L”-shaped excavation block (Block A) which consisted of nineteen 1 x 1m excavation units between the two, 1 x 2m test units (TU1 and TU2), as well as five other excavation units adjacent to the BHT-1 and BHT-4. Multiple occupations were noted at the sites between A.D. 700 and 1650 and constituted thirteen distinct features. Of these, two features (Features 4 and 9) were radiometrically dated to the Terminal Late Prehistoric Period Concepcion Phase (Table 5.5) and possessed macrobtoanical remains (Cloud 2004) as presented in the following chapters. Brief feature descriptions are provided below.

Feature No.	***Sample No.***	***Age, ^{14}C BP***	***Age, cal BP (1 σ range)***	***Age, cal AD (1 σ range)***
Feature 4	Beta 155618	400 ± 60	513 – 327	1438 – 1624
Feature 4	Beta 155619	380 ± 60	503 – 325	1448 – 1625
Feature 9	UGA 12098	340 ± 40	465 – 317	1485 – 1634
Feature 9	Beta 155167	440 ± 40	526 – 476	1424 – 1474
Feature 9	Beta 155171	290 ± 60	453 – 289	1438 – 1624

Table 5.5. Terminal Late Prehistoric Period radiocarbon dates from Arroyo de la Presa (41PS800). Table reprinted from Cloud (2004).

5.2.3.1 Terminal Late Prehistoric Period Feature Descriptions from Arroyo de la Presa

Feature 4 was the best preserved feature of the entire site and had a diameter of 1.1 – 1.2 m. Along the eastern edge of the pit five marks, likely from a digging stuck used to excavate the pit, were noted and large masses of charcoal were noted in the basal area. Artifacts recovered from Feature 4 included two cores, three groundstone artifacts, one drill or perforator, 231 pieces of unmodified debitage, and one manuport were noted. Based on a single radiocarbon date the use of the pit is associated with either the end of the La Junta Phase or the Concepcion Phase. Generally stated, the original function of the pit is unknown at this time (Cloud 2004).

Like Feature 4, Feature 9 also had a concentration of charcoal at its base. Feature 9 had a long, east-west axis of some 70 – 80 cm though the exact dimensions could not be ascertained due to feature removal from backhoe trenching activities in BHT-1. Sediment filling the pit was like that of the overlying matrix from Zone IV though the pit fill possessed more charcoal (Cloud 2004).

For the site, lithic tools dominated the entire assemblage though a stone bead, etched pebble, *Olivella* shell bead, two etched hematite pebbles, one decoratively etched pebble, and two pieces of burned daub were also encountered. Arrow points and fragments recovered from Arroyo de la Presa included one Toyah-like, one Livermore/Perdiz-like, one Livermore-like, two Livermore, one untyped corner-notched, three untyped side-notched, seven untyped point fragments, and a single untyped preform. Other chipped stone materials collected during mitigation included five drills or perforators, twelve notched pebbles, three choppers, three complete bifaces, three biface fragments, two scrapers, and twenty-three cores. Debitage constituted the largest artifact class with 126 pieces being modified and 8,269 pieces unmodified. Groundstone tools included eighty-two grinding implements and a possible bannerstone fragment. Hammerstones were also present at the site with two being complete and eight fragments collected during investigations. Ceramics recovered included one sherd from the testing phase and four from the mitigation phase, all of which are from Chihuahuan Brownware vessels (Cloud 2004).

5.2.4 Fulcher Site (41BS1495)

Investigations at the Fulcher Site (41BS1495) (Figure 5.13) occurred in 2005 and 2006 by staff from the Center for Big Bend Studies with Richard Walter serving as the primary investigator. Work in 2005 constituted the first phase of investigations and two features, a rock cairn and mortared-stone thermal feature, were bisected through hand excavation. In 2006 excavations included a single 1 x 1 m test unit, four 50 x 50 cm shovel test pits, and a backhoe trench. A total of fifteen features were documented through surface and subsurface investigations. Through this work it was determined that the Fulcher Site experienced four occupations. The first two occupations were associated with the Late Archaic occupation while the third was a Terminal Late Prehistoric Period occupation around A.D. 1435 and 1536 as evidenced from a radiocarbon date associated with Feature 14. The fourth and final occupation occurred during the Historic Period and is attributed to the construction and use of the lime kiln (Walter 2008).

Figure 5.13. Site overview of the Fulcher Site (41BS1495). Figure modified from Walter (2008).

As the only discretely defined, Terminal Late Prehistoric Period feature at the Fulcher Site, Feature 14 was encountered while profiling the north wall of the backhoe trench (BHT-1) (Figure 5.14). The feature itself consisted of heavily carbon-stained sediment, 50 x 70 cm area with approximately fives pieces of FCR. A radiocarbon date places the time of use between A.D. 1465 and 1628 (Walter 2008).

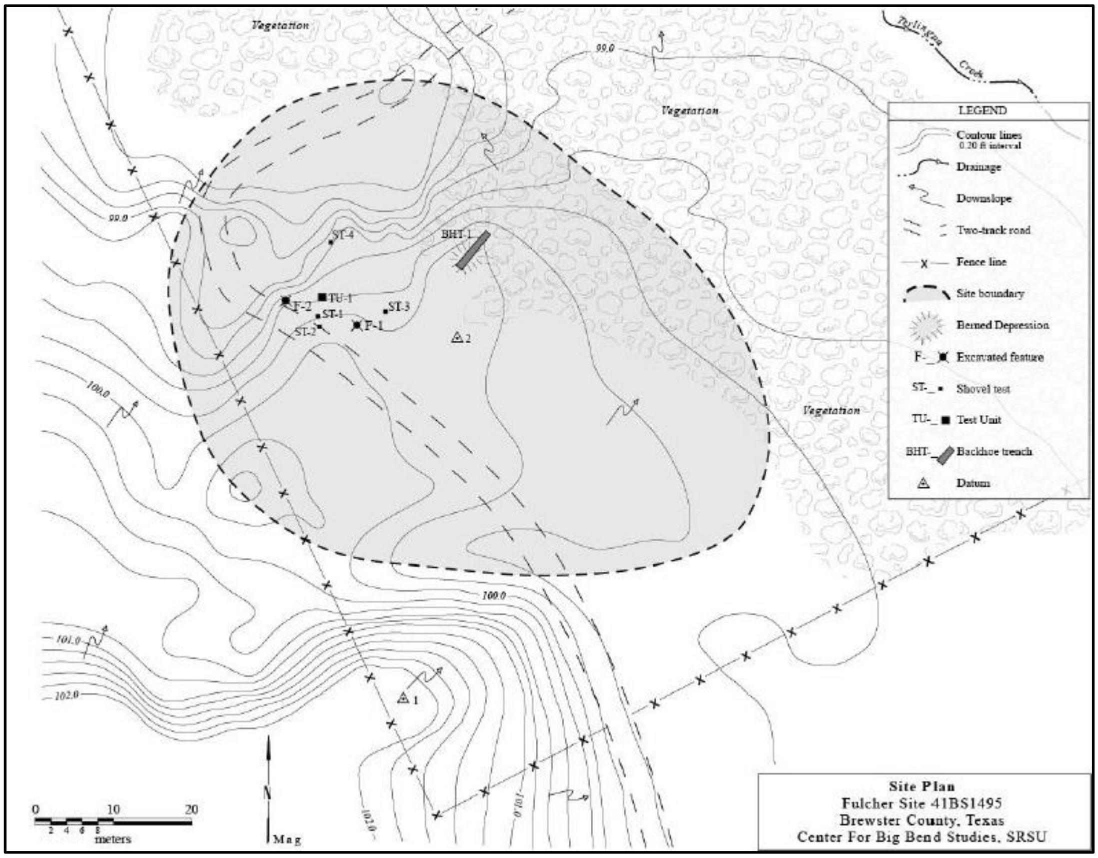

Figure 5.14. Excavation and site map of the Fulcher Site. Figure modified from Walter (2008).

The entire artifact assemblage for the site included three Perdiz arrow points and two arrow points similar to Talco, Fresno, and Guerrero types. Other flaked stone items were biface fragments, modified and unmodified debitage, and five cores. Groundstone artifacts included a ground pigment stone and two metate fragments. Faunal remains included a small mammal bone and four freshwater mussel shell fragments. Historic artifacts from the Fulcher Site included charred corncobs, assorted glass and metal objects, and 51 pottery sherds. One of the most unique artifacts recovered was a painted pebble attributed to the Late Archaic occupation event (Walter 2008).

5.2.5 41PC502

Turning now to the Stockton Plateau, 41PC502 is located in northeast Pecos County, Texas and was excavated through mitigation efforts initiated by the construction of the Indian Mesa Wind Farm in 2002. Maximum dimensions for the site are 600 meters east-west and 200 meters north-south and the site is situated on a bedrock exposure near the edge of the mesa. A total of three FCR features (Features 1, 2, 3) were present at the site, all connected by a lithic scatter. Features 1 and 3 were excavated both by hand and by backhoe excavation. Feature 2 was investigated only by backhoe trenching. Of these three features, Feature 3 was the most heavily investigated, with results including radiocarbon data (Table 5.6) as well as macrobotanical analyses (Godwin 2002) and will be briefly described below. Note that no radiocarbon ladoratory identification numbers were reported for this site.

Feature No.	*Assay No.*	*Age, ^{14}C BP*	*Age, cal BP (1σ)*	*Age, cal AD (1σ)*
Feature 3	2	650 ± 60	668 – 559	1284 – 1390
Feature 3	3	690 ± 50	683 – 564	1267 – 1387
Feature 3	4	560 ± 40	632 – 531	1318 – 1419
Feature 3	5	740 ± 30	692 – 666	1258 – 1285

Table 5.6. Terminal Late Prehistoric Period radiocarbon dates from Feature 3 at 41PC502. Table reprinted from Godwin (2002).

5.2.5.1 41PC502- Feature 3 Description

Feature 3 at 41PC502 was a large, semi-crescent shaped midden measuring twenty-four meters north-south and twelve meters east-west with five ancillary accumulations of FCR. The primary oven was a natural cavity within the bedrock of the mesa top while the crescent midden and ancillary accumulations resultant from clean-out episodes throughout its history of use. Four zones were identified during excavations and dates indicated repeated use from the Late Archaic to the early Historic Periods. Uniquely some of the most recent dates originate from the deepest zones (Zones 3 and 4) and are Terminal Late Prehistoric Period in nature (Table 4.6). It is hypothesized that the upper deposits are from older use events which then slumped into the central depression via colluvial action (Godwin 2002).

Artifacts within Feature 3 included 73 pieces of debitage, five unifaces, and a single biface. The unifaces were all convex side scrapers made of local Indian Mesa chert and stand in contrast to the to the artifact assemblage from the remainder of the site which was dominated by generalized bifaces. Radiometrically dated materials from the basal zones, Zones 3 and 4, indicated use between A.D. 1300 and 1420, firmly within the Terminal Late Prehistoric Period (Table 5.6) (Godwin 2002).

5.3 Overview of Terminal Late Prehistoric Sites in the Eastern Trans-Pecos Archaeological Region

As presented above a total of nine archaeological are included in this analysis to understand Terminal Late Prehistoric Period human plant foods and dietary landscapes. Four of these are protected sites, three being rockshelters and a fourth a cave, constitute a portion of the archaeological site sample within this study. Chosen because the original investigators utilized modern paleoethnobotanical procedures during analysis, these sites present unique attributes which attest to the rich archaeological record of the eastern Trans-Pecos. All of the sites were utilized for subsistence reasons and provide information regarding wild resource use throughout their occupations. Two protected sites had evidence for the storage of plant foods, Tranquil Rockshelter (Cason 2018) and Tres Metates Rockshelter (Seebach 2007), while the remaining two, Rough Cut Rockshelter (Gray 2008) and Granado Cave (Hamilton 2002), furnished mortuary data. More specifically Rough Cut Rockshelter, with its ninety-one Perdiz points indicated a focus on the procurement of game species while Tranquil and Tres Metates Rockshelters possessed evidence of ties with the La Junta Phase in the La Junta de los Rios area. Granado Cave constituted the primary source of botanical foodways for the Castile Phase as well as a key site for describing the material culture of this phase.

Though the remaining five sites are unprotected, these still provided information regarding lifeways during the Terminal Late Prehistoric Period. Related to the Cielo Complex, Cielo Bravo and Arroyo de las Burras contributed data regarding site organization, layout, and stone-based wickiup construction. The Arroyo de la Presa site demonstrated hunting and gathering over a 3,000 year period and included data related to the Concepcion Phase during the Terminal Late Prehistoric Period. Though the remaining two open sites do not have an archaeological cultural affiliation, 41PC502 and the Fulcher Site displayed evidence for wild resource use during the Terminal Late Prehistoric Period.

All of the archaeological sites presented here assisted in addressing the three primary research questions of this study. Because these sites directly date to the Terminal Late Prehistoric and possessed preserved botanical remains related to past human diet, the data gathered from these locations was analyzed through a variety of techniques as presented in the following chapter.

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CHAPTER VI

MATERIALS, METHODOLOGY, AND MODELS

For this study two primary analyses, one focusing on the physical remains of plant diet and the second reconstructing botanical dietary landscapes, were used to define Terminal Late Prehistoric (TLP) Period (A.D. 1250/1300 – 1535) plant diet and botanical dietary landscape access. Due to the inherently fragmented nature of the archaeological record, and paleoethnobotanical remains in particular, multiple analyses were required to gain needed information for understanding this aspect of prehistoric human behavior. To develop said understanding this study utilized original sample analyses and incorporated results from other studies undertaken within the eastern Trans-Pecos as well as regions surrounding it, specifically the western Trans-Pecos, Lower Pecos, Central Texas, and southern New Mexico region. Original analyses were undertaken with samples taken from Tranquil Rockshelter (41BS1513), Rough Cut Rockshelter (41BS1507), Cielo Bravo (41PS52), and Arroyo de las Burras (41PS104). These materials were chosen to expand paleoethnobotanical knowledge not only for the study time period but for the region as a whole. These analyses were then incorporated into the larger corpus of data inter-regional level.

To fully understand available plant food resources for a given location a spatial analysis was undertaken for the nine archaeological sites described in Chapter 4. This analysis builds upon and refines the methods used in Riggs (2014) by utilizing reconstructed site catchments rather than foraging radii. With this information it was possible to more fully hypothesize seasonal botanical diet breadth as it provided information regarding dietary plant taxa which rarely preserve in the archaeological record. Differences in foraging catchment plant community composition and arrangement are also analyzed to understand decision making and landscape use of these past peoples

6.1 Botanical Remains

To understand the taxonomic composition of Terminal Late Prehistoric Period human plant diet published, unpublished, and original sample analyses were utilized. Four archaeological sites have been previously published, three have unpublished data, and two were originally analyzed. For the three sites with unpublished data, two were further analyzed by this researcher. Requirements for inclusion within the study sample required the use of modern, in-field paleoethnobotanical sample gathering, laboratory processing, and reporting (Pearsall 2015).

Site No.	Site Name	Published Report	Unpublished Report	Original Analysis
41PC502		Dering (2002)		
41CU8	Granado Cave	Hamilton and Bratten (2001)		
41PS800	Arroyo de la Presa	Dering (2004)		
41PS915	Tres Metates Rockshelter	Seebach (2007)		
41BS1495	Fulcher Site		Dering (2008a)	
41BS1513	Tranquil Rockshelter		Dering (2009a)	X
41BS1507	Rough Cut Rockshelter		Dering (2009b)	X
41PS52	Cielo Bravo			X
41PS104	Arroyo de las Burras			X

Table 6.1. Published, unpublished, and original paleoethnobotanical analyses within the study sample.

6.1.1 Eastern Trans-Pecos Published and Unpublished Macrobotanical Data

Previously published studies included macrobotanical analyses from 41PC502 (Dering 2002), Tres Metates Rockshelter (41PS915) (Seebach 2007), Arroyo de la Presa (41PS800) (Dering 2004), and Granado Cave (41CU8) (Hamilton and Bratten 2001) (Table 6.1). It should be noted that macrobotanical analyses were not undertaken at Granado Cave, rather pollen analyses were undertaken from sediment and coprolite samples (Hamilton and Bratten 2001).

Because of this Granado Cave was excluded from macrobotanical statistical analyses but included in other analyses regarding plant diet composition, presence-absence, and comparison with historic and available floral food resources.

Three archaeological sites have paleoethnobotanical data, have yet to be published, but were accessed via archival research at the Center for Big Bend Studies at Sul Ross State University, Alpine, Texas. These included Tranquil Rockshelter (41BS1513) (Dering 2009a), Rough Cut Rockshelter (Dering 2009b), and the Fulcher Site (41BS1495) (Dering 2008a) (Table 5.1). Two of these sites, Tranquil and Rough Cut Rockshelters, were furthered analyzed for this study and the procedures described below.

To analyze results from previous studies Microsoft Excel spreadsheets were generated for each site and then grouped together for the region as a whole. Information recorded from within the spreadsheets included the feature number, sample metric data, and metrics regarding recovered human diet associated plant parts. These metrics included counts, weight, and volume of the plant parts. A data cleaning method used at this stage was to include only those plant parts which were carbonized when the sample was from an open archaeological site. This is a commonly undertaken step as these plant parts are most likely evidence of human activity. Additionally, the charring process also prevents decay of the plant part. In some instances, unburned plant materials may be present within a sample, and associated with post-occupational processes and not indicative of human activity. For protected sites this data cleaning was not utilized as all plant parts present within a given sample’s assemblage are considered evidence of human activities. Preservation of materials from protected sites within the study site sample was exceptionally high and botanical remains associated with faunal activities were recognized and noted by the original excavator; these faunal-attributed materials were then excluded from this analysis.

A total of four sites were included as original analyses. Two of these sites, Cielo Bravo (41PS52) and Arroyo de las Burras (41PS104), had not received previous paleoethnobotanical analyses. The remaining two sites for which samples were analyzed within this analysis included Tranquil and Rough Cut Rockshelters, as mentioned above. For these standard macrobotanical laboratory analyses were utilized and briefly described below.

6.1.2 Laboratory Procedures

For the four sites which were originally analyzed, the original field samples were procured from storage at the Center for Big Bend Studies at Sul Ross State University in Alpine, Texas. Provenience data from the samples themselves as well as fieldwork paperwork were recorded in spreadsheet format. After this the samples were processed using techniques most appropriate for the preservation values at each site. The main difference between these techniques was the use of flotation to separate organic from nonorganic remains for samples from open sites and those from protected sites skipping this procedure.

6.1.2.1 Open Site Macrobotancial Sample Processing

Eleven samples from two open archaeological sites, Cielo Bravo and Arroyo de las Burras, were analyzed for this study. Upon receiving the samples, provenience data recorded and sample numbers assigned. After this the samples were weighed, and volume recorded before undergoing flotation with the data presented in Appendix A. Flotation was considered a necessary step in processing to separate organic from inorganic material as well as to extract botanical remains from adhering matrix (Pearsall 2015).

For flotation a bucket was filled with water and then agitated to create a vortex which the sample was gently poured into. The liquid was then poured into a colander lined with chiffon fabric that was placed in a sink to collect the light, floating fraction of the sample. Decanting took place until all liquid had left the bucket and a slurry of sediment had begun to enter the chiffon-lined colander. After this the bucket was refilled with water, stirred, decanted, and the process repeated until the decanted liquid ran clear. Having collected the light fraction the edges of the fabric were gathered, a piece of flagging tape with the sample number tied the fabric together and then hung from a rope in a heated barn to slowly dry.

The remaining material in the bucket, the heavy fraction of the sample, was then washed into a 1 mm mesh screen which lined a colander in a sink. Once in the lined colander the heavy fraction was rinsed to removed smaller sediments. The edges of the mesh were then gathered and tied by a piece of flagging tape with the sample number written on it. To dry the heavy fraction subsamples, each subsample was attached to a section of hog fencing panel with clothespins and allowed to dry in a heated barn.

After seven days of drying the samples were removed and taken to an indoor, temporary laboratory space. Each subsample was weighed, volume taken, and then sieved through a set of geologic sieves. This created size fractions of greater than 4 mm, 4 to 2 mm, 2 to 0.5 mm, and less than 0.5 mm. Each size fraction was then collected in petri dishes, observed with a Nikon SMZ-1 dissecting macroscope, and floral, faunal, and artifactual remains collected. For botanical remains collection was further split into uncharred plant fragments, charred woody plant fragments, and charred non-woody plant fragments. Here charred plant parts were only used to document prehistoric plant use as they were likely altered, and thereby preserved, by human activities and provide direct evidence of them. Uncharred plant remains were considered to be from post-occupation contamination (Pearsall 2010). Charred non-woody plant remains were then identified with seed identification manuals (Bonner and Karrflat 2008, Martin and Barkley 2000), online resources (Adams and Murray 2004), and comparative samples from the Texas A&M Macrobotanical Comparative Collection housed in the Department of Anthropology at Texas A&M University, College Station, Texas. After identifying the plant part the taxonomic information was recorded in the corresponding spreadsheet as well as the number, weight, and volume when possible.

6.1.2.2 Protected Site Macrobotanical Sample Processing

Seventeen matrix samples from two protected archaeological sites, Rough Cut Rockshelter and Tranquil Rockshelter, were analyzed for this study. Additionally, botanical materials recovered from screening through 2 mm excavation screens and/or point plotted during excavation were also analyzed. The inclusion of these types of samples for a given feature was considered necessary to obtain the maximum about of botanical materials from a given feature.

Unlike samples from open sites the high preservation of the rockshelter settings precluded the use of flotation to separate materials. Due to the desiccated nature of the plant remains the sudden addition of water would destroy many of the remnants and in so doing destroy the integrity of the sample (Pearsall 2015). Rather, the samples were sieved and otherwise processed as described above. The only difference in processing occurred during sorting, with sort groups being AMARANTHACEAE seeds, other forb seeds, grass seeds and inflorescence parts, small cacti seeds, prickly pear (*Opuntia* spp.) reproductive parts and tissue, western honey mesquite (*Prosopis glandulosa*) reproductive parts, Agavoidea parts, charred wood fragments, and uncharred wood fragments. Identifications were made with the same resources discussed above and metric data recorded as previously discussed. Additionally, the plant remains from said rockshelters were considered to have been attributed to human activities, unless excavation records mentioned samples coming from post-deposition faunal activities, and did not require exclusion if un-charred (ex. Pearsall 2010). For samples gathered from excavation screenings or encountered during excavation the sieving process was omitted. Instead the samples were sorted into the classes discussed previously and the resultant identification and data recording processes duplicated as outlined above.

6.1.3 Inter-Regional Literature Review

A secondary analysis related to macrobotanical remains was the comparison of botanical diet as identified through macrobotanical remains between the eastern Trans-Pecos Archaeological Region and surrounding areas between A.D. 1250 and 1535. For this a large-scale literature review was undertaken to identify and provide data from archaeological studies with occupations synchronous to this study. Another filter for this literature review was the use of modern paleoethnobotanical procedures, both in the field and in the laboratory, and reporting. This was necessary as outlined above to ensure comparability between assemblages. Table 6.2 presents basic information for the archaeological sites identified with the literature review.

Table 6.2. Inter-regional sites used in analysis.

Site No.	**Site Name**	**Cultural Affiliation**	**Source**
41HZ119	Wind Canyon Site	Western Trans-Pecos	Bohrer (1994)
LA37130		Southern New Mexico	Miller et al. (2011)
LA161981		Southern New Mexico	Miller et al. (2011)

Table 6.2. Continued

Site No.	Site Name	Cultural Affiliation	Source
LA37157		Southern New Mexico	Miller et al. (2012)
LA123504		Southern New Mexico	Miller, Graves, and Landreth (2012)
4:014E	Three Lakes Pueblo	El Paso Phase	Ford (1977)
41EP4700		El Paso Phase	O'Laughlin (1997)
LA72859	MOTR Site	El Paso Phase	Cummings (1992)
	Firecracker Pueblo	El Paso Phase	O’Laughlin, unpublished data
LA43414	Merchant Site	Ochoa Phase	Dering and Smith (2016)
LA10832	Abajo de la Cruz	Lincoln Phase	Minnis et al. (2016)
LA68188	Fox Place	Plains-Pueblo	Toll (2002)
41VV1895		Flecha Interval	Dering (2003)
41VV1897		Flecha Interval	Dering (2003)
41HY165		Toyah Phase	Leezer (2013)
41TV441	Toyah Bluff Site	Toyah Phase	Dering (2001)
41ED28	Varga Site	Toyah Phase	Quigg et al. (2008)
41KM69	Flatrock Road Site	Toyah Phase	Dering (2012)
41HM61		Toyah Phase	Bush (2015)
41HY209-T	Mustang Branch Site	Toyah Phase	Cummings (1994)
41TG346	Rush Site	Toyah Phase	Dering (1995)

Note that the macrobotanical data from Firecracker Pueblo has not been previously published.

6.2 Macrobotanical Dietary Analysis

To determine botanical dietary breadth as well as staple foods five primary methods were used to quantify this aspect of human behavior at two scales: within the study area and between the study area and surrounding regions. At the study area scale these methods were used to quantify dietary differences between sites, compare the diversity of archaeologically encountered plant foods to the diversity of the surrounding reconstructed botanical dietary landscape, as well as test the accuracy of these reconstructed landscapes. For the inter-regional scale these methods were used to compare differences in plant diet between regions. It should be noted that due to the preservation value differences between rockshelters and open sites these two site-types were analyzed separately. In total five primary analytical techniques were utilized. The simplest included presence-absence in conjunction with ubiquity, botanical diet breadth, and recorded vs.

recovered diet with the tandem delineation of seasonally available foods. Beyond these more basic approaches species diversity indices were also incorporated into the analysis. Finally, an attempt was made to use correspondence analysis for the inter-regional dataset and rockshelter data from the eastern Trans-Pecos.

6.2.1 Presence-Absence and Ubiquity

Within paleoethnobotany two measures have demonstrated great utility in reporting and describing macrobotanical assemblages, presence-absence and ubiquity (Marston 2014, Pearsall 2015). Here presence-absence is used to identify which plant taxa were identified at a given site without standardization. With this method a simple list of plant taxa was generated for each site to delineate the total taxonomic breadth for a given site assemblage. Ubiquity was calculated as the percent of samples for which a taxon occurs though this was only used with the eastern Trans-Pecos rockshelter data. This was due to said dataset being the most standardized in terms of sample processing and similar preservation values compared to all other archaeological within the study sample.

6.2.2 Botanical Diet Breadth

Subsequent to this a comparison of plant diet breadth was undertaken. Though not a true diet breadth model (i.e., faunal material is not utilized in this analysis) the analysis incorporated aspects of previous models and dietary descriptions, specifically from Dering (2008b) in Central Texas, Riley (2012) in the Lower Pecos, and Hard and Roney (2005) in Far West Texas, southern New Mexico, and northwestern Chihuahua.

As noted by Kelly (2013), a diet breadth model consists of four parts: goal, currency, constraints, and options. The goal for this analysis is to maximize caloric return with currency set as kcal per hour of work. This model uses the same constraints as Riley (2012) in reproductive habits of plants as well as inter-annual dependability. From Riley (2012), desert succulents, specifically prickly pear and agaves, are more reliable resources due to their reproductive habits and year-round availability, especially for those producing caudexes. Other, mast producing taxa are considered less reliable due to wide swings in interannual fruit production. An additional constraint added to this modeling attempt is task scheduling conflicts. The dataset included both hunter-gatherers as well as farmers located in southern New Mexico as well as the western Trans-Pecos. It is assumed here that farming activities would create a conflict between time spent foraging for wild foods versus maintaining and harvesting gardens. The options are defined herein as individual plant taxa at the study area scale and groupings of plant taxa at the interregional. This grouping was deemed necessary to streamline analysis and repeated for the multivariate analyses described later in this chapter.

6.2.3 Recovered vs. Recorded Diet

Another, basic analysis included within this work is the comparison of recovered macrobotanical diet versus that recorded within early Historic Spanish accounts as well as ethnographic data from the Mescalero Apache. Previous research by myself (Riggs 2014) has demonstrated a significant overlap between the Mescalero Apache plant diet and that of Late Prehistoric diet within the eastern Trans-Pecos. The current study differs from my previous work in two ways. First, Riggs (2014) only utilized data from four published studies (Dering 2002 and 2004, Hamilton and Bratten 2001, Seebach 2007) and analyzed from the entirety of the Late

Prehistoric Period. This work focuses on the TLP, includes data from nine archaeological sites within the eastern Trans-Pecos instead of four, and doubles the number of protected archaeological sites from two to four. Essentially the narrowing of the time period and increase in data, especially from rockshelters, provides another level of scrutiny in comparing recovered versus recorded plant diet specifically to the identification of staple plant food resources.

In tandem with comparing historic and archaeological diet is identifying seasonality of plant use based upon maturation of target plant food resources. This will assist in identifying seasonality of site occupation as well as defining menus on an annual basis. Through inclusion of this the importance of a given plant taxa in comparison to other seasonally available foods can further assist in determining staple botanical food resources.

6.2.4 Species Diversity Indices

Two indices were also used in this study to assess the diversity of plant assemblages at both levels of analysis and are frequently used within paleoethnobotany (Marston 2014, Pearsall 2015, Popper 1988). These included the Shannon-Weaver Diversity Index (Shannon and Weaver 1949) (Equation 5.1) and Simpson's Diversity Index (Simpson 1949) (Equation 5.2). Though both of these indices provide measures of diversity the outputs of these differ. For the Shannon-Weaver Diversity Index the output ranges from 0 to a maximum relative to the total number of plant taxa within the sample (Marston 2014, Shannon and Weaver 1949). With Simpson's Diversity Index the output ranges from 0, meaning no diversity, to infinity with the higher the output the greater the level of diversity (Marston 2014, Simpson 1949). Because the goal for this sub-analysis is to compare dietary diversity evenness indices were not used.

The equations for these are:

$$SHDI = -\sum_{i=1}^{m}(P_i * \ln P_i) \text{ (Eq. 6.1)}, \; SIDI = 1 - \sum_{i=1}^{m} P_i^2 \text{ (Eq. 6.2)},$$

Equations 6.1 Shannon's Diversity Index and *6.2* Simpson's Diversity Index.

For both of these equations P_i represents the proportion of the sample occupied by species I while m is the total number of dietary plant taxa within a given assemblage.

6.2.5 Multivariate Statistics

A multivariate statistical method, correspondence analysis (CA), was also used in this study to further delineate dietary composition and included hierarchical cluster analysis and correspondence analysis. This method has been noted as a robust means to identify patterns within a dataset as well as summarize large datasets (Gauch 1982, Smith 2014). As an open-ended exploratory approach, another strength of CA is that no presumption of variables affecting the data are needed (Smith 2014). CA also allows for the creation of groupings to better represent the data while decreasing the dataset size (Smith 2014). In order to perform this analysis the statistical program Past v3.2 (Hammer et al. 2001) was used.

Through the use of weighted averages created for both columns (plant species or plant use group) and rows (archaeological site), CA uses eigenanalysis to calculate the total variance of the species/plant group data. This total variance is measured by the taking the X^2 of the site-species, or site-plant group, data and dividing by the table's total (Smith 2014, ter Braak and Smilauer 2002).

Results of CA are usually presented as a bi-plot which graphs both the taxa and site information along two axes. Here the first axis represents the highest variance, and then each subsequent axis less variance than the first. Ideally the first two axes capture >50% of the variance and if this threshold is not met the analysis should be reconsidered as not enough of the variance is being explained (Bush 2004). Specific to interpreting the CA plot, common species usually graph near the origin with more rare taxa towards to outer limits of the graph (Smith 2014).

With the inter-regional analysis two data reduction strategies were used. First the taxa use groups were generated and the resultant counts were converted into binary format with a 1 equating to presence and 0 to indicate absence. With these two data reduction techniques the resultant dataset was then analyzed with Past 3.2 using an unweighted pair-group average algorithm and a Jaccard similarity index. The results of this are also presented in the following chapter.

Two datasets were also generated which allowed for the best representation of the data. Within the study area raw taxa counts were tallied for the rockshelter sites at the feature level and said features were then compared. Table 5.3 identifies which taxa were grouped into use groups at the inter-regional scale. These groupings were developed so a single taxon could only be present in single group and that inclusion within the use group could occur regardless of ecological constraints at the inter-regional level.

Table 6.3. Use group based on taxonomic identifications from original manuscripts and identifiable parts.

Study Group Name	Parts	Taxa Included
Agaves	Caudex fragments, fiber bundles	*Agave* spp. *Dasylirion* spp. *Yucca* spp.
Geophyte	Bulb skin fragments	LILIACEAE
	Tuber fragments	*Pediomelum* spp.
Cholla	Seeds, seed fragments	*Cylindropuntia* spp.
Wild cucurbit	Seeds, seed fragments	*Apodanthera* spp. *Cucurbita foetidissima*
Cushaw	Seeds, seed fragments	*Cucurbita mixta*
Mast	Nutshell fragments	*Carya illinoisensis*

Table 6.3. Continued

Study Group Name	Parts	Taxa Included
		JUGLANDACEAE
		Juglans microcarpa
		Juglans nigra
		Quercus spp.
Domesticated bean	Seeds	*Phaseolus acutifolius*
		Phaseolus vulgaris
Shrub fleshy fruits	Seed fragments	*Celtis reticulata*
		Rhus microphylla
Forbs	Seeds, seed fragments	AMARANTHACEAE
		Artemisia spp.
		ASTERACEAE
		Compositae
		Euphorbia glyptosperma
		Iva ambrosiaefolia
		Mollugo spp.
		Oenothera spp.
		Portulaca spp.
Grape	Seeds	*Vitis* spp.
Grass seeds	Seeds	POACEAE
		Sporobolus spp.
Juniper	Fruit fragments	*Juniperus* spp.
Maize	Cobs, kernels, cupules	*Zea mays*
Mesquite	Endocarp fragments,	*Prosopis glandulosa*
		P. pubescens
Prickly pear	Seeds, epidermis fragments	*Opuntia* spp.
Piñon	Seeds, seed coats, cone scales	*Pinus* spp.
Small cacti	Seeds, seed fragments	*Echinocactus* spp.
		Echinocereus spp.
Yucca	Seeds, fruit fragments	*Yucca* spp.

At the inter-regional level a more stringent data reduction technique was used to decrease the noise in the dataset. Here the same taxonomic groupings as presented in Table 6.3 were used as was conversion from raw totals to binary format. After this the dataset was further reduced by combining sites to their material culture affiliation or geographic area. Basically, this dataset counts the number of archaeological sites which a plant use group was encountered in a given archaeological culture.

6.3 Botanical Dietary Landscape Reconstruction

Within archaeology several studies have been undertaken to delineate areas around archaeological sites which would have been accessed by past inhabitants to access resources. The first studies utilized a radius around sites based on Euclidean, or isotropic, distance (ex. Roper 1979, Vita-Finzi and Higgs 1970) and did not account for costs, such as topographic relief and caloric expenditure, associated with an individual moving across a given landscape (anisotropic distance) (ex. Morgan 2008). A previous study by this researcher (Riggs 2014) also utilized this methodology within the study area. Though this method provides a general understanding for available resources it is less accurate than those which utilize anisotropy. More recent studies have included these movement costs not only in moving across a landscape to access resources (Morgan 2008) but also between sites (Surface-Evans 2012), largely a result of modern geographic information systems (GIS) which allow for multiple variables to be used. These studies use topographic relief as the primary cost associated with movement and this study reflects the current trend.

For this analysis, hypothesized single-day foraging catchments were developed to identify available plant foods and landscape patches for Terminal Late Prehistoric Period peoples in the eastern Trans-Pecos archaeological region. These catchments were then used to extract historic climax plant community (HCPC) data from United States Department of Agriculture-Natural Resource Conservation Service (USDA-NRCS) ecological site description (ESD) data. After this a spatial analysis was undertaken using the categorical map pattern analysis software program FRAGSTATS v4.2 (McGarigal, Cushman, and Ene 2012) to identify and compare metrics for each catchment at the class and landscape levels.

6.3.1 Ecological Site Descriptions

One of the most fundamental parts of ecological theory is that of ecological succession. With ecological succession a given area progresses from either a newly created surface, primary succession, or one that has recently been disturbed, secondary succession, until a climax community is developed through successive seral stages (Clements 1916, Weaver and Clements 1938, Tobey 1981). In recent decades it has been demonstrated that though some areas, primarily forests, move along a trajectory of an early seral stage to that of a climax community, others, especially rangelands in arid and semi-arid regions, do not have a single trajectory of succession. Rather multiple pathways with many stable ecological communities can exist for a given area with this referred to as alternative stable state theory (Bestelmeyer et al. 2003, Brown 2010, Westoby et al. 1989).

Within alternative stable state theory, a given area can alternate between stable and transitional states as determined by changes in ecological disturbance type, frequency, and intensity (Westoby et al. 1989). Because this theory provides a better understanding for ecological variability the USDA-NRCS implemented the Ecological Site Description System (ESDS) as a means to better classify and provide management guidance for rangelands of the United States of America. At the most basic level the ESDS classifies land areas based on the ecological site, with this being a distinctive kind of land with specific abiotic and biotic factors which can produce a specific kind and quantity of vegetation. Additionally, this classification unit can respond equivalently to natural disturbances and management actions (Moseley ey al. 2010). Typically, the baseline datum for delineating an ecological site are the abiotic factors: moisture conditions, soils, aspect, and topography. This further assists resource researchers and land managers in delineating an ecological site when no vegetation may be present (Moseley et al. 2010). From here additional research is undertaken to identify the potential stable and transitional plant communities as well as disturbances which may occur in a given ecological site. The result of this is a state-and-transition model which identifies the plant communities, disturbances, anthropogenic processes, and management considerations for an ecological site. Figure 6.1 provides a state-and-transition model example for the ecological site Limestone Hill 14-19” PZ, R081AY556TX within the study area.

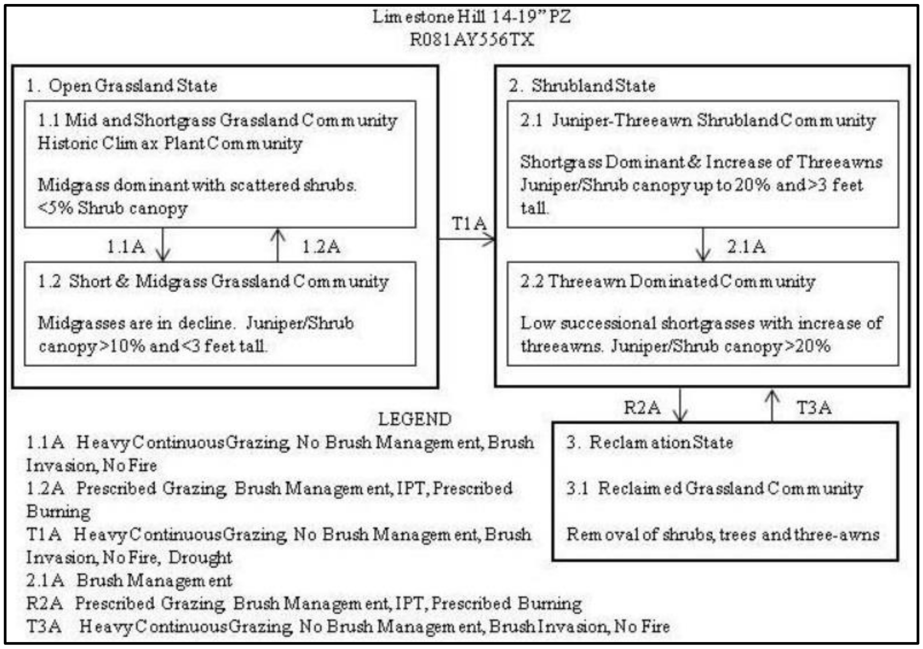


Figure 6.1. State and transition model example for Limestone Hill 14-19” PZ, R081AY556TX.

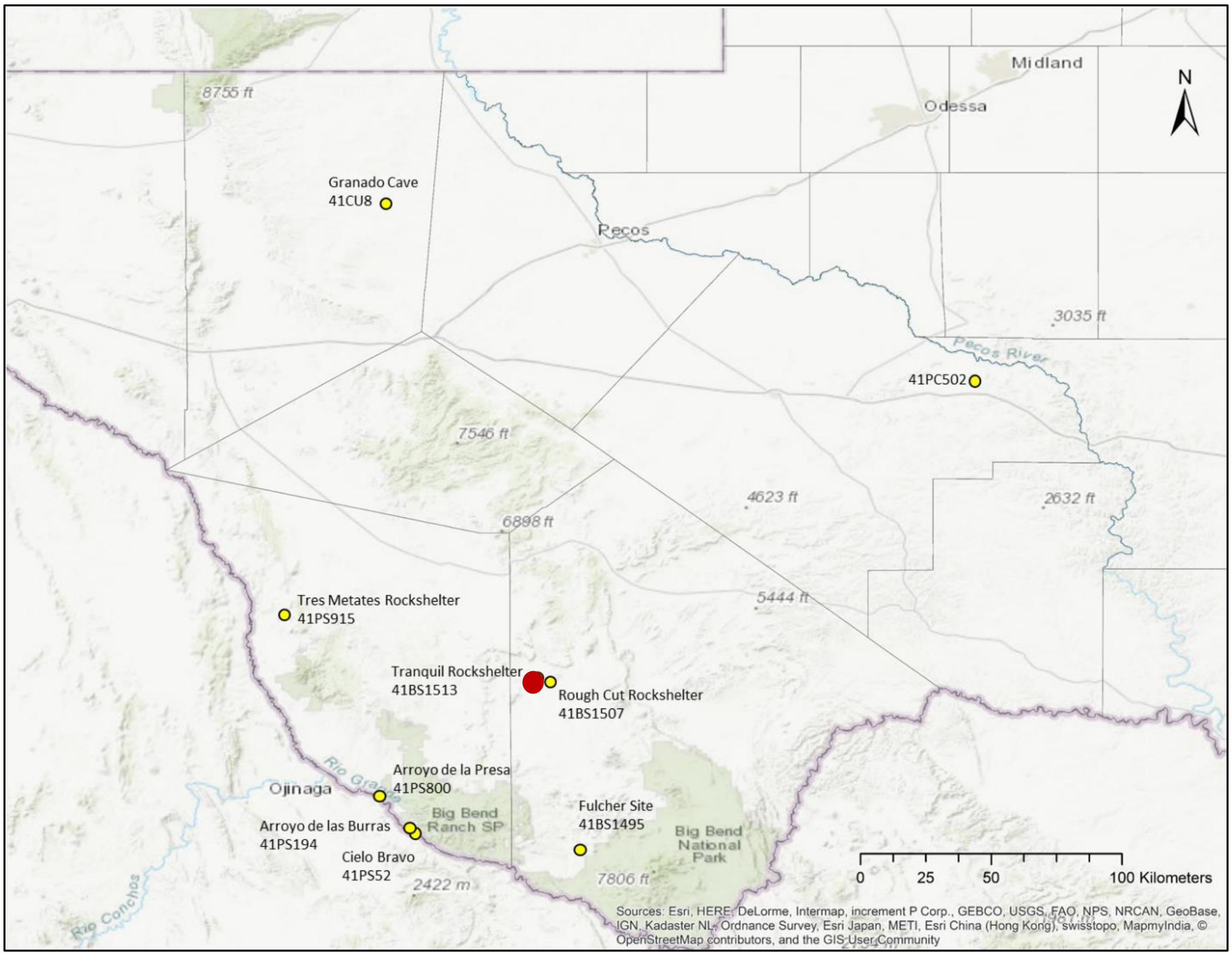
As outlined above the ESDS provides a realistic understanding of HCPC composition as well as spatial coverage. The ESDS also includes a temporal component with a goal for delineating the HCPC to recent prehistoric times of up to 500 years prior to European settlement (Winthers et al. 2005, Caudle et al. 2013). Currently it is theorized that the mosaic of plant communities encountered by the first Europeans in the Chihuahuan Desert was a result of climatic conditions attributed to the Little Ice Age, primarily because precipitation was higher in the warm season rather than the cool season (Neilson 1986, Okin et al. 2009). Thus, because the ESDS seeks to identify the plant communities which existed at European contact and because these plant communities stabilized at the onset of the Little Ice Age, HCPC from the ESDS can be used to identify botanical resources patches during the Terminal Late Prehistoric Period.

To incorporate HCPC information into this analysis a GIS was utilized to digitally plot the recorded spatial extent of HCPCs. Because the archaeological sites do not occur in every county within the study area, spatial soil data was downloaded from Web Soil Survey (Soil Survey Staff) for Brewster, Culberson, Pecos, and Presidio Counties as well as Big Bend National Park in Brewster County. After this the soils data was loaded into a Microsoft Access database and then plotted in a blank ArcMap 10.5 map document using Soil Data Viewer 6.2.

6.3.2 Foraging Catchment Reconstruction

As stated previously, hypothetical site catchments were developed for each archaeological site within the study to identify resource patches which could have been accessed, plant collection activities undertaken, and then the collected resources returned to the campsite. From here the plant resources would have been further processed, consumed, and/or stored for future use. These catchments were delineated through a spatial analysis utilizing archaeological site locations, topographic data, Tobler’s hiking function (Tobler 1993), and modelled hunter-gatherer foraging behavior (Kelly 2013).

To reconstruct the foraging catchments for a single location the nine archaeological within the study sample the spatial locations were needed. This spatial information was gathered from the Texas Archeological Site Atlas by querying the database using each site’s trinomial number. The site coordinates were recorded in a blank Microsoft Excel spreadsheet and then plotted in the ArcMap 10.5 document with the HCPC data. Figure 6.2 portrays the site locations for the nine sites in the eastern Trans-Pecos sample. Tranquil Rockshelter is highlighted in maroon as it will be used as a visual example for the following analytical steps.



Sources: Esri, HERE, DeLorme, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, MapmyIndia, © OpenStreetMap contributors, and the GIS User Community

Figure 6.2. Archaeological sites at the regional level.

Because this study considered topography as the primary cost for moving across a given landscape a topographic layer was added to the map document. This layer consisted of digital elevation model (DEM) data gathered from The National Map Version 1.0 (https://www.usgs.gov/core-science-systems/national-geospatial-program/national-map-0) in ArcGrid format at a resolution of 1/3 arc-second, or 30 x 30 m. A DEM was acquired for each archaeological site within the study sample. For ease in analysis the DEM data was converted from ArcGrid format into integer format and then further processed to convert the DEM to degree of slope for use with Tobler's hiking function (Tobler 1993). Figure 6.3 presents the DEM generated for Tranquil Rockshelter and Figure 6.4 presents the same DEM data but in hillshade effect.

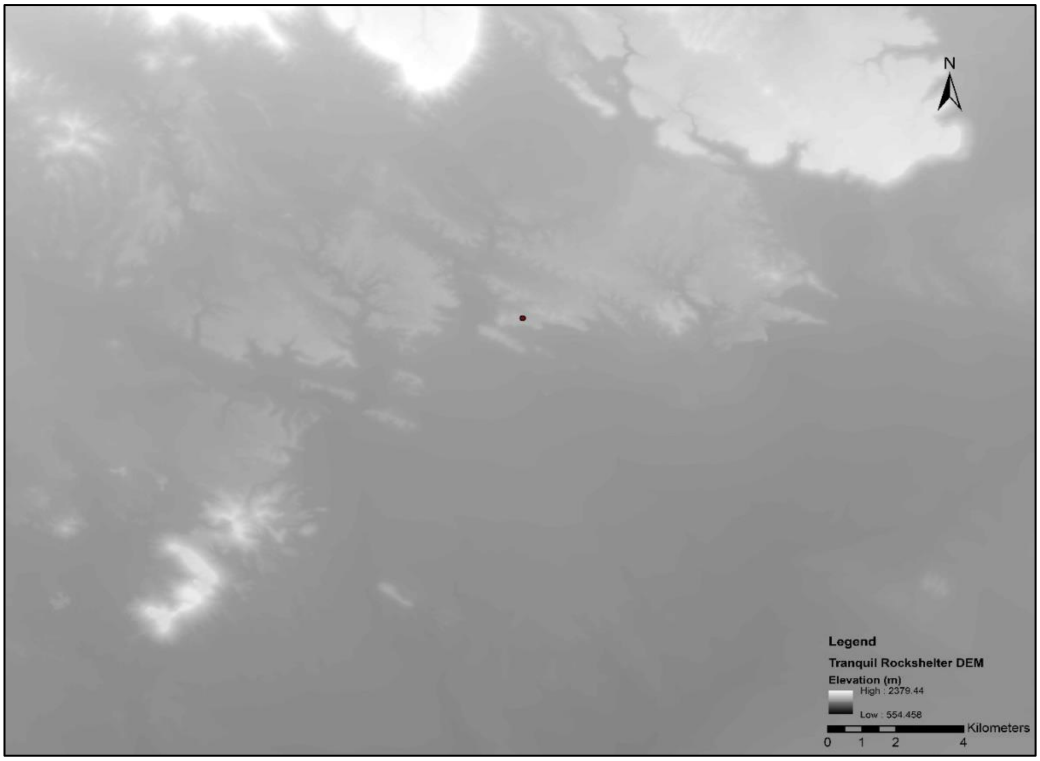


Figure 6.3. Tranquil Rockshelter DEM with archaeological site in maroon.

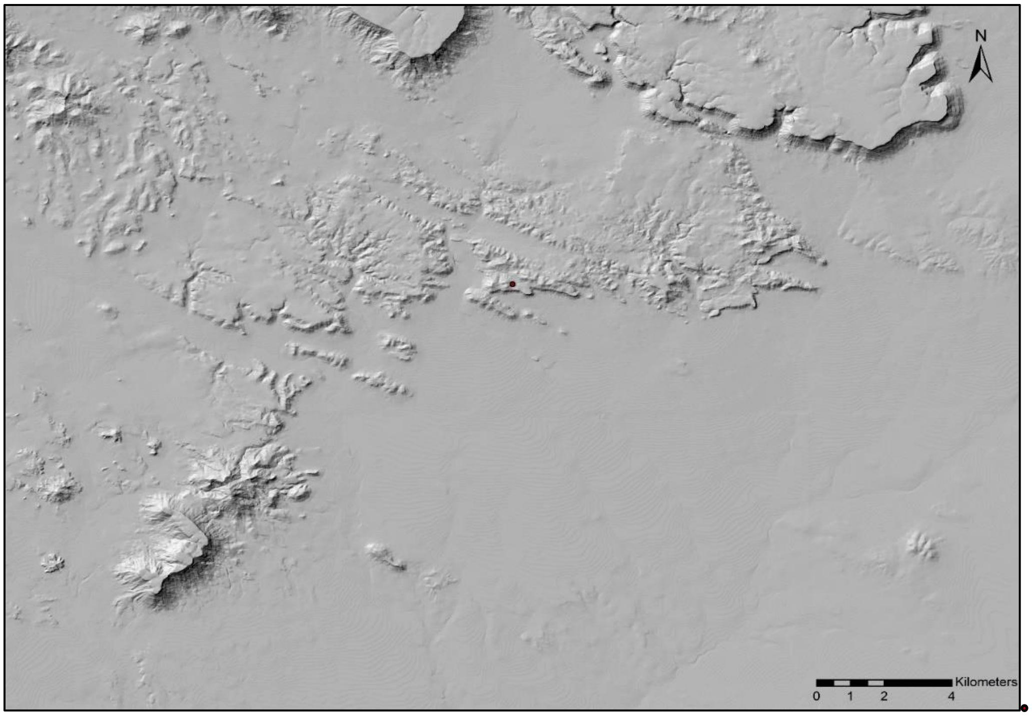


Figure 6.4. Tranquil Rockshelter DEM with hillshade effect and site location in maroon.

For reconstructing the foraging catchments the reciprocal of Tobler's hiking function was utilized to spatially delineate the distance and time (cost distance) an individual collector could have travelled from a given archaeological site. Tobler's hiking function is an exponential function which determines one's hiking speed while taking into account the angle of slope (Tobler 1993). The equation for this function is:

$$W = 6e^{-3.5\left|\frac{dh}{dx}+0.05\right|}$$

And

$$\frac{dh}{dx} = S = tan\theta$$

Equation 6.3. Tobler's Hiking Function.

Here W is the walking velocity (km/hr), dh is the elevation difference, dx equal to distance, S is slope, and θ the inclination.

To calculate the reciprocal of Tobler's hiking function, or the pace which is the reciprocal of speed, a conversion is needed and calculated by:

$$p = 0.6e^{3.5|m+0.05|}$$

Equation 6.4. Reciprocal of Tobler's Hiking Function.

Here p is the space or steps per meter and m is the gradient downhill or uphill as defined by S from Tobler's hiking function.

Essentially what these calculations identify is that an individual travelling along a flat surface can move 5.04 km in a single hour, or 0.084 km/minute. Slope affects this speed with movement uphill taking longer rather than downhill. Additionally, steeper slopes, either positive or negative, can also decrease one's pace. This reciprocal demonstrates that the furthest distance an individual can walk within an hour is 5.04 km and correlates with models of human gathering behavior.

For this analysis four assumptions were made to complete the foraging catchment/cost distance modeling. First, dense shrub growth was not considered a cost for travel as historic accounts nor HCPC data indicate the presence of dense brush within the study area historically. Though dense brush is present today it is attributed to alternative stable states not assumed to have been present in the recent past. Second, the inhabitants of the study area were landscape "knowers" (Rockman 2009) and knew the locations of resource patches, thus minimizing time in finding said patches. Third, these peoples were also provisioned with water as attested to by the presence of gourd (*Lagenaria* spp.) encountered in the archaeological record (ex. Hamilton 2001, Cason 2018) as well as historic accounts (Krieger 2002). The fourth and final assumption was that fording watercourses, specifically the Rio Grande, was a negligible cost as difficulty in its crossing was never described in the historic accounts.

Kelly (2013) provides modelled foraging behavior by combining the marginal value theorem as well as central place foraging theory as it applies to human behavioral ecology. In his model a hypothesized hunter-gatherer family unit gatherer needs to collect 14,000 kcal/day to supply the family. If this cannot be met a decision is made to move the family's location so that an appropriate return rate can be achieved. Assuming this gatherer is utilizing a landscape with homogenously distributed resources on level terrain, the individual will increase their foraging distance within a hypothetical eight-hour work day as resources are depleted immediately around the central place or campsite. Because of this the net return rate for these foraging trips decreases as one-way distance to the resource increases. Within the Kelly (2013) model the minimum net return rate must be 1,750 kcal/hr and the distance at which the minimum net return rate is achieved is 6 km. Once this distance is reached the hypothetical hunter-gatherer group will perform a residential move or begin logistical foraging to another foraging patch and repeat the process.

By combining Tobler's hiking function with the hypothetical resource collector from Kelly (2013) it is assumed here that the effective foraging radius of 6 km would be achieved after approximately 72 minutes according to the reciprocal of Tobler's hiking function. The exact distance is 6.048 km though further dividing time to the second is considered largely irrelevant for the purpose of this model.

Using the 72-min foraging limit as outlined by Tobler’s hiking function, a path distance analysis was undertaken using ArcGIS Pro 3.0. Within this software the archaeological site locations were plotted in combination with the digital slope layer described above. From this the Path Distance tool was used to calculate the one-way distance away from the site by modifying the software’s native algorithm with a Vertical Factor Table based on Tobler’s hiking function (Tobler 1993, Tripcevich 2015) which assigns a time cost to the slope value within the slope DEM. The file path for this is broken in ArcMap 10.5, hence the use of ArcGIS Pro 3.0. Within ArcGIS the program uses a cost function which analyzes the slope DEM raster using a “Queen’s move” which calculates the cost from a given raster cell to the eight surrounding raster cells. Figure 6.5 gives an example of the cost distance raster generated around Tranquil Rockshelter.

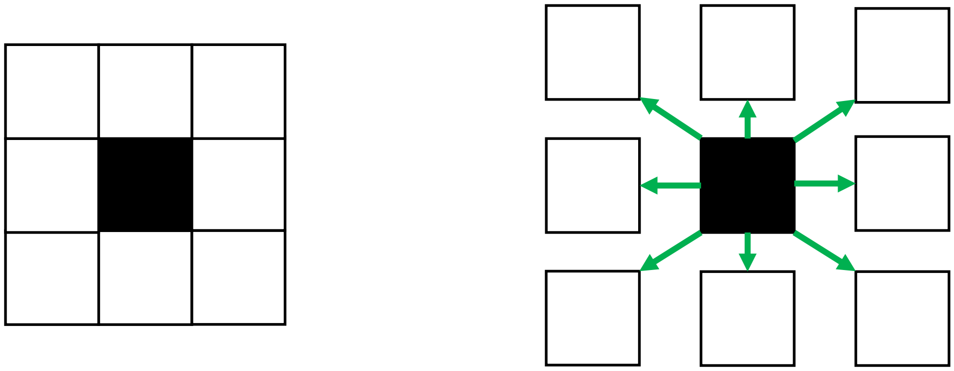


Figure 6.5. Example of the Queen’s Move used in the Path Distance tool from the center, colored raster cell to the eight surrounding raster cells.

After this cost distance raster was generated the output was loaded into the ArcMap HCPC document, converted into 1-min. contours and the 72-min. distance contour extracted to represent the maximum single day forging distance as described above. With the single hour contour delineated the underlying spatial HCPC data was then clipped to identify the plant communities within the foraging catchment (Figure 6.6). Because ecological sites are mapped primarily based on soil type multiple, adjoining polygons can contribute to a single patch of a given HCPC. To prevent FRAGSTATS from assuming an edge a data cleaning method was used whereby the adjoining polygons were merged into a single polygon. The same procedure was undertaken primarily to remove the boundary between Big Bend National Park and Brewster County. After this the feature was converted from vector to raster format, and then analyzed using the software program FRAGSTATS v4.2 (McGarigal, Cushman, and Ene 2012). It should be noted that the final three steps were not undertaken for three of the archaeological sites (Arroyo de la Presa, Cielo Bravo, and Arroyo de las Burras) because their foraging catchments includes portions of Chihuahua, Mexico and do not have comparable ecological spatial data. Figure 5.6 presents the 72-min. foraging catchment with HCPCs as well as relevant hydrologic features near Tranquil Rockshelter.

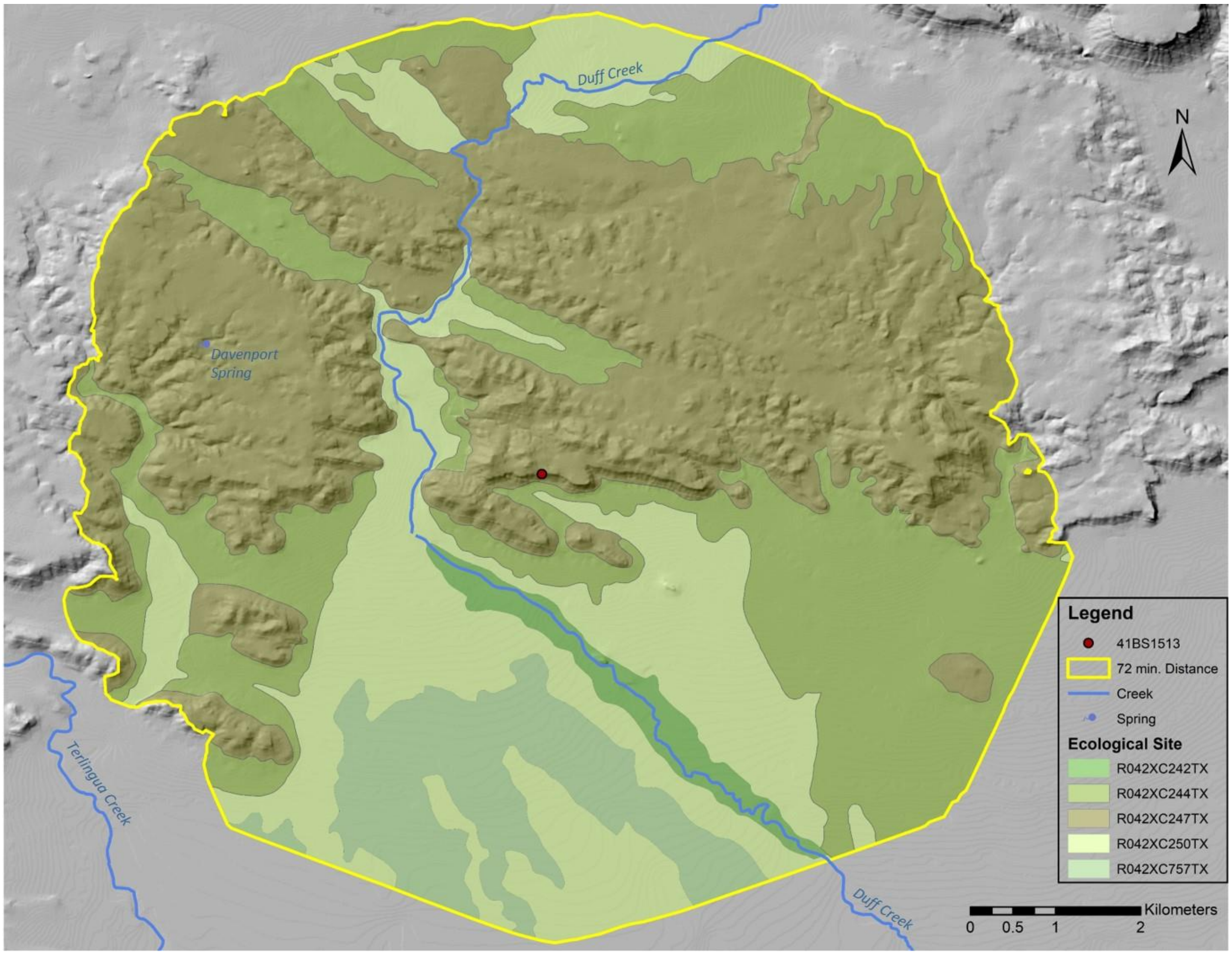


Figure 6.6. Seventy-two minute foraging catchment for Tranquil Rockshelter with Ecological Site IDs.

6.3.2.1 Foraging Catchment Statistical Analysis

A software program used by landscape ecologists (ex. Perotto-Baldivieso 2006, Li et al. 2001), FRAGSTATS is a software developed to analyze the spatial patterning of categorical maps. This software allows for the analysis of landscape data at three different scales: patch, class, and landscape. With FRAGSTATS one can calculate several metrics at varying scales (patch, class, landscape) of analysis (McGarigal, Cushman, and Ene 2012). Because of this metrics for the landscape scale were utilized to describe the general makeup of the foraging catchment as well as to allow comparisons between the foraging catchments. Here “patch” is defined as a single, discrete HCPC, a “class” is multiple patches all of which are defined as a given HCPC (i.e., a defined HCPC can have multiple patches within a landscape), and “landscape” is all HCPCs within a 72 min. cost catchment from a given archaeological site.

Eleven metrics were used to analyze the foraging catchments and included the total area (TA), number of patches (NP), landscape shape index (LSI), contagion index (CONTAG), patch richness density (PRD), as well as three diversity and three evenness indices. At the landscape level TA is calculated as the total area of the landscape, here the foraging catchment, and NP the total number of patches within the landscape (McGarigal, Cushman, and Ene 2012). Because ecological edge has been noted as sought-after areas of resource conglomeration by humans (ex. Ford 2000, Minnis and Elisens 2000, Turner, Davidson-Hunt, and O’Flaherty 2003), LSI was used because the metric can be used to compare the total ecological edge between landscapes of different sizes. PRD was also used as the metric standardizes the patch richness per area and allows for comparison between landscapes. Finally patch richness refers to the number of classes, of plant community types.

Owing to its usefulness in summarizing the overall clumpiness of a landscape, CONTAG is used here as a measure of patch type interspersion and dispersion at the landscape level (McGarigal, Cushman, and Ene 2012, O’Neill et al. 1988). The equation for the contagion index is:

$$CONTAG = \left[1 + \frac{\sum_{i=1}^{m}\sum_{k=1}^{m}\left[P_i * \frac{g_{ik}}{\sum_{k=1}^{m} g_{ik}}\right] * \left[ln\left(P_i * \frac{g_{ik}}{\sum_{k=1}^{m} g_{ik}}\right)\right]}{2\ln(m)}\right] * 100$$

Equation 6.5. Contagion Index.

Here P_i is the proportion of the landscape with class, or patch type i, g_{ik} the number of adjacencies between pixels of patch types i and k, and m the total number of patches present within the landscape, including the landscape border (McGarigal, Cushman, and Ene 2012).

The six indices used to compare the foraging catchments at the landscape scale were Shannon's Diversity Index (SHDI) (Shannon and Weaver 1949), Simpson's Diversity Index (SIDI) (Simpson 1949), Modified Simpson's Diversity Index (MSIDI) (Pielou 1975), Shannon's Evenness Index (SHEI) (Shannon and Weaver 1949), Simpson's Evenness Index (SIEI) (Simpson 1949), and Modified Simpson's Evenness Index (MSIEI) (Pielou 1975). SHDI, SIDI, and MSIDI were used to evaluate and compare diversity at the landscape scale and SHEI, SIEI, and MSIEI were used to evaluate how evenly dispersed patched were across the corresponding landscapes. The equations for these are:

$$SHDI = -\sum_{i=1}^{m}(P_i * \ln P_i) \text{ (Eq. 6.6)}, \; SIDI = 1 - \sum_{i=1}^{m} P_i^2 \text{ (Eq. 6.7)},$$

$$SHEI = -\frac{\sum_{i=1}^{m}(P_i * ln P_i)}{\ln m} \text{ (Eq. 6.8)}, \; SIEI = 1 - \frac{\sum_{i=1}^{m} P_i^2}{1-(\frac{1}{m})} \text{ (Eq. 6.9)},$$

Equations 6.6 Shannon's Diversity Index, *6.7* Simpson's Diversity Index, *6.8* Shannon's Evenness Index, and *6.9* Simpson's Evenness Index.

For all of these equations P_i represents the proportion of the landscape occupied by patch type I while m is the total number of HCPCs within a given landscape.

6.3.3 Foraging Catchment Floral Food Resource Analysis

One of the advantages of the HCPC data is the inclusion of species information to define the composition and structure (provided in lbs./acre) for each ecological site. Borrowing the same methodology I have used previously, Riggs (2014), the recovered plant taxa list was then compared to the available plant foods based on historic and ethnographic data. This method was used to perform an all-around analysis to determine:

1. Correlation between historically described foods, especially staples, and the archaeological record,
2. Further test the use of HCPC data in archaeological research as presented in Riggs (2014),
3. Determine any correlation between expected seasonal use of a landscape based on available dietary taxa vs. seasonality as identified from macrobotanical remains, and
4. Identify other food resources not encountered in the archaeological record, or otherwise not visible via macrobotanical analysis.

6.4 Overview of Project Methods

For this study a variety of methods were used to quantify and compare botanical diet of Terminal Late Prehistoric Period peoples of the eastern Trans-Pecos. Within the study area presence-absence, ubiquity scores, and multivariate statistics were used to compare plant foods identified in archaeological contexts as well as establish plant dietary composition. Outside of the study area, but temporally concomitant with this study, presence-absence and multivariate statistics were utilized to identify botanical dietary composition as well as elucidate floral diet-ways of the eastern Trans-Pecos versus surrounding regions. Plant diet breadth was also used to assess resource use at both the regional and interregional scales. A secondary analysis was also undertaken to define single-day botanical dietary landscapes for inhabitants of five archaeological sites within the study sample. These landscapes were then further analyzed using a variety of metrics to quantify differences and to elucidate potential decision making of the prehistoric inhabitants. Finally, a holistic analysis was undertaken which compared historically recorded plant foods, taxa available on the landscape, and those identified based upon archaeobotanical remains.

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CHAPTER VII

RESULTS AND TESTING OF SPATIAL MODELING VALIDITY

Apart from performing original analyses of macrobotanical samples, archival research, and a literature review, this body of work attempted to reach a level of redundancy in terms of what plant foods, both preserved and modelled as available, contributed to the diet of Terminal Late Prehistoric Period (TLP) peoples of the eastern Trans-Pecos. In total six techniques were used to analyze the raw data, model resource and availability, and test said modelling.

The most basic techniques performed were the presence and absence of dietary floral taxa from both open and protected archaeological sites within the study area based upon macrobotancial remains. Secondary to this ubiquity scores were calculated for macrobotanical remains found at two of the rockshelters, Tranquil and Rough Cut Rockshelters. To assess similarity of botanical dietary composition a correspondence analysis was undertaken of open archaeological sites both within the study area and in neighboring regions. The same method was also used to assess plant dietary composition based on macrobotanical assemblages for the rockshelters in the study sample. An assessment of diet plant breadth which identified high, low, and mid-ranked food resources was undertaken at the inter-regional scale as well as between the eastern Trans-Pecos rockshelters.

To quantify the spatial composition of the landscapes surrounding the nine archaeological sites with TLP components and evidence of plant use, 72-min. foraging catchments were reconstructed and assessed. The same preliminary data was also used to compare the floral foods identified in the archaeological record with what was modelled to have been available, serving as a test of the spatial modelling. In conjunction with this other plant foods were identified which had documented use by the Mescalero Apache (Basehart 1971, Castetter and Opler 1936) as well as other indigenous peoples of North America.

7.1 Terminal Late Prehistoric Eastern Trans-Pecos Open Site Dietary Botanical Assemblage Results and Discussion

For original macrobotanical analyses four archaeological sites with TLP components were included in this analysis. Two of these were open archaeological sites, Cielo Bravo (41PS52) and Arroyo de las Burras (41PS104) and both considered type sites for the Cielo Complex (Mallouf 1985, 1999). For Cielo Bravo eight samples were included while three samples were analyzed from Arroyo de las Burras; samples were processed via flotation and standard macrobotanical procedures as described in Chapter Five. The remaining two sites, Tranquil Rockshelter (41BS1513) and Rough Cut Rockshelter (41BS1507), were protected sites and no flotation was used though macrobotanicals recovered from laboratory sieving. Botanical remains from in situ finds and field screening were also included in this analysis. With Tranquil Rockshelter ten features were analyzed based on results from twelve matrix samples; 70 screen and in-situ botanical remains were also identified. From Rough Cut Rockshelter two primary features were analyzed with seven matrix samples and 42 screen recovered and in-situ encountered samples.

7.1.1 Cielo Bravo

From the Cielo Bravo Site, eight samples from four contexts were analyzed by this researcher: five from two middens, one from a stone wickiup enclosure, and another from a hearth or earth oven feature (Table 7.1). Preservation was exceedingly poor across all samples despite being in different contexts. This is not an uncommon occurrence in the eastern Trans-Pecos wherein ethnobiological remains are rarely recovered from open archaeological sites.

Common Name	**Taxon**	**Plant Part**	**Midden 1**	**Midden 2**	**Feature H-1**	**Enclosure E-10**
Agave	Agavoidea	Fibers	6*			
Creosotebush	*Larrea tridentata*	Seeds	8	2	9	
Creosotebush	*Larrea tridentata*	Leaflets	10		30	
Curlycup gumweed	*Grindelia squarrosa*	Seeds	56			
Grass family	POACEAE	Seeds	1			
Sunflower Family	ASTERACEAE	Seeds	7		13	2
Pitaya	*Echinocereus* spp.	Seeds	131		1	1*
Prickly pear	*Opuntia* spp.	Seeds	7			
Amaranth Family	AMARANTHACEAE	Seeds	1			
	Indeterminate	Seed			2*	
Mesquite	*Prosopis glandulosa*	Charcoal	13	7	4	8
Fourwing saltbush	*Atriplex canescens*	Charcoal			1	
Willow, cottonwood	SALICACEAE – like	Charcoal		1		3
Sagebrush	*Artemisia* spp.	Charcoal		1		
Ocotillo	*Fouquerqia splendens*	Charcoal		2		
	Diffuse porous	Charcoal	1	4		2
	Indeterminate	Charcoal	19	10	10	11

Table 7.1 Macrobotanical remains from Cielo Bravo.
*Charred plant remains.

A total of sixteen identifiable groups were encountered from the eight samples though only ten show presence of human alterations, specifically carbonization. Of these ten, two taxa were identified as evidence of human food use. From Midden 1 two samples (N86/W31 20-30 cm and N/86/W31 30-40 cm) yielded a total of six burned Agavoidea fibers and fiber bundles. Considering the fire-cracked midden context it is unsurprising this taxon was present in the samples and indicated the cooking of Agavoidea caudexes. From Enclosure E-10 a single burned pitaya cactus (*Echinocereus* spp.) seed was recovered. Two burned seeds were recovered from Feature H-1 though post-occupational events had destroyed any identifiable characteristics of the seeds. In total two plant taxa have direct evidence of food use based on recovered remains:

members of the order Agavoidea (ex. agaves [*Agave* spp.], sotol [*Dasylirion* spp.], and yucca [*Yucca* spp.]) and pitaya cactus.

7.1.2 Arroyo de las Burras

From Arroyo de las Burras three samples were analyzed for macrobotanical remains, all of which originated from sub-features within a wickiup stone enclosure (Structure 16). Matrix Sample #4 was from Feature 16e, Matrix Sample #2 from Feature 16c, and Sample #15 from a pit hearth within the stone enclosure (Table 7.2). Much like the samples from Cielo Bravo, identifiable plant remains from Arroyo de las Burras were also exceedingly poor owing to this also being an open site.

			Feature 16e	**Feature 16c**	**F16 – Pit Hearth**
Common Name	**Taxon**	**Plant Part**	*MS-4*	*MS-2*	*Sample 15*
Creosotebush	*Larrea tridentata*	Seeds	5		7
	Larrea tridentata	Leaflets	1	1	3
Grass family	POACEAE	Seeds	3	2	1
Sunflower Family	ASTERACEAE	Seeds	25	5	18
Pitaya cactus	*Echinocereus* spp.	Seeds	10		10
Prickly pear cactus	*Opuntia* spp.	Seeds	2		
Cholla	*Cylindropuntia* spp.	Seeds		17	
Western honey Mesquite	*Prosopis glandulosa*	Endocarp fragments		1*	
Goosefoot Family	AMARANTHACEAE	Seeds		1	1*
	Indeterminate	Epidermis		1*	
Mesquite	*Prosopis glandulosa*	Charcoal		1	
Fourwing saltbush	*Atriplex canescens*	Charcoal		3	
	Diffuse porous	Charcoal	4	2	
	Indeterminate	Charcoal		8	

Table 7.2 Macrobotanical remains from Arroyo de las Burras.
*Charred plant remain.

In total twelve botanical groups were identified from the three samples used in this analysis. Of those only four show evidence of carbonization with two dietary taxa being identified. From Feature 16c a single, burned Western honey mesquite (*Prosopis glandulosa*) endocarp fragment was recovered. A fragment of carbonized plant epidermis was also encountered but lacked diagnostic attributes. From the F-16 pit hearth a single, burned seed from the AMARANTHACEAE family was also recovered. Based on this two botanical dietary taxa were identified from the Arroyo de las Burras site, those being western honey mesquite, or mesquite, and a member of the Amaranth Family.

7.2 Eastern Trans-Pecos TLP Open Site Dietary Botanical Presence-Absence

For the five open archaeological sites within this analysis only six dietary plant taxa were recovered based on macrobotanical remains (Table 7.3). These included members of the genus *Agave*, such as lechuguilla (*A. lechuguilla*), amaranth, mesquite, purslane, dropseed, and pitaya.

Common Name	**Taxon**	*41PC502*	*Arroyo de las Burras*	*Cielo Bravo*	*Arroyo de la Presa*	*Fulcher Site*
Agaves	Agavoidea	X		X	X	X
Amaranth Family	AMARANTHACEAE	X	X		X	X
Mesquite	*Prosopis glandulosa*	X	X			
Purslane	*Portulaca* spp.	X				
Dropseed	*Sporobolus* spp.				X	
Pitaya cactus	*Echinocereus* spp.			X		

Table 7.3. Presence-absence of plant dietary taxa from open TLP archaeological sites in the eastern Trans-Pecos.

Of the six dietary plant taxa identified from macrobotanical remains, agave and amaranth were the most frequently encountered taxa at the site level. Agave was recovered from 41PC502, Cielo Bravo, Arroyo de las Presa, and the Fulcher Site while amaranth was encountered at 41PC502, Arroyo de las Burras, Arroyo de la Presa, and the Fulcher Site. The third most common plant taxa encountered from the open site sample was western honey mesquite which was recovered from Arroyo de las Burras and 41PC502. The three remaining taxa were only encountered once each with purslane from 41PC502, dropseed from Arroyo de la Presa, and pitaya from Cielo Bravo.

Examining the diversity of taxa at the site level, 41PC502 had the highest number of unique taxa with four (agave, amaranth, mesquite, and purslane) recovered from macrobotanical samples. Arroyo de la Presa had the second highest count of unique taxa with three recovered which included agave, amaranth, and dropseed. The remaining three open sites each had two taxa represented with amaranth and mesquite from Arroyo de las Burras, agave and pitaya from Cielo Bravo, and the Fulcher Site possessing remains of agave and amaranth in TLP components.

7.3 TLP Eastern Trans-Pecos Rockshelter Dietary Botanical Assemblage Results and Discussion

Data presented below was the result of original analysis undertaken with this study, archival research of un-reported macrobotancial analyses, and the published report with pollen analyses from Granado Cave (Hamilton 2001). Results of this analysis were more fruitful than those from open sites in terms of plant foods identified due to the high preservation found within caves and rockshelters in the study area.

7.3.1 Tranquil Rockshelter

Materials from Tranquil Rockshelter constituted the bulk of analyzed matrix samples as well as field recovered macrobotanical remains. Owing to the protected nature of the site botanical recovery was extremely high. For clarity only those plant remains associated with botanical foods will be presented below. Additionally, the results from this study will be combined with the unpublished results from Dering (2009a) to better quantify the floral dietary assemblage. Table 7.4 presents the results of matrix sample analyses and Table 7.5 provides identifications for individual finds and screen recovered materials.

Common Name	**Taxon**	*F7*	*F7**	*F11*	*F12*	*F17*	*F25*	*F26**	*F29*	*F31*	*F32*
Agaves	Agavoidea					1				6	
Lechuguilla	*Agave lechuguilla*		46	13				4			6
Amaranth family	AMARANTHACEAE	16	93	183	675	1065	200	50	274	260	353
Buffalo gourd	*Cucurbita foetidissima*			4	3				3	1	
Cholla	*Cylindropuntia* spp.					1	4	14			
Hedgehog cactus	*Echinocereus* spp.	3	15	26	20	15	3		11	23	9
Littleleaf walnut	*Juglans microcarpa*									5	2
Nipple cactus	*Mammillaria* spp.								1		
Prickly pear cactus	*Opuntia* spp.	1	18	102	34	24	2	112	21	86	22
Buckwheat	*Polygonum* spp.					4					
Purslane	*Portulaca* spp.	2		4	35	119	15		11	2	13
Mesquite	*Prosopis glandulosa*			40	20		11	19	24	33	22
Oak	*Quercus* spp.				1						
Sand dock	*Rumex hymenospalus*							24			
Dropseed grass	*Sporobolus* spp.			74						70	
Banana yucca	*Yucca bacatta*					1					
Lotebush	*Ziziphus obtusifolia*							9			

Table 7.4. TLP plant food remains from Tranquil Rockshelter- Feature Matrix Samples.
*Dering (2009a).

Common Name	**Taxon**	*F11*	*F12*	*F29*	*F31*	*F32*
Agaves	Agavoidea			1		
Lechuguilla	*Agave lechuguilla*	30	10	4	11	3
Sotol	*Dasylirion* spp.	1	1	4		
Buffalo gourd	*Cucurbita foetidissima*	4	3	3		
Pitaya	*Echinocereus* spp.	5				
Littleleaf walnut	*Juglans microcarpa*	4		3		
Prickly pear	*Opuntia* spp.	35		6	1	
Piñon	*Pinus cembroides*	1				
Mesquite	*Prosopis glandulosa*	24	4	26		
Banana yucca	*Yucca bacatta*	1		8		
Maize	*Zea mays*		1			

Table 7.5. TLP plant food remains from Tranquil Rockshelter- Screen and In-situ Remains.

For diversity a total of twenty-three taxa were identified from all sample types. Based on recovery from matrix samples the minimum number of taxa identified was six from Feature 25 and the matrix sample with the highest diversity of taxa was Feature 31 with nine identified. Features with seven plant taxa based from matrix samples included Features 26, 29, and 32. Features 7, 11, 12, and 17 had a total of eight taxa identified. Screen and in-situ finds were identified from five features with Feature 11 having the highest number (n = 10) and Feature 32 the lowest (n = 1) based on three agave quids. Feature 32 also had a low diversity with two taxa identified, those being lechuguilla and prickly pear. From Feature 12 five plant taxa were noted from screen and excavation finds while Feature 29 possessed eight.

When the two data types are combined the total number of taxa per feature increases slightly. Features with more than ten taxa present included Feature 11 (n = 13), Feature 29 (n = 12), Feature 12 (n = 11), and Feature 31 (n = 10). Features 32 and Feature 26 had seven plant taxa identified, Feature 17 had eight, and Feature 25 had six identifiable botanical dietary taxa. The feature with the lowest taxa count was Feature 7 which had five.

7.3.2 Rough Cut Rockshelter

Much like Tranquil Rockshelter, Rough Cut Rockshelter had high levels of preservation though not as high as Tranquil Rockshelter. Through a combination of matrix samples as well as materials encountered during excavation fifteen botanical dietary taxa were identified. Table 7.6 presents those materials identified from matrix samples and Table 7.7 will present botanical remains identified during the excavation process.

	Feature	**Grass flooring**	**Feature 1**									
	Ash Lense									B		A*
	Test Unit	3	6	7						7	7	7W
	Matrix Sample #	2	2	1	2	3*	4	6	11	8	9	5
Common Name	**Taxon**											
Agaves	Agavoidea					7	2		15			
Lechuguilla	*Agave lechuguilla*	4	1							3	11	
Amaranth Family	AMARANTHACEAE	19	51	12		92				17	75	35
Buffalo gourd	*Cucurbita foetidissima*			2		6	1					27
Cholla	*Cylindropuntia* spp.	3			1							
Piñon	*Pinus* spp.	1	1			2						
Purslane	*Portulaca* spp.		6	2							1	
Mesquite	*Prosopis glandulosa*	102	21	5	12	49	8	5		10	38	21
Oak	*Quercus* spp..											
Yucca	*Yucca* spp.					3			2		1	1

Table 7.6. TLP plant food remains from Rough Cut Rockshelter- Feature Matrix Sample. **Dering 2009b.*

		Grass flooring near F1	***Feature 1***		
Common Name	**Taxon**	**TU-3**	**TU-6**	**TU-7**	**TU-7E**
Lechuguilla	*Agave lechuguilla*	28	2	1	3
Hackberry	*Celtis* spp.	6			1
Buffalo gourd	*Cucurbita foetidissima*	1		1	3
Texas persimmon	*Diospyros texana*				1
Littleleaf walnut	*Juglans microcarpa*	4		4	17
Prickly pear	*Opuntia* spp.	336		14	8
Piñon	*Pinus cembroides, P. remota*.	8		4	8
Mesquite	*Prosopis glandulosa*			36	67
Oak	*Quercus* spp..	1			
Yucca	*Yucca* spp.	3		17	13

Table 7.7. TLP plant food remains from Rough Cut Rockshelter- Screen and In-situ Remains.

Across all sample types fifteen taxonomic groups were identified in this study. Matrix samples represent the highest taxonomic diversity with twelve taxa identified while the samples recovered from excavation screening and in situ finds included ten taxa. Taxa appear to have been evenly distributed between the features and sub-features with no specific taxa attributed to a given feature. The Texas persimmon seed (*Diospyros texana*) is of note from the botanical assemblage and represents the sole find of this taxon from an archaeological context within the study area.

7.3.3 Rockshelter Metrics and Multivariate Statistical Analyses

In order to quantify differences between assemblages as well as determine Terminal Late Prehistoric botanical diet composition four types of analyses were applied to the macrobotanical dietary assemblages from three rockshelters in the study area. These included Tranquil Rockshelter, Rough Cut Rockshelter, and Tres Metates Rockshelter (Seebach 2007). The most basic level was simple presence-absence which outlines the total diversity of floral diet based on macrobotanical remains. A slightly more complicated measure, ubiquity scores, was used to quantify dominant plant foods based on frequency of encounters within features from a given archaeological site. Table 7.8 outlines the presence-absence of the dietary floral taxa from the rockshelters as well as the total number identified across the sites and within the sites.

Common Name	**Taxon**	*Tranquil Rockshelter*	*Rough Cut Rockshelter*	*Tres Metates Rockshelter*
Agaves	Agavoidea	X	X	X
Lechuguilla	*Agave lechuguilla*	X	X	X
Amaranth Family	AMARANTHACEAE	X	X	X
Buffalo gourd	*Cucurbita foetidissima*	X	X	X
Cholla	*Cylindropuntia* spp.	X	X	X
Prickly pear	*Opuntia* spp.	X	X	X
Purslane	*Portulaca* spp.	X	X	X
Mesquite	*Prosopis glandulosa*	X	X	X
Oak	*Quercus* spp.	X	X	X
Banana yucca	*Yucca bacatta*	X	X	X
Pitaya	*Echinocereus* spp.	X	X	
Littleleaf walnut	*Juglans microcarpa*	X	X	
Pinon	*Pinus cembroides, P. remota*	X	X	
Sand dropseed	*Sporobolus* spp.	X		X
Maize	*Zea mays*	X		X
Sotol	*Dasylirion* spp.	X		
Nipple cactus	*Mammillara* spp.	X		
Canaigre	*Rumex hymenosepalus*	X		
Lotebush	*Ziziphus obtusifulia*	X		
Hackberry	*Celtis* spp.		X	
Texas persimmon	*Diospyros texana*		X	
Wild onion	*Allium* spp.			X
Common bean	*Phaseolus vulgaris*			X
Plantain	*Plantago* spp.			X
Tornillo	*Prosopis pubescens*			X
	Total	23	15	15

Table 7.8. Presence-absence of dietary plant taxa from the rockshelter sub-sample.

With this study a total of twenty-nine dietary plant taxa were identified from original analyses, archived materials (Dering 2009a, 2009b), and published manuscripts (Seebach 2007) from three rockshelters within study area based on macrobotanical remains. Tranquil Rockshelter had the highest number of taxa with twenty-three identified while Rough Cut Rockshelter and Tres Metates Rockshelter had fifteen taxa. Nine taxa were identified at all three sites and included agave/lechuguilla (Order Agavoidea, *Agave lechuguilla*), members of the amaranth family (AMARANTHACEAE), buffalo gourd (*Cucurbita foetidissima*), cholla (*Cylindropuntia* spp.), prickly pear (*Opuntia* spp.), purslane (*Portulaca* spp.), western honey mesquite (*Prosopis glandulosa*), oak (*Quercus* spp.), and yucca (*Yucca* spp.).

Between Tranquil Rockshelter and Rough Cut Rockshelter, these sites share two dietary taxa which are not present at Tres Metates Rockshelter: pitaya cactus (*Echinocerus* spp.) and littleleaf walnut (*Juglans microcarpa*). Additionally, Tres Metates Rockshelter and Tranquil Rockshelter share two taxa not present at Rough Cut Rockshelter one of which is a cultivar, maize (*Zea mays*), and the other a wild plant, members of the dropseed grass genus (*Sporobolus* spp.). Rough Cut and Tres Metates Rockshelters did not share identified botanical dietary taxa independent of Tranquil Rockshelter.

Unique taxa were also present at each rockshelter not found in others within the study sample with Tranquil Rockshelter having three, Tres Metates Rockshelter possessing four, and Rough Cut Rockshelter two. From Tranquil Rockshelter one cactus genus (Mammaliarai), the brush species lotebush (*Ziziphus obtusifolia*), and the forb canaigre (*Rumex hymenosepalus*) were noted in the assemblage. Rough Cut Rockshelter included two fleshy-fruit tree/shrub taxa: hackberry (*Celtis* spp.) and Texas persimmon (*Diospyros texana*). Of the four unique taxa from Tres Metates Rockshelter, two were wild forbs, wild onion (*Allium* spp.) and buckwheat (*Plantago* spp.), one brush species (tornillo [*P. pubescens*]), and the only domesticated legume found within the study area sample, common bean (*Phaseolus vulgaris*). It should be noted that for the cultigens (maize and beans) and Texas persimmon, these taxa were only identified from excavated materials and not from matrix sample analysis.

Though the above data presentation provides important baseline data regarding the total botanical dietary composition as well as assumptions regarding preferred foods, ubiquity values were used to further assess the importance of plant foods. Using this standardized measure it was possible to identify dominant and subordinate taxa within this sub-sample of all sites within the study area. Despite the fact some of the most unique and rare taxa from rockshelters within this sample were only encountered during excavation, only data from controlled analysis of feature matrix was used in the ubiquity analysis. This was considered appropriate as it removed discrepancies in reporting from Seebach (2007) as well as excavator bias. Ubiquity analysis was undertaken at the feature level for Tranquil (Table 7.9) and Rough Cut (Table 7.10) Rockshelters. Though it is possible to undertake this at the sample level, in several instances the same feature was sampled multiple times. As such ubiquity analysis at the sample level would present unnecessary analytical redundancy. Additionally, it should be noted that for this analysis the taxonomic groups Agavoidea and *A. lechuguilla* were combined into the grouping Agavoidea to streamline the analysis.

Common Name	**Taxa**	F7	F11	F12	F17	F25	F26*	F29	F31	F32	*Total Frequency*	*Ubiquity Value*
Amaranth Family	AMARANTHACEAE	1	1	1	1	1	1	1	1	1	10	100
Prickly pear	*Opuntia* spp.	1	1	1	1	1	1	1	1	1	10	100
Pitaya	*Echinocereus* spp.	1	1	1	1	1		1	1	1	9	90
Purslane	*Portulaca* spp.	1	1	1	1	1		1	1	1	9	90
Mesquite	*Prosopis glandulosa*		1	1		1	1	1	1	1	8	80
Agaves	Agavoidea	1	1		1		1		1	1	7	70
Buffalo gourd	*Cucurbita foetidissima*		1	1				1	1		4	40
Chlla	*Cylindropuntia* spp.				1	1	1				4	40
Littleleaf walnut	*Juglans microcarpa*								1	1	3	30
Dropseed	*Sporobolus* spp.		1						1		2	20
Nipple cactus	*Mammaliara* spp.							1			1	10
Oak	*Quercus* spp.			1							1	10
Canaigre	*Rumex hymenosepalus*						1				1	10
Banana yucca	*Yucca bacatta*				1						1	10
Lotebush	*Zizipuhus obtusifulia*						1				1	10

Table 7.9. Tranquil Rockshelter Ubiquity Values.

Common Name	**Taxa**	Grass flooring	F1	F1, Ash Lense A	F1, Ash Lense B	*Total Frequency*	*Ubiquity Value*
Mesquite	*Prosopis glandulosa*	1	1	1	1	4	100
Amaranth Family	AMARANTHACEAE	1	1	1	1	4	100
Pitaya	*Echinocerus* spp.	1	1	1	1	4	100
Prickly pear	*Opuntia* spp.		1	1	1	3	75
Agaves	Agavoidea	1	1		1	3	75
Yucca	*Yucca* spp.		1	1	1	3	75
Buffalo gourd	*Cucurbita foetidissima*		1	1		2	50
Littleleaf walnut	*Juglans microcarpa*	1	1			2	50
Piñon	*Pinus cembroides, P. remota*	1	1			2	50
Purslane	*Portulaca* spp.		1		1	2	50
Cholla	*Cylindropuntia* spp.	1	1			2	

Table 7.10. Rough Cut Rockshelter Ubiquity Values.

Of the ten features analyzed from Tranquil Rockshelter two taxa occur in all features: members of the Amaranth Family and prickly pear (Table 7.9). Four other botanical food taxa have ubiquity values (UV) over 50 and included hedgehog cactus (UV = 90), purslane (UV = 90), mesquite (UV = 80), and caudex producing members of the order Agavoidea (UV = 70). Less common taxa included buffalo gourd and cholla (UVs = 40) as well as littleleaf walnut (UV = 30) and dropseed grasses (UV = 20). The rarest plant taxa with UVs equal to 10 included nipple cactus, knotweed, oak, sand dock, yucca, and lotebush.

Unlike Tranquil Rockshelter, Rough Cut Rockshelter had a more evenly distributed frequency of plant taxa within the four features identified in this study with UV ranging from 100 to 50 (Table 7.10). Three dietary taxa were noted as having some frequency between features and included mesquite, members of the amaranth family, and pitaya cactus. Three other taxa occurred with slightly less frequency though are not considered rare and included prickly pear, members of the order Agavoidea, and yucca. The rarest taxa by feature frequency, though not extremely rare, were buffalo gourd, littleleaf walnut, piñon, purslane, and cholla.

7.4 Eastern Trans-Pecos Botanical Diversity Index Analysis

To better quantify botanical diet diversity within the Eastern Trans-Pecos two diversity indices were used in this study and included Shannon's Diversity Index (SHDI) (Shannon and Weaver 1949) as well as Simpson's Diversity Index (SIDI) (Simpson 1949). Here it is noted that high diversity values are associated with an even distribution of several taxa while a low value is associated with few taxa dominating a given assemblage or a low number of taxa (Pearsall 2010). Though SHDI is noted as being more sensitive to rare taxa, SIDI is more easily interpreted as its range is from 0 – 1 versus 0 – infinity for SHDI (Marston 2014, McGarigal, Cushman, and Ene 2012). Owing to massive differences in preservation potential in open sites vs. rockshelters within the study area the resultant values were only compared between similar types and not across all sites.

7.4.1 Diversity Analysis- Results and Discussion

Results of this analysis indicated wide variation in macrobotanical plant diet remains between sites independent of site type. Both SHDI and SIDI show high agreement regarding ranking of highest to lowest diversity, though SHDI values are low in comparison to the possible range of values for this index.

Site Type	**Site Name**	**Trinomial**	*SHDI*	*SIDI*
Open		41PC502	1.51	0.79
	Arroyo de las Burras	41PS194	1.10	1*
	Arroyo de la Presa	41PS800	1.01	0.73
	Fulcher Site	41BS1495	0.45	0.30
	Cielo Bravo	41PS52	0.35	0.22
Rockshelter	Rough Cut Rockshelter	41BS1507	1.67	0.78
	Tres Metates Rockshelter	41PS915	1.64	0.72
	Tranquil Rockshelter	41BS1513	1.11	0.46

Table 7.11. Archaeological site name, trinomial, SHDI and SIDI values. *High number is attributed to poor preservation.

For the three rockshelters within the sample, Rough Cut Rockshelter had the highest diversity values with SHDI = 1.67 and SIDI = 0.78 followed closely by Tres Metates Rockshelter with SHDI = 1.64 and SIDI = 0.78 (Table 7.11). This indicated that several taxa are evenly distributed across the macrobotanical assemblage. Tranquil Rockshelter had the lowest diversity values (SHDI = 1.11, SIDI = 0.46) despite having the highest number of total taxa (n = 16). Because a low diversity value is due to either a low number of taxa or a single taxon dominating the assemblage, here it is due to the latter. Seeds of the family AMARANTHACEAE make-up the majority of recovered plant elements (n = 3169) from feature macrobotanical samples and decreased the total plant food diversity at this site.

Of the five open archaeological sites within the study sample both values varied widely with SHDI ranging from 1.15 to 0.35 and SIDI from 0.79 – 0.22 (Table 7.11). 41PC502 had the highest SHDI (1.15) and SIDI (0.79) values while Cielo Bravo had the lowest of both (SHDI = 0.35, SIDI = 0.79). Arroyo de la Presa also had high values (SHDI = 1.01, SIDI = 0.73) while the Fulcher Site was closer in resultant values to Cielo Bravo (SHDI = 0.45, SIDI = 0.30). Arroyo de las Burras yielded a surprisingly high SIDI value (1) and a moderately high SHDI value (1.10) in comparison to the open site sample, however this is attributed to so few macrobotanical remains being preserved.

As Pearsall (2010) notes diversity values should rarely be used to compare between sites due to differences in preservation potential which would otherwise skew the results of a diversity index analysis. The results of this analysis further support this observation and caution as evidenced by the open site macrbotanical assemblage with Arroyo de las Burras having the highest possible SIDI value despite only having three taxa and a single element identified for each. As such the results for the open sites should be approached cautiously because these were compared across sites with variation in preservation in addition to the excruciatingly low recovery of macrobotanical remains. Despite Pearsall (2010)'s warning the results from the rockshelter comparison are considered here to be valid as preservation was exceptionally high and allowed for site-to-site comparison.

7.5 Correspondence Analysis (CA)- Results and Discussion

Correspondence analysis (CA) has been shown to be a fruitful means of data exploration within paleoethnobotany and was used in this study for data at two scales. The first scale was the larger, interregional level when compared the dietary macrobotanical record of Central Texas, the Texas Trans-Pecos, and Southern New Mexico. The second iteration was carried out at the regional level with feature level data from the three rockshelters with TLP components in the Eastern Trans-Pecos.

7.5.1 Inter-Regional CA- Results and Discussion

Results of the CA at the inter-regional level indicated a high degree of similarity between archaeological sites spanning from Central Texas west to the Western Trans-Pecos and Southern New Mexico. Though the scatterplot generated from this analysis is crowded toward the origin, Axes 1 and 2 account for 52.47% of the variation (Table 7.12). This value is low but still within the range of appropriately explaining the variation of the dataset. Table 7.13 presents the final data array with counts of archaeological sites for which a given plant use group was recovered. Figure 7.1 illustrates the final CA scatter plot generated from the data array (Table 7.13).

Axis #	Eigenvalue	% of Total	Cumulative
1	0.671931	32.71	32.71
2	0.405984	19.76	52.47
3	0.263608	12.83	65.30
4	0.222417	10.83	76.13
5	0.163944	7.98	84.11
6	0.136353	6.664	90.74
7	0.108317	5.27	96.01
8	0.052194	2.54	98.56
9	0.021613	1.05	99.61
10	0.008077	0.39	100

Table 7.12. Numeric data from inter-regional scale correspondence analysis.

Botanical foods identified from macrobotanicals which were the most common across all archaeological entities were agaves, mesquite, and forb seeds. This is unsurprising given that the taxa which constitute the groups have widespread ranges at the scale of analysis. Farmed food resources (maize, beans, cushaw) all cluster to the upper-right of the origin while more water-reliant resource groups (grape, hackberry, mast, and geophytes) are located in the lower right quadrant of the scatterplot (Figure 7.1). Of these water-reliant resources, mast and geophytes are somewhat of outliers in relation to the other food resources. Two plant resource groups with large ranges included cholla as well as juniper, though these two are outliers compared to all other plant groups within the sample.

Table 7.13. CA data array for the inter-regional dataset.

Culture	*Agaves*	*Fleshy shrub fruits*	*Cucurbit (wild)*	*Cushaw*	*Forbs*	*Small cactus*	*Cholla*	*Mast*	*Juniper*	*Geophytes*	*Prickly pear*	*Grass seeds*	*Piñon*	*Domesticated beans*	*Mesquite*	*Grape*	*Yucca*	*Maize*
WT-HG	1	0	0	0	1	1	0	0	0	0	1	0	1	0	0	0	1	0
Cielo Complex	1	0	0	0	2	1	0	0	0	0	0	0	0	0	2	0	0	0
Concepcion Phase	1	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0
ETP	2	0	0	0	2	0	0	0	0	0	0	0	0	0	1	0	0	0
Toyah Phase	1	1	0	0	3	0	0	5	0	2	1	0	0	0	2	1	0	1
Flecha Interval	2	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0
Ochoa Phase	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	1	1

Table 7.13. Continued.

Culture	*Agaves*	*Fleshy shrub fruits*	*Cucurbit (wild)*	*Cushaw*	*Forbs*	*Small cactus*	*Cholla*	*Mast*	*Juniper*	*Geophytes*	*Prickly pear*	*Grass seeds*	*Piñon*	*Domesticated beans*	*Mesquite*	*Grape*	*Yucca*	*Maize*
Lincoln/El Paso Phase	0	0	0	0	1	1	0	0	0	0	1	0	1	0	1	1	0	1
El Paso Phase	2	1	1	1	4	1	0	0	0	0	3	1	0	2	2	0	1	4
Plains-Pueblo	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	1
Southern NM	1	0	0	0	0	0	2	0	1	0	0	1	0	0	0	0	0	0

Much like the plotting of foods, the majority of the archaeological entities plot in close proximity to the origin with eastern Trans-Pecos sites lacking in archaeological culture identification having the most in common with the other archaeological assemblages. Also located within the central cluster is the Ochoa Phase, represented by the Merchant Site, Cielo Complex sites (Arroyo de las Burras and Cielo Bravo), El Paso Phase sites, western Trans-Pecos hunter-gatherers from the Wind Canyon Site, as well as the Lincoln Phase Abajo de la Cruz Site. Outside of this cluster the Plains-Pueblo Fox Place Site, Concepcion Phase-associated Arroyo de la Presa, Toyah Phase, and Flecha Interval sites plot in accordance to the presence of other plant groups either not found in the central-plotting archaeological groups or in lower frequency. Like the cholla and juniper mentioned previously, non-archaeological culture affiliated sites in Southern New Mexico are outliers in relation to the other archaeological cultures owing to an extreme lack of recovered botanical diversity.

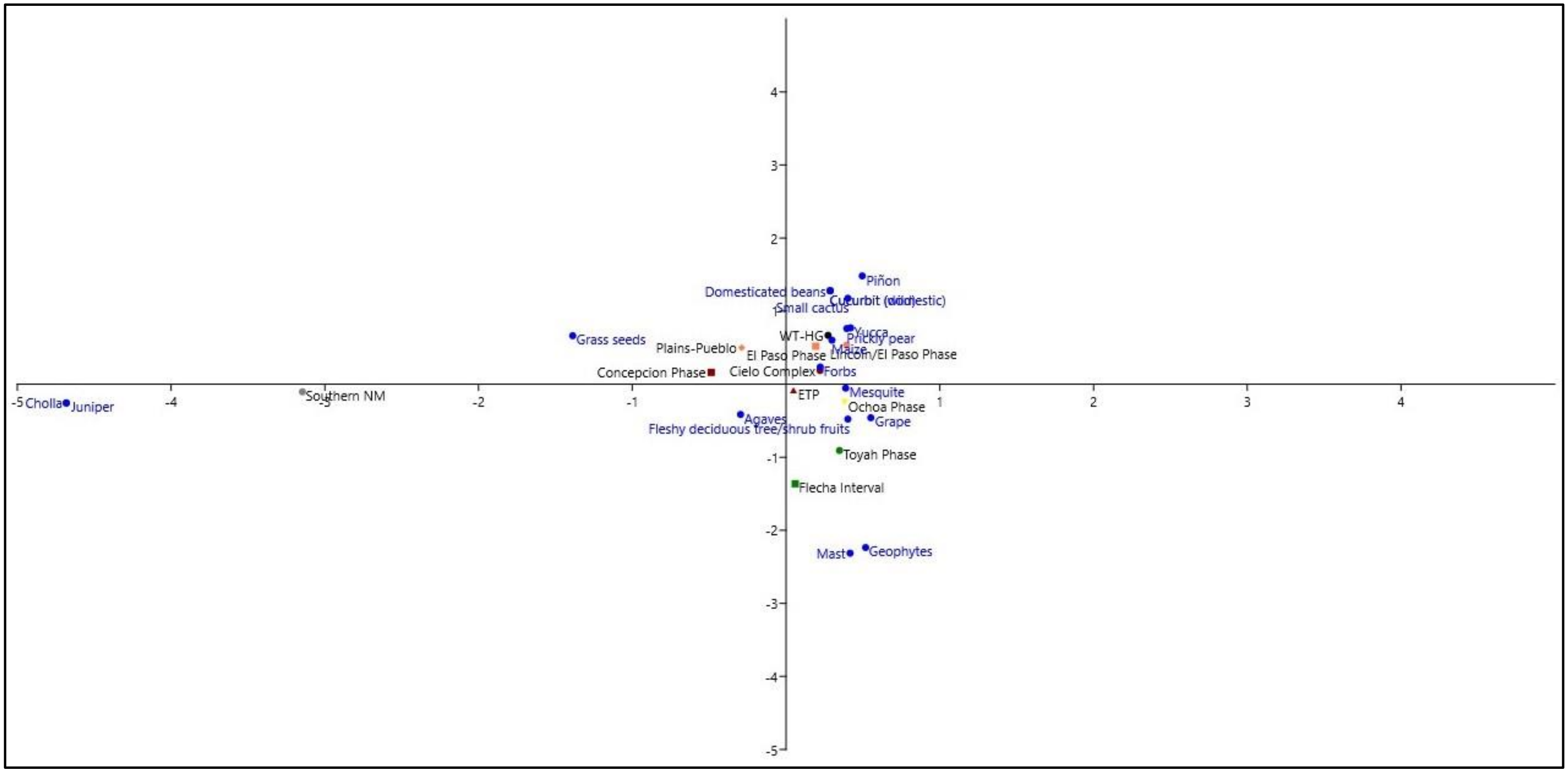

Figure 7.1. CA scatterplot of the inter-regional macrobotanical data.

The results of this CA further support the conclusions reached by other analyses within this study in that forbs, mesquite, and agaves constituted the bulk of plant diet as could be archaeologically visible with macrobotanicals. Specific to plant dietary make-up, the Fulcher Site and 41PC502 had the most common plant diet compared to all other archaeological entities within the sample. Groups associated with an emphasis on farming (El Paso Phase, Lincoln Phase, and Ochoa Phase) all shared a common diet of wild and farmed foods. Hunting and gathering archaeological groups plot in a way which indicates high diversity as well as region-specific reliance on certain plant foods undoubtedly related to restricted plant taxon ranges, or at the minimum a higher chance of resource encounter in specific regions.

7.5.2 Eastern Trans-Pecos TLP Rockshelter CA- Results and Discussion

In order to more easily assess similarity between plant food use within the Eastern Trans-Pecos a CA was repeated with macrobotanical data from the three rockshelters within the study sample: Tranquil Rockshelter, Rough Cut Rockshelter, and Tres Metates Rockshelter. To ensure comparability of samples only data from macrobotanical matrix samples were incorporated into this analysis. Additionally, the numerical results of the regional rockshelter CA indicate the first two axes describe 63.76% of the variance of the data (Table 7.13). As such the resultant CA scatterplot (Figure 7.2) can be confidently used to identify patterns within the dataset.

Table 7.14. Numeric data from eastern Trans-Pecos rockshelter correspondence analysis.

Axis #	**Eigenvalue**	**% of Total**	**Cumulative**
1	0.398217	42.97	42.97
2	0.192675	20.79	63.76
3	0.133613	14.42	78.18
4	0.0853006	9.20	87.38
5	0.0495702	5.35	92.73
6	0.0368933	3.98	96.71

Table 7.14. Continued

Axis #	**Eigenvalue**	**% of Total**	**Cumulative**
7	0.0231747	2.50	99.21
8	0.00449543	0.49	99.69
9	0.00231716	0.25	99.94
10	0.000519073	0.06	100.00

Plant groups have a highly dispersed patterning within the scatterplot (Figure 7.2) with the primary outliers being yucca and piñon. According to the scatterplot none of the plant groups are very common as none lie near the origin of the scatterplot, though between x-axis values of -1 and 1, and y-axis values of -2 and 2, seven plant groups are loosely concentrated in this center portion of the scatterplot. The plant groups included tree nuts, prickly pear, grass seeds, agaves, mesquite, forbs, and shrub berries, all of which were commonly found in the majority of features. Slightly outside this central area are two cacti groups, cholla and small cacti, which had unequal distribution across all features.

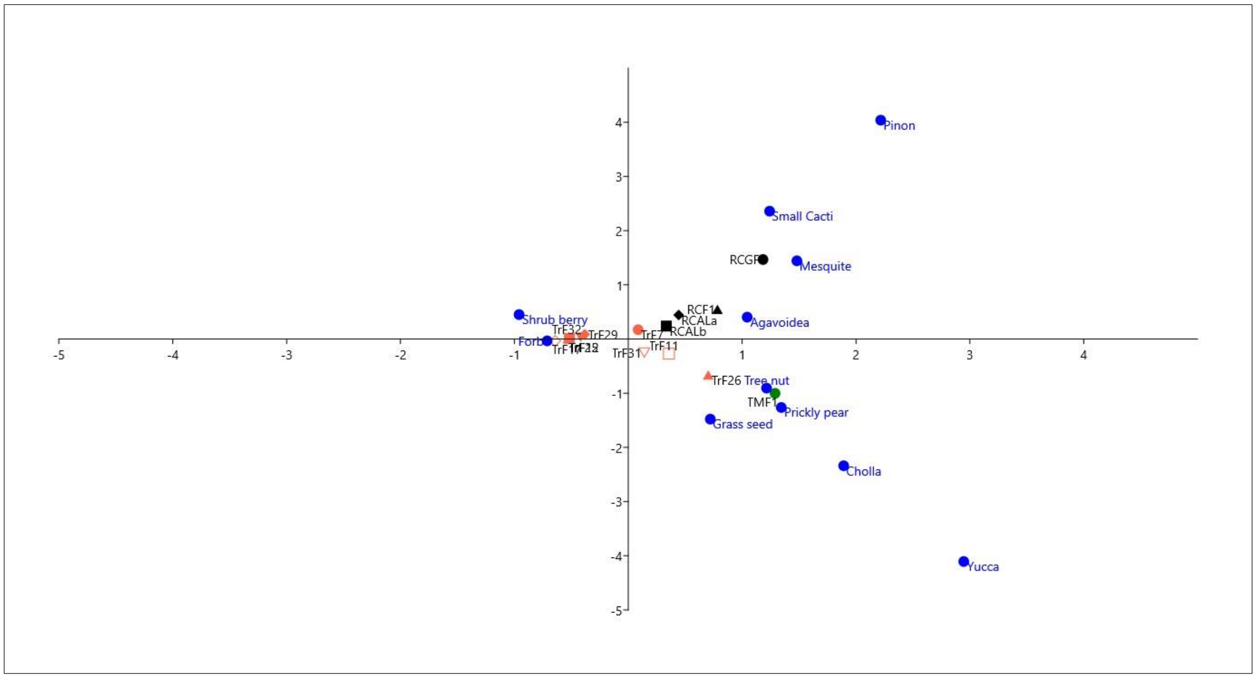

Figure 7.2. CA scatterplot of the TLP eastern Trans-Pecos rockshelter data.

Figure 6.2 indicates strong clustering between certain features within each rockshelter though as a whole features from Tranquil and Rough Cut Rockshelters cluster more closely than does the storage feature, Feature 1, from Tres Metates Rockshelter. The five features which cluster most tightly are from Tranquil Rockshelter and are Features 12, 17, 25, 29, and 32. A second cluster focused around the origin were Feature 7, 11, and 31, all from Tranquil Rockshelter. Tranquil Rockshelter's Feature 26 does not plot closely with any of the other features from said rockshelter, largely due to the high number of prickly pear seeds (n = 112) which were recovered from the feature's sample. From Rough Cut Rockshelter all but the remains of the grass floor plotted in close proximity to one another, indicative of more resource-specific activities associated with these features than the more generalized activities which likely occurred atop the grass floor. The single feature from Tres Metates Rockshelter plots the furthest away from all other features within the dataset due to the high number of yucca seeds (n = 46) recovered from the feature’s samples. This observation lends to a hypothesis that the feature’s use may have been focused on the storage of yucca fruits and possibly yucca seeds.

Despite the multi-scalar approach and use of data from vastly different archaeological site types, three types of plant groups were noted as widely used both at the regional and interregional scales. These groups included members of the plant order Agavoidea, a variety of forbs, as well as mesquite, one of the most common rangeland plants at both scales. Additionally, the results from both analyses demonstrated some clustering, with maize agriculture focused groups clustering closer together at the interregional scale and five features from Tranquil Rockshelter plotting very closely together, largely due to the high amount of forb seeds found within the original samples.

7.6 Botanical Diet Breadth Modeling

Results of the TLP botanical diet breadth modeling analysis with two datasets, inter-regional open archaeological sites and rockshelters within the eastern Trans-Pecos, demonstrated that all groups utilized a variety of ranked resources during the Little Ice Age. At the inter-regional level it was noted that the use of high ranked plant food resources were either not used within the eastern Trans-Pecos or are not archaeologically visible with macrobotanicals recovered from open sites. Data from rockshelters within the study area indicated that some high ranked plant food resources were used, an unsurprising result given the higher preservation within dry rockshelters and caves of the area.

Based on work undertaken in other studies a ranking system was developed from high, mid, to low kcal/hr. return rates as outlined by Hard and Roney (2005). High ranked resources included tree nuts (piñon, hickory, pecan), geophytes (wild onion), and prickly pear tunas

(Dering 2008). Mid ranked resources included those from shrubs (mesquite, hackberry, Texas persimmon) and yucca fruit (Hard and Roney 2005, Stilley 2005). Low ranked forbs included the rosettes of agave-type plants, forb seeds, grass seeds, and non-*Opuntia* cacti such as cholla and pitaya (Dering 2008, Hard and Roney 2005).

	Tree	Opuntia	Geophyte	Shrub	Yucca	Crops	Agave	Forbs	Grass seeds	Non-Opuntia
E. Trans-Pecos				M			L	L	L	L
Flecha Interval	H						L			
Toyah Phase	H	H	H	M		M/H	L	L		
W. Trans-Pecos H-G	H	H			M		L	L		L
SNM				M			L		L	L
El Paso Phase		H		M		M/H	L	L	L	L
Lincoln Phase	H	H		M		M/H		L		L
Ochoa Phase	H			M	M	M/H	L			
Plains-Pueblo						M/H		L	L	

Table 7.15. Ranking of plant resources identified at the inter-regional scale.

At the inter-regional scale (Table 7.14), the two sub-regions with the greatest diversity of plant food resource types were the El Paso Phase of the Western Trans-Pecos and Southern New Mexico and the Toyah Phase of Central Texas. Between the two, the Toyah Phase incorporated more high ranked resources (mast, prickly pear, and geophytes) than the El Paso Phase peoples which only had prickly pear noted as their highest food resource, with the exception of maize. Maize was also present at a single Toyah Phase sites (41HM61) and was likely obtained via trade (Weinstein 2015). This use of resources is largely attributed to local ecology rather than forager and forager-farmer decision making as Central Texas is more mesic than the Chihuahuan Desert and allows for the growth of calorie-dense tree nuts as well as geophytes. It should be noted here that mast producing species such as pecan do not have a historic range in the Trans-Pecos. Two other species, Arizona walnut (*Juglans major*) and little leaf walnut (*J. microcarpa*) of the

Walnut Family do have ranges in the Trans-Pecos with the former being highly restricted to canyons and draws in high elevation locales (Powell 1998). However, piñon does grow in the Chihuahuan Desert and its lack of presence in El Paso Phase sites may indicate either lack of access to said resource or task scheduling conflicts in that piñon nuts are available only in the fall, likely corresponding with harvesting of maize. Alternatively, this resource may not be archaeologically visible via macrobotancial remains. Finally, the El Paso Phase also utilized more low ranked resources which included grass seeds and other CAM plants such as pitaya.

The remaining farming groups, specifically the inhabitants of Abajo de la Cruz, the Merchant Site, and the Fox Place Site, used a variety of high, mid, and low ranked resources. At the early Lincoln Phase Site, Abajo de la Cruz, high ranked tree nuts and prickly pear were utilized as well as maize. The only definitively low ranked plant food resource were shrub fruits, specifically mesquite. Low ranked plant food resources were also used and included forbs as well as other cacti which were not in the order Agavoidea nor prickly pear. Transitional between the pueblo and plains areas the Fox Place Site used low ranked gathered plant foods, grasses and forbs, as well as maize indicating a plant diet of low diversity and use of low ranked resources.

The remaining Chihuahuan Desert hunter-gatherer sites show a mixed use of resources with peoples in the eastern Trans-Pecos lacking use of high ranked resources during the TLP and instead focusing on low-ranked plant foods. Macrobotanical remains from Southern New Mexico show the same patterning. Flecha Interval plant gatherers appear to have focused time and energy on gathering both high, tree nut, and low, Agavoidea, ranked resources. Hunter-gatherers from the Wind Canyon Site made use of several high ranked resources, piñon and prickly pear, as well as low value ones, agaves, forbs, and other CAM plants.

Examination of the macrobotanical record from rockshelters in the eastern Trans-Pecos outlines a distinctly different use of high to low ranked resources as compared to the open sites within the study sample. Rather than consisting primarily of low ranked plant foods, the rockshelter materials included several high and mid-ranked botanical foods.

	Tres Metates Rockshelter	**Tranquil Rockshelter**	**Rough Cut Rockshelter**
Tree	H	H	H
Opuntia	H	H	H
Geophyte	H		
Shrub	M	M	M
Yucca	M	M	M
Maize	M/H	M/H	
Common bean	M/H		
Lechuguilla	L	L	L
Forb	L	L	L
Non-Opuntia	L	L	L
Grass seed	L	L	

Table 7.16. Ranking of plant resources from rockshelters in the eastern Trans-Pecos.

As shown in Table 7.15, foods from trees (littleleaf walnut, piñon, and oak) are present in all confirmed TLP rockshelter deposits as well as prickly pear seeds, likely evidence of prickly pear fruit use. Another high plant food source with high rates of return in spite of intense processing if the geophyte, wild onion, found at Tres Metates Rockshelter. Maize and common beans were also found in the rockshelters, though if these were traded foods, portable resources brought by La Junta District forager-farmers to the sites, or locally grown is currently unknown. Still, their presence in the macrobotancial record indicates use of both wild and grown resources. All of the rockshelters also demonstrated use of food resources with low return rates and included forb seeds, small cacti such as pitaya as well as cholla, and sand dropseed.

Results of this analysis demonstrated that a variety of plant foods with varying rates of caloric return were used from Central Texas to southern New Mexico. High ranked resources were more commonly used by Toyah Phase folk though each region made use of those foods which were locally available and did not conflict in seasonal timing with other subsistence activities. All groups made use of low ranked resources, primarily forb seeds. Additionally, this analysis demonstrated that when examining subsistence data the archaeological site type must also be taken into consideration. The interregional scale analysis showed that peoples in the Eastern Trans-Pecos did not make use of high ranked resources, rather low ranked foods dominated plant diet during the TLP. Macrobotancial data from protected sites showed the opposite and high ranked food were incorporated in the TLP diet. Finally, cultivated plant foods were also used though the means by which they arrived at the two archaeological sites with evidence of their use, Tranquil and Tres Metates Rockshelters, is currently unknown.

7.7 Results of Spatial Analyses

Shifting back to the study area, but using a different dataset, the modelled foraging catchments were used to define the spatial configuration of the landscape surrounding the archaeological sites. The same dataset was also used to identify possible plant foods based upon the historic climax plant community (HCPC) data for each ecological site (ES) and is discussed later in this chapter. To undertake these analyses a series of maps (Figures 7.3 – 7.10) were generated and provided below for visual comparison to the metrics and diversity values discussed later.

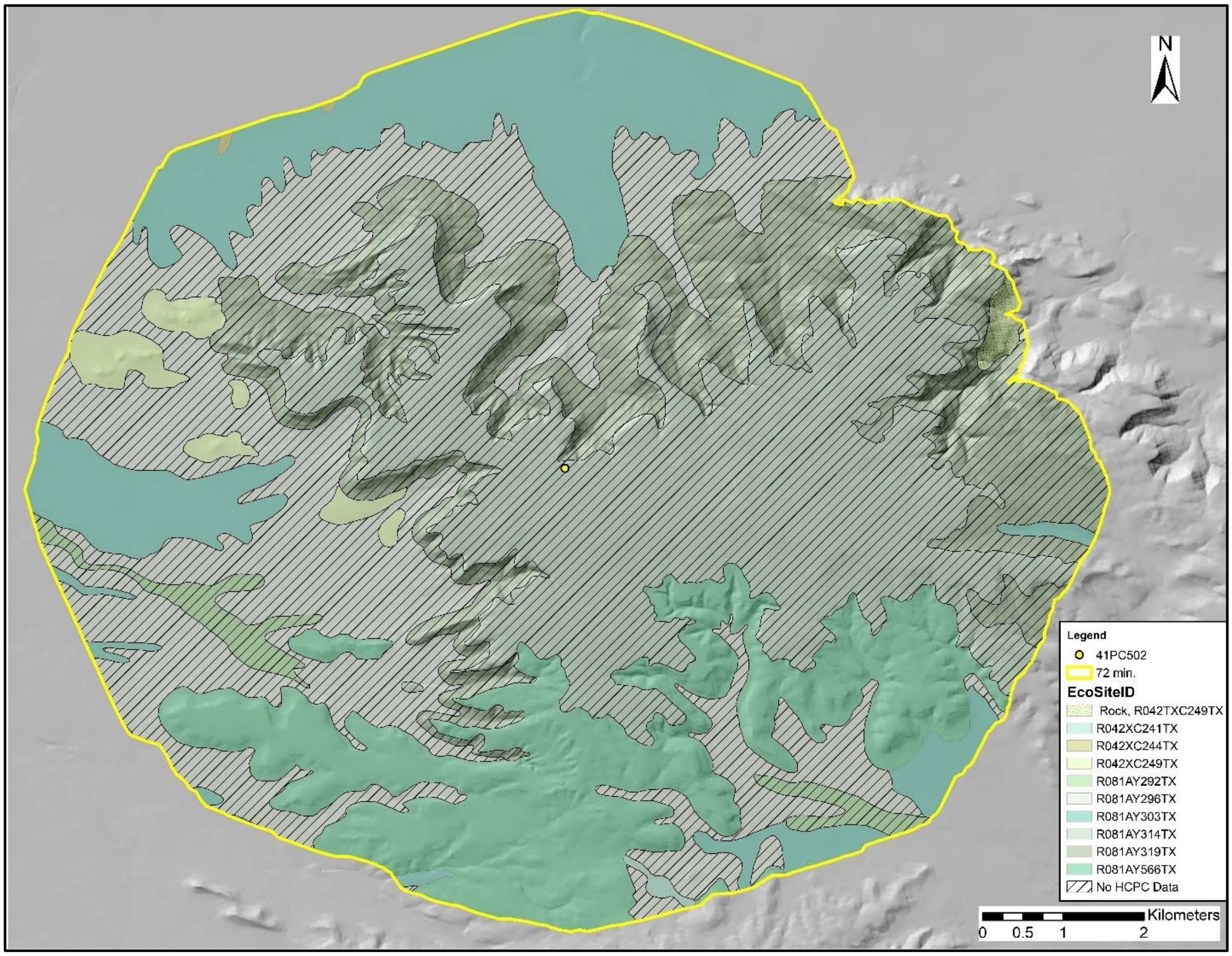

Figure 7.3. 72-min. foraging catchment and ESs for 41PC502.

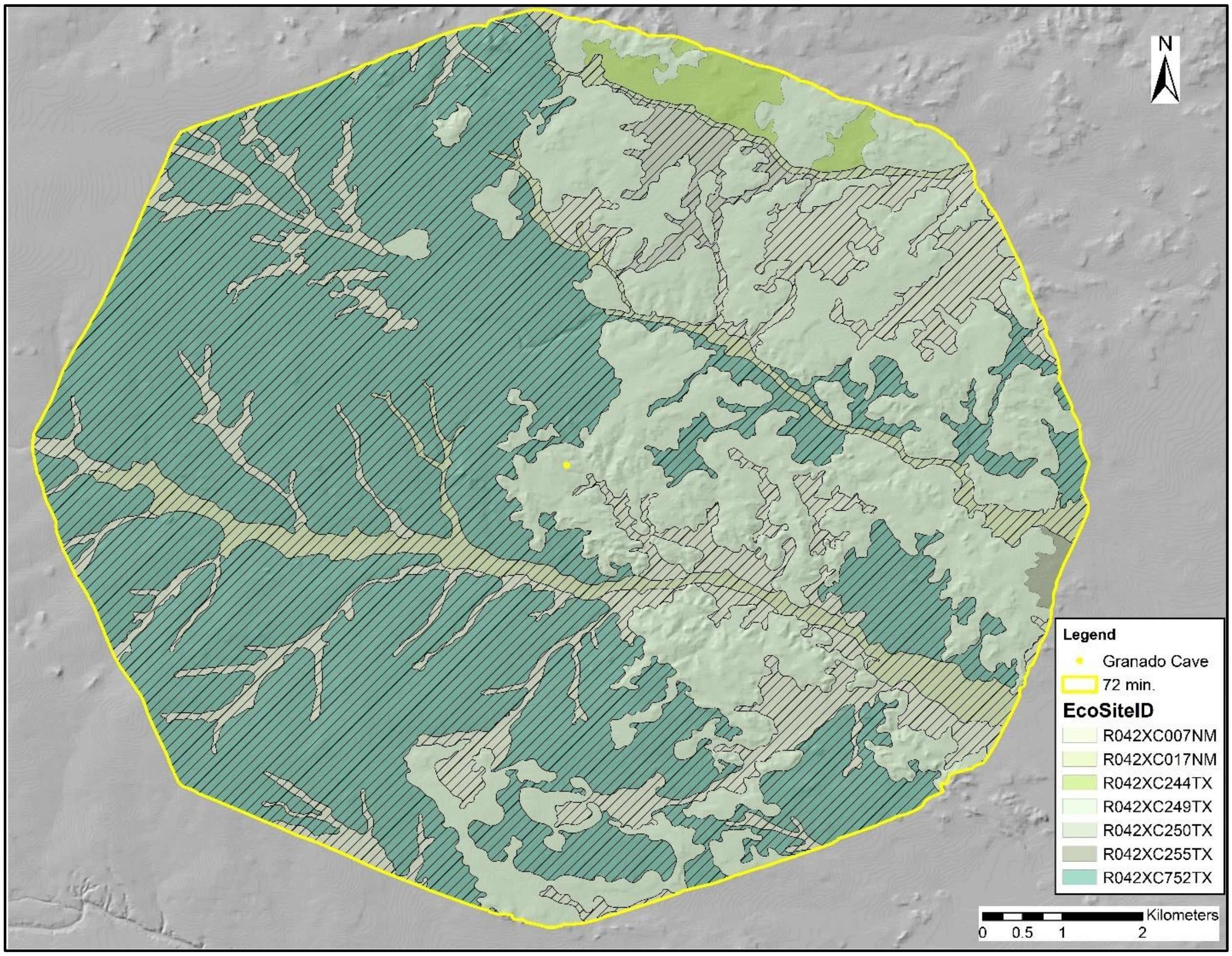

Figure 7.4. 72-min. foraging catchment and ESs for Granado Cave.

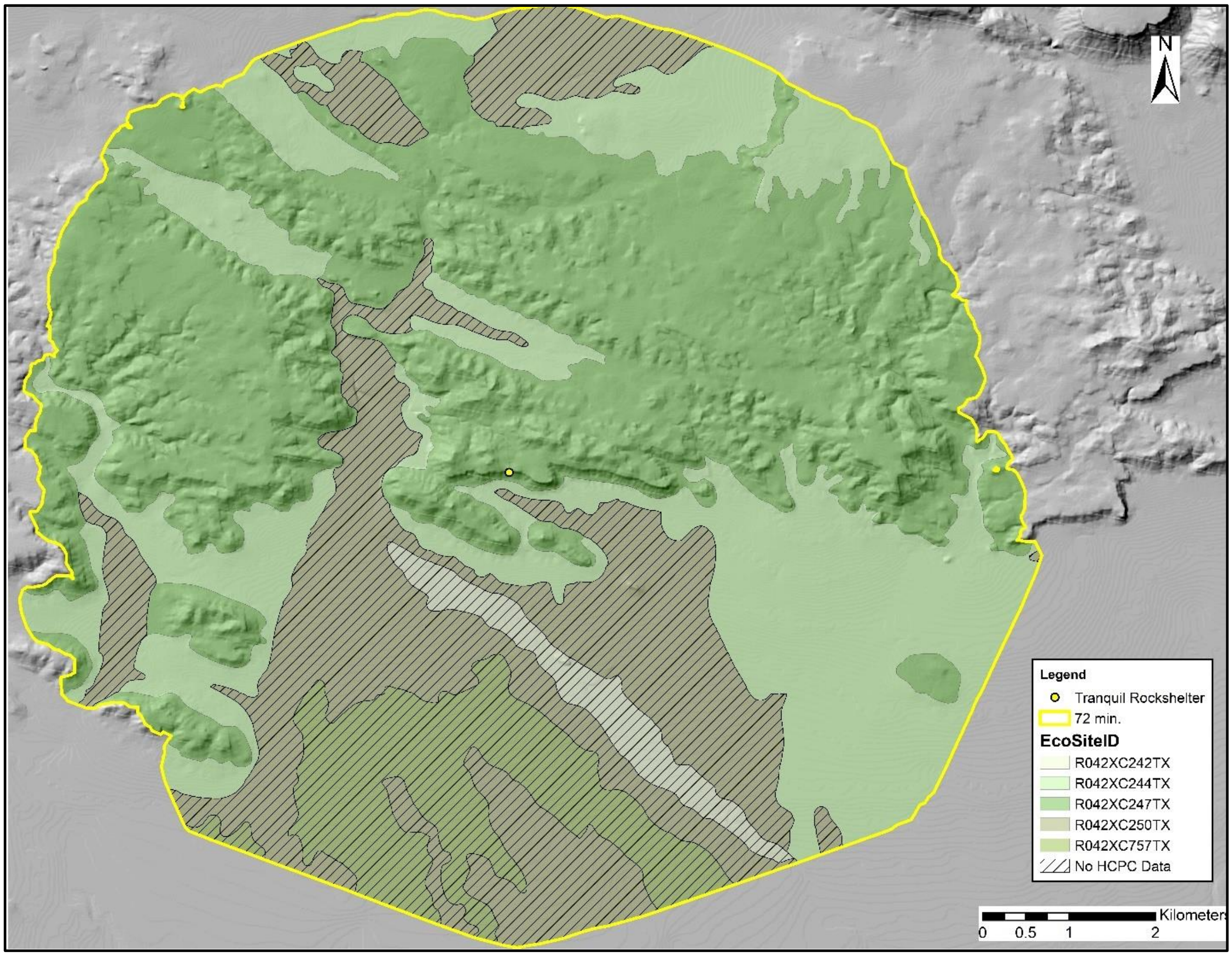

Figure 7.5. 72-min. foraging catchment and ESs for Tranquil Rockshelter.

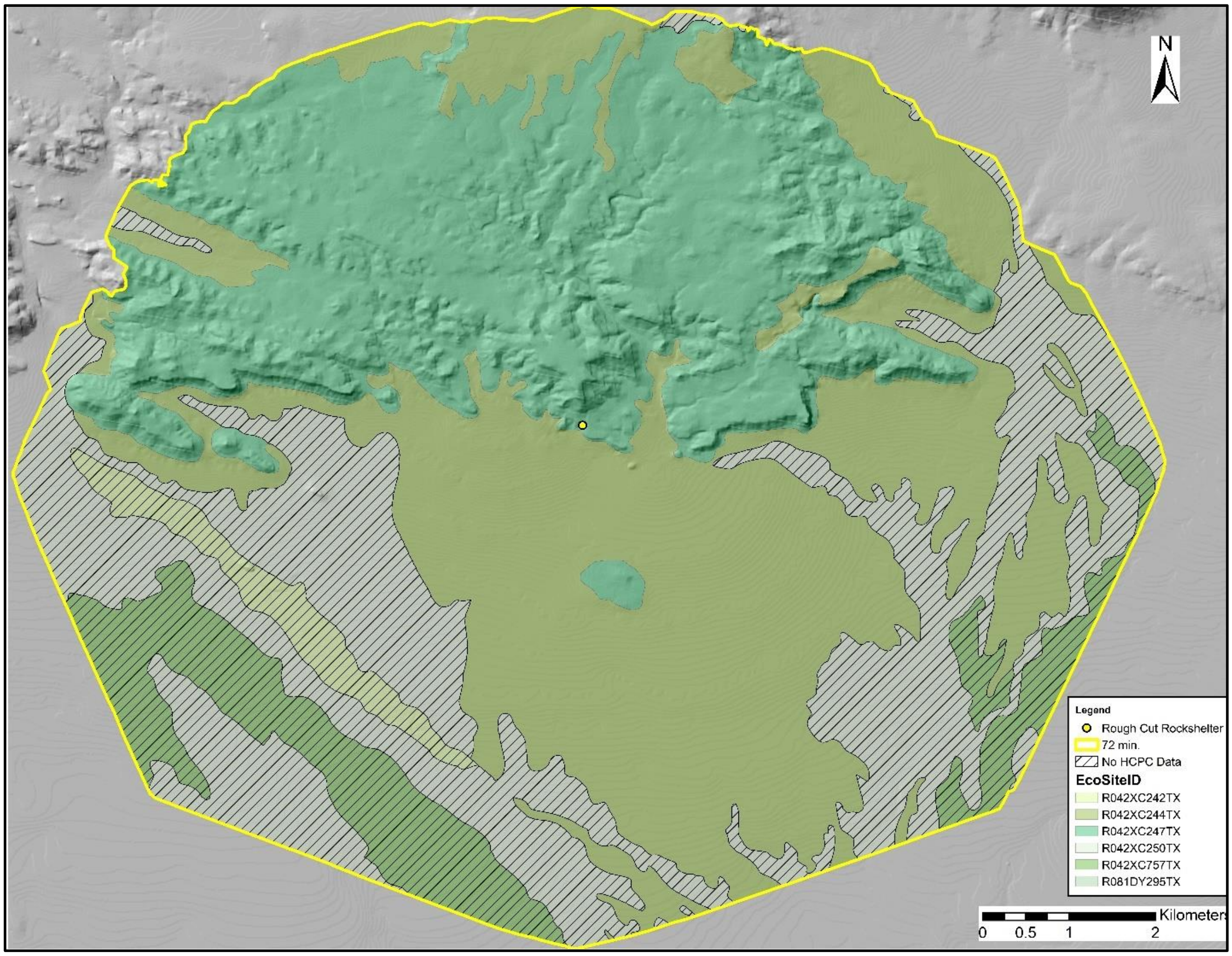

Figure 7.6. 72-min. foraging catchment and ESs for Rough Cut Rockshelter.

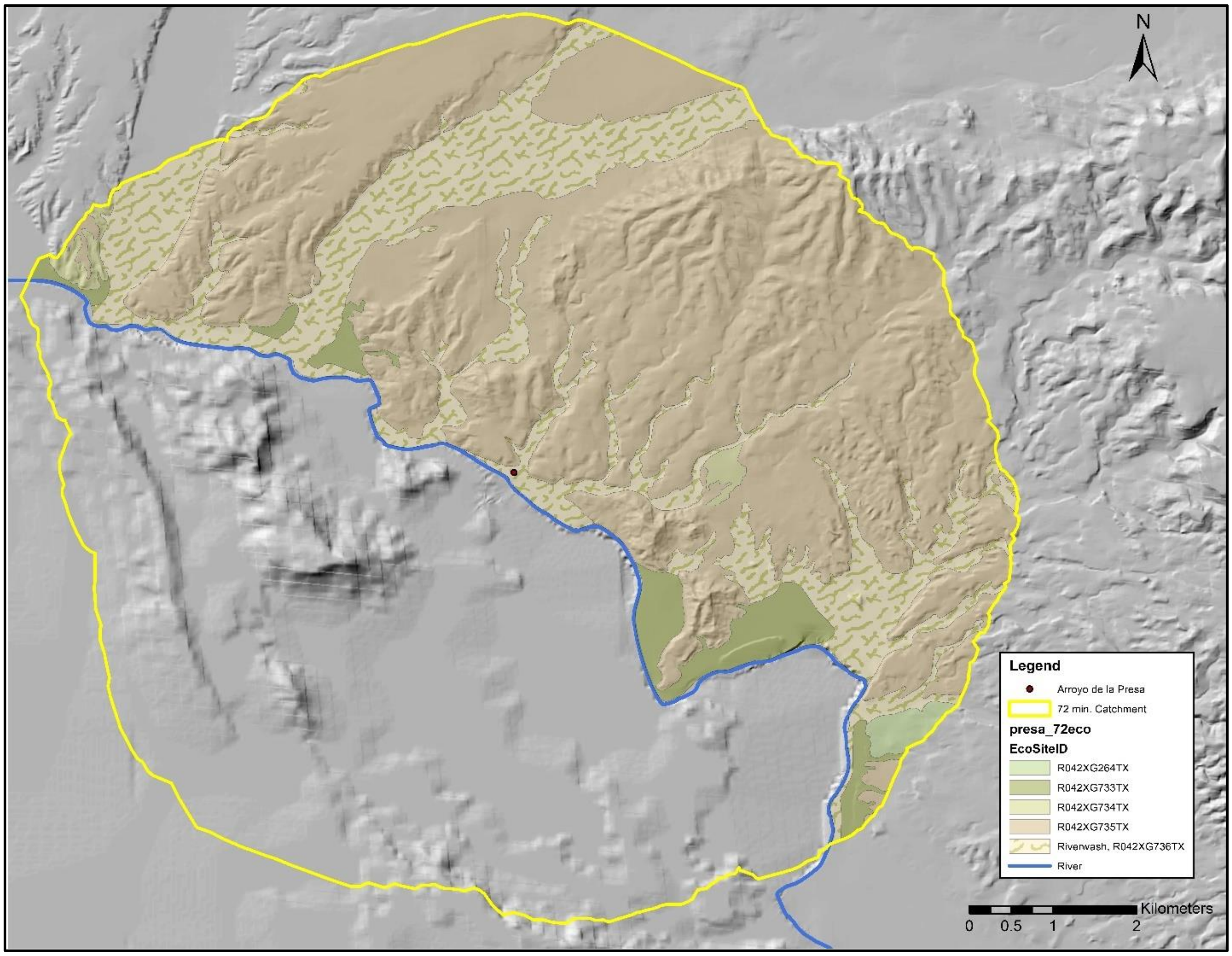

Figure 7.7. 72-min. foraging catchment and ESs for Arroyo de la Presa.

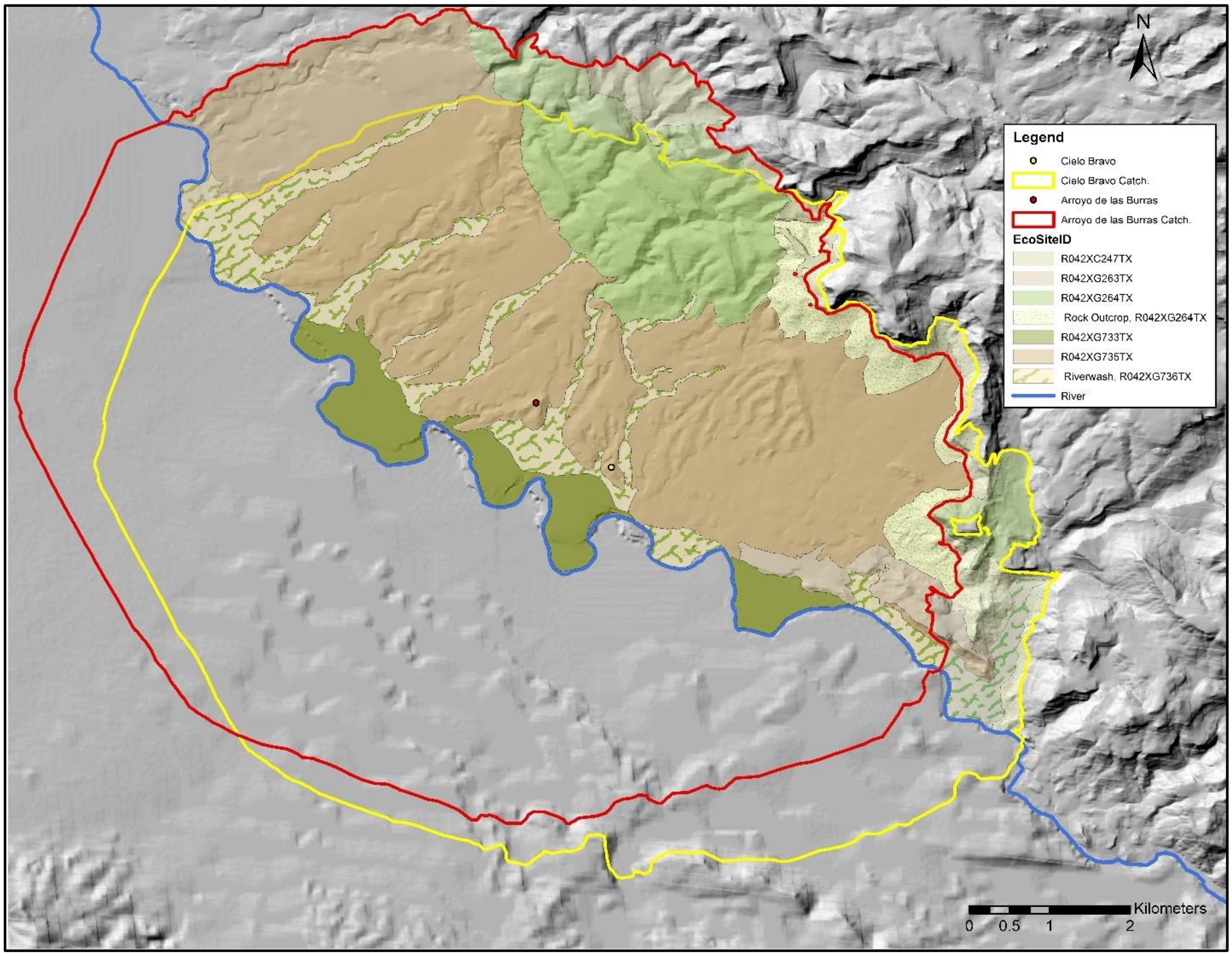

Figure 7.8. 72-min. foraging catchments and ESs for Cielo Bravo and Arroyo de la Presa.

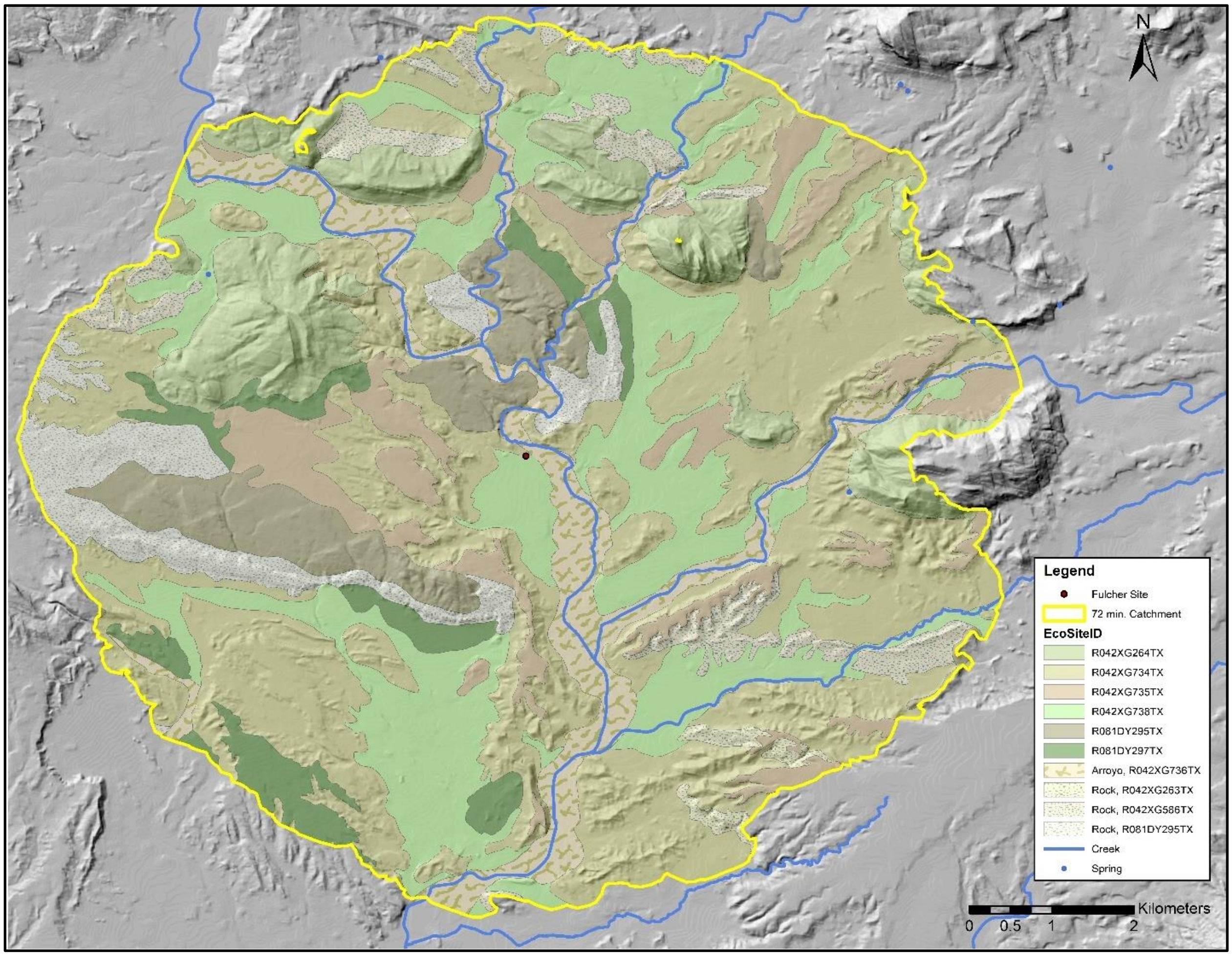

Figure 7.9. 72-min. foraging catchment and ESs for the Fulcher Site.

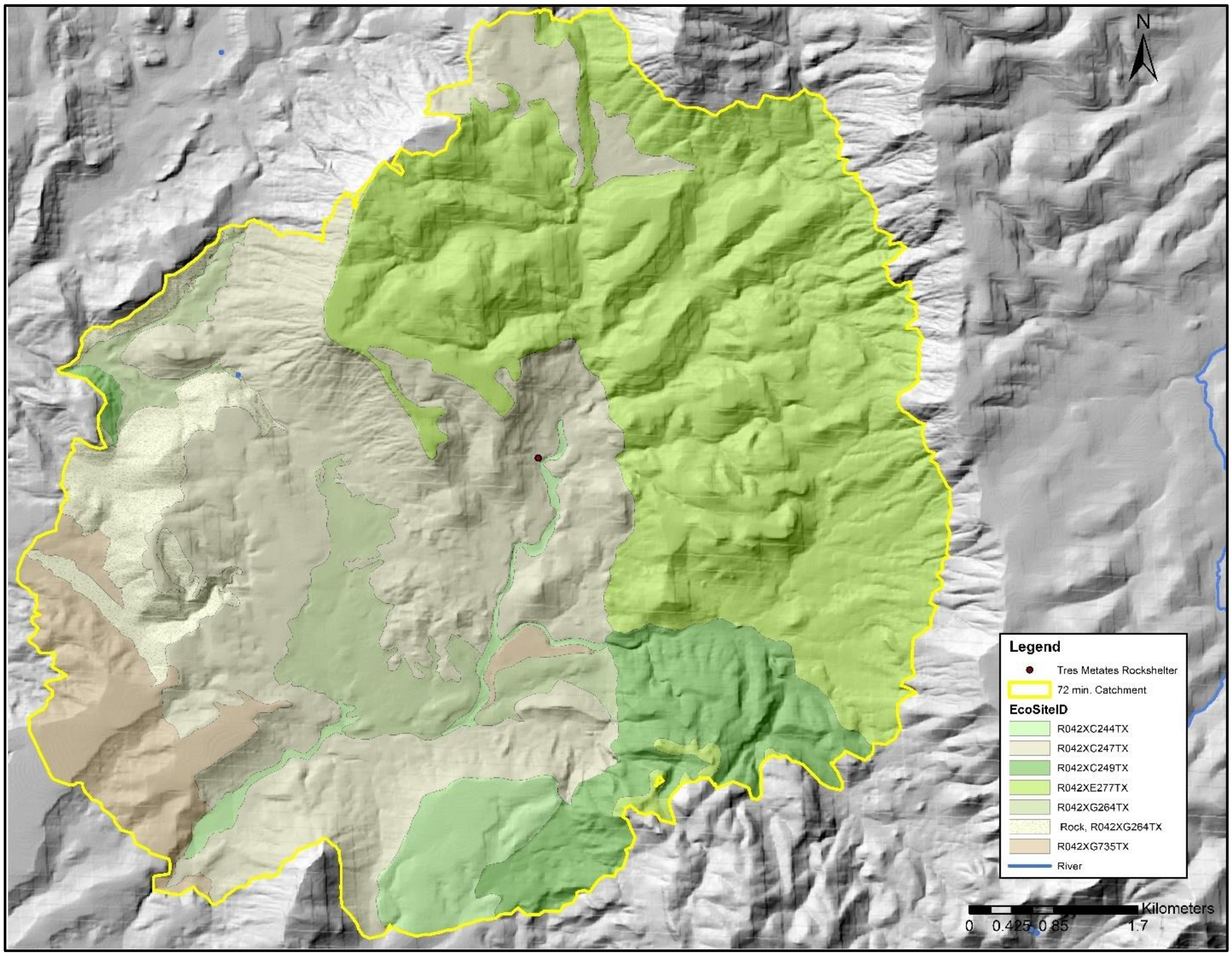

Figure 7.10. 72-min. foraging catchment and ESs for Tres Metates Rockshelter.

The results from FRAGSTATS (McGarigal, Cushman, and Ene 2012) provided otherwise unavailable insight into landscape use and potential decision making of foragers within the eastern Trans-Pecos during the TLP. This analysis in particular sought to assess the complexity of a given foraging catchment working under the assumption that landscapes with higher diversity and greater patch dispersion were more sought after due to a conglomeration of potential food resources.

7.7.1 Landscape Metric Analyses - Results

Total Area (TA) As one of the most basic landscape-level metrics, total area (TA) measured the total area of a given foraging catchment, which based on the use of the reciprocal of Tobler's hiking function (1974) is related to both time as well as topographic relief. Within this study topographic relief was the primary limitation and, as such, a foraging catchment with greater topographic relief (i.e., an area that is "rough") is considered to have a smaller forging catchment.

Three archaeological sites had areas over 70 km^2 with Rough Cut Rockshelter having the largest (78.02 km^2), followed by Granado Cave (74.5 km^2), 41PC502 (72.79 km^2), and Tranquil Rockshelter (71.84 km^2). Tres Metates Rockshelter and the Fulcher Site had the smallest foraging areas with 58.1 km^2 for the former and 68.45 km^2 for the latter (Table 7.16).

	TA (km^2)	**NP**	**LSI**	**CONTAG**	**PR**	**PRD**	**SHDI**	**SIDI**	**SHEI**	**SIEI**
41PC502	72.79	43	8.445	55.8246	10	0.1055	1.7304	0.8071	0.715	0.8968
Fulcher Site	68.45	143	12.464	47.7665	10	0.1222	1.9229	0.8054	0.8351	0.8949
Granado Cave	74.5	113	12.956	56.9542	7	0.0727	1.2502	0.6447	0.6425	0.7521
Rough Cut Rockshelter	78.02	37	6.819	51.2575	5	0.0539	1.3491	0.716	0.8382	0.895
Tranquil Rockshelter	71.84	32	6.397	52.4335	5	0.0585	1.3172	0.6948	0.8184	0.8685
Tres Metates Rockshelter	58.1	30	5.493	55.0527	7	0.1337	1.5504	0.7273	0.7967	0.8486

Table 7.17. Spatial metrics of reconstructed foraging catchments in the study area.

Number of Patches (NP) A second basic landscape metric is the number of patches (NP) on a given landscape (Table 7.16). The Fulcher Site had the greatest number of patches with 143 being present within the foraging catchment while Tres Metates Rockshelter having only 30, the lowest count within the study sample. The foraging catchment at Granado Cave also had a high number of patches with 113 being present on the landscape. The remaining archaeological sites had lower NP with 41PC502 having 43, Rough Cut Rockshelter 32, and Tranquil Rockshelter 30 (Table 7.16).

Landscape Shape Index (LSI) Results from the Landscape Shape Index (LSI), which measures the complexity of the landscape, indicate none of the foraging catchments are very complex. Granado Cave and the Fulcher Site had the highest geometric complexity with the Granado Cave foraging catchment having an LSI value of 12.9556 and the Fulcher Site's foraging catchment LSI = 12.464. The remaining four foraging catchments had low LSI values with 41PC502 = 8.445, Rough Cut Rockshelter = 6.819, Tranquil Rockshelter = 6.397, and Tres Metates Rockshelter = 5.493 (Table 7.16).

Contagion Index (CONTAG) As a metric which accounted for both dispersion and interspersion, the contagion index (CONTAG) was used to determine if patches were well distributed across a given foraging catchment. Within the study sample Granado Cave had the highest CONTAG value at 56.954 indicating few, large patches dominate the foraging catchment, however this CONTAG was not appreciably higher than those for 41PC502 (55.825) and Tres Metates Rockshelter (55.503). The remaining rockshelters had similar CONTAG values though Tranquil Rockshelter was slightly higher (52.434) compared to Rough Cut Rockshelter (51.258). The Fulcher Site's foraging catchment had the lowest CONTAG at 47.767 indicating a landscape dominated by small, well dispersed patches compared to the remainder of the study sample. However, it should be noted the range of values for CONTAG is 0 – 100 and indicated none of the foraging areas were heavily dominated by few patches nor are the patches exceptionally well dispersed (Table 7.16)

Patch Richness (PR) and Patch Richness Density (PRD) Much like LSI, patch richness density (PRD) can be compared between landscapes as it is a standardized measure of patch richness per area and is closely related to patch richness (PR) or the number of patch types on a given landscape. Foraging catchments with the highest PR were 41PC502 and the Fulcher Site with both having 10 and two of the protected sites having slightly fewer (Granado Cave, Tres Metates Rockshelter = 7). Tranquil Rockshelter and Rough Cut Rockshelter had the lowest PR with both having 5 patch types. It should be noted that the PR values are low and this resulted in similarly low PRD values (Table 7.16).

For the foraging catchment surrounding Tres Metates Rockshelter, the PRD value was 0.134 and indicated a landscape with high richness per area, at least in comparison to the other foraging catchments. The Fulcher Site and 41PC502 also had high PRD values with the former equal to 0.122 and the latter 0.106. Granado Cave (PRD = 0.073), Tranquil Rockshelter (PRD = 0.059), and Rough Cut Rockshelter (PRD = 0.054) were all comparatively low and indicated landscapes with low patch richness in comparison to their area (Table 7.16).

Landscape Diversity and Evenness Indices- Results Because SIDI has a limit of 0 – 1 the values of this index are more easily interpreted than for SHDI which does not have a limit. 41PC502 and the Fulcher Site had the highest SIDI values and most similar values with 0.807 for the former and 0.805 for the latter, indicating a higher number of HCPCs and a more equitable, proportional distribution of the HCPCs. Rough Cut and Tranquil Rockshelters had similar, high

SIDI values with Rough Cut Rockshelter = 0.727 and Tranquil Rockshelter = 0.716. Granado Cave had an SIDI = 0.645 and indicated a landscape with an uneven proportional distribution of HCPCs (Table 7.16).

SHDI provides a similar quantification of landscape diversity as SIDI, however it is more sensitive to rare patch types, or HCPCs, which are not common within a foraging catchment. Additionally, SHDI values are more difficult to interpret than SIDI values because there is no upper limit. Values for this index were quite low with a maximum value of 1.923 for the Fulcher Site foraging catchment and the lowest for Granado Cave (SHDI = 1.250). Comparable to the Fulcher Site, Tres Metates Rockshelter had an SIDI value of 1.730 and Tres Metates Rockshelter = 1.550. SIDI values for Rough Cut (SIDI = 1.349) and Tranquil (SIDI = 1.317) were similar. Interpretations of this index are that even though the Fulcher Site and Tres Metates Rockshelter had comparatively high SHDI values, none of the landscapes were exceptionally diverse in terms of the number of patch types, or HCPCs, nor in their distribution given that this index has no limit in its results (Table 7.16).

Another quantitative assessment at the landscape, or foraging catchment, scale was made with evenness indices. These two indices, Shannon's Evenness Index (SHEI), Simpson's Evenness Index (SIEI), quantify how evenly distributed HCPC patches are across a given landscape. Both values are easy to interpret given that the limits are from 0 – 1, though like SHDI, SHEI is more sensitive to rare patch types, here uncommon HCPCs, on a given landscape.

SHEI values varied from 0.838 to 0.643 with Rough Cut Rockshelter having the greatest SHEI (SHEI = 0.838) and Granado Cave having the smallest (SHEI = 0.643). The Fulcher Site (SHEI = 0.835), Tranquil Rockshelter (SHEI = 0.818), and Tres Metates Rockshelter (SHEI = 0.797) foraging catchments also had appreciably high SHEI values. From this analysis it can be interpreted that 41PC502 and Granado Cave have the lowest SHEI values because there was a spatial dominance of a single HCPC in comparison to the other foraging catchment's (Table 7.16).

Foraging catchments SIEI values differed substantially from the SHEI values in that the resultant values were high and had smaller variance; 41PC502 (SIEI = 0.897), the Fulcher Site (SIEI = 0.895), and Rough Cut Rockshelter (SIEI = 0.895) and indicated foraging catchments dominated by few HCPCs. The remaining foraging catchments (Tranquil Rockshelter [0.869], Tres Metates Rockshelter [0.849], and Granado Cave [0.752]) were also high and dominated by fewer HCPCs (Table 7.16).

7.7.2 Foraging Catchment Reconstruction – Discussion

The primary goal of this analysis was to assess the evenness and diversity of food resource patches across reconstructed foraging catchments within the Eastern Trans-Pecos archaeological during the TLP. In addition to this, said analysis also sought to quantify and compare the spatial configuration of these six foraging catchments to better understand TLP foraging decisions.

Regarding landscape metrics, the Fulcher Site consistently ranked the highest compared to the other sites across all metrics and indices. This indicates a site potentially occupied to access a sizable catchment with a diverse set of small resource patches evenly distributed across the foraging area. At Granado Cave, despite having a slightly larger foraging catchment when compared to the Fulcher Site (9.62 km^2 vs 8.15 km^2) this catchment had fewer patches (n = 113 vs. 143) and fewer patch types, or ESs (n = 7 vs. 10). Measures of diversity (SHDI, SIDI), evenness (SHEI, SIEI), patch density (PRD), and dispersion (CONTAG), all indicated a landscape with low diversity, evenness, dispersion, and interspersion. 41PC502 had the largest foraging catchment (TA = 9.48 km^2), was equal to the Fulcher Site in number of ESs but patches of these ESs were not equitably dispersed or interspersed across the reconstructed foraging catchment (CONTAG = 55.82) when compared to the remainder of the sample. Despite this the reconstructed foraging catchment was fairly diverse and even in the distribution of patches across the catchment. The two rockshelters located in closest proximity to one another, Tranquil and Rough Cut Rockshelters, shared similar metric and index scores. Rough Cut Rockshelter's reconstructed foraging catchment had a larger area (9.28 km^2), high NP (37), higher LSI (6.819), the same number of ESs (5), and a lower CONTAG (51.2575) which indicates a landscape with high dispersion and interspersion. Additionally, Rough Cut Rockshelter's catchment had the lowest PRD value (0.0539), indicating that said catchment had the lowest richness of patches per area. Despite this Rough Cut Rockshelter had slightly higher diversity and evenness index values than Tranquil Rockshelter though not extremely so. Tres Metates Rockshelter's reconstructed foraging catchment analysis was the most unique of the six within the sample. Despite having the smallest catchment size, 5.24 km^2, only 30 patches of ESs, lacking geometric complexity (LSI = 5.493), and low patch dispersion (CONTAG = 55.0527), this catchment had the highest PRD value, 0.1337. Essentially, despite including a small catchment the concentration of patches, and their resultant resources which included plant foods, was quite high when compared to the other catchments.

7.8 Foraging Catchment Analysis- Recorded and Potential Foods

What follows is an overview of available foods based on ethnographic information as compared to those foods which were archaeological visible based upon macrobotanical and microbotanical remains. In regards to order of presentation, reconstructed foraging catchments missing significant areas of HCPC data are described first (i.e., Granado Cave and 41PC502), followed by those with a large portion lacking spatial data second (Tranquil and Rough Cut Rockshelters), catchments with a large portion occurring in the state of Chihuahua, Mexico next, and then the two catchments which have all HCPC plant community information available, the Fulcher Site and Tres Metates Rockshelter, last.

In total this analysis expanded the archaeologically defined diet of 31 taxa, which included two cultigens (maize, common bean) to 44 of which were known to have been used by other cultural groups across North America. Additionally, this analysis tested the validity of the human foraging spatial model via the presence of two piñon taxa, Mexican piñon (*Pinus cembroides*) and papershell piñon (*P. remota*, syn. *P. cembroides* Zucc. var. *remota*) in archaeological samples from Tranquil and Rough Cut Rockshelters. The spatial distribution of these taxa lay outside of the 72-min. but hypothesized here as evidence of logistical groups accessing piñon patches north of both sites.

Granado Cave The foraging catchment of Granado Cave is missing a large portion (51.5%) of the ES-HCPC data in that of the seven ESs which comprised the landscape, HCPC data is only available for five, or 48.5%, of the area of the catchment. Though this analysis did produce some data, it should be noted that the results may not accurately reflect the maximum possible botanical food assemblage.

Common Name	**Taxon**	**HCPC**	**Pollen**	**Historic**	**Mescalero**	**Other**
Lechuguilla	*Agave lechuguilla*	X	X	X	X	
Prickly pear	*Opuntia* spp.	X	X	X	X	
Sunflower	*Helianthus annuus*	X	X		X	
Vine mesquite*	*Panicum obtusum*	X	X		X	
Littleleaf sumac	*Rhus microphylla*	X	X		X	
Sand dropseed*	*Sporobolus cryptandrus*	X	X		X	
Amaranthus family**	AMARANTHACEAE	X	X		X	
Evening primrose family	ONAGRACEAE	X	X		X	
Purslane**	*Portulaca* spp.	X	X		X	
Mesquite	*Prosopis glandulosa*	X		X	X	
Cholla	*Cylindropuntia imbricata*	X			X	
Sotol	*Dasylirion leiophyllum*	X			X	
Sacahuista	*Nolina texana*	X			X	
Yucca	*Yucca* spp.	X			X	
Blue grama*	*Bouteloua gracilis*	X	X			X[1,2]
Knotweed family	POLYGONACEAE	X	X			X[3]
Catclaw acacia	*Acacia greggii*	X				X[4,5,6,7]
Ocotillo	*Fouquieria splendens*	X				X[4]
Lotebush	*Ziziphus obtusifolia*	X				X[5,8]
Nipple cactus	*Mammilaria* spp.		X		X	
Hackberry	*Celtis* spp.		X		X	
Pecan/hickory	*Carya* spp.		X			X[9]

Table 7.18. Archaeologically visible, modelled available, and historically known plant foods surrounding Granado Cave.

[1]Buskirk (1986), [2]Reagan (1929), [3]Steward (1933), [4]Bean and Saubel (1972), [5]Curtin (1949), [6]Dawson (1944), [7]Weber and Seaman (1985), [8]Castatter and Bell (1951), [9]Carlson and Jones (1940).

*The original pollen analysis noted grass family (POACEAE) pollen which cannot be further differentiated to genus nor species.

**HCPC data indicates undifferentiated, annual forbs of which identified taxa may have been present on the landscape.

Fossil pollen analysis of coprolites from Excavation Unit 4 and sediments associated with Burial 7 identified fourteen dietary taxonomic identifications. Hamilton and Bratten (2001) noted that of the pollen present, grass pollen grains dominated the coprolite pollen assemblage and indicated that grass seeds contributed a significant portion to diet, an observation supported by a myriad of tools associated with grass and forb seed processing found within the cave (Hamilton and Bratten 2001, pg. 254). In total the HCPC data from the foraging catchment identified 17 possible plant foods, of which three were known to have been used according to early Spanish accounts (Table 7.18). Sixteen of the possible foods were described as foods by the Mescalero Apache while six others have ethnographic evidence of use as foods.

When comparing the archaeologically identified plant taxa with the HCPC data three taxa are not present within the foraging catchment: nipple cactus, hackberry, and pecan/hickory. Of these nipple cactus is the most likely to be present on the landscape as it is a widespread genus within the eastern Trans-Pecos (Powell and Weedin 2004). Hackberry is also a common brush species which can occupy a number of niches, though areas with slightly more available water are preferred (Powell 1998). The genus *Carya* is the most unique of the plant taxa identified and was found in either coprolite 4-3 or 4-7 (Hamilton and Bratten 2001, Table 14.1, pg. 244) as well as several of the burials, possibly including Burial 7 (Hamilton and Bratten 2001, Table 14.4, pg. 250) at Granado Cave. The importance, as well as uniqueness, of this genus is more fully described in the results section of this analytical method.

When comparing all of the presented data the available plant taxa identified within the reconstructed foraging catchment is complementary, though three of the botanical food resources identified from the pollen analysis were not present on the modelled landscape. At the juncture of this writing said difference is attributed a lack of HCPC data, though this will undoubtedly be resolved in the future via work by the USDA-NRCS as well as other, coordinating agencies.

41PC502 Much like Granado Cave, the HCPC botanical composition for 41PC502 on the Stockton Plateau is also missing. Of the nine ESs within the reconstructed foraging catchment only five, or 32.75% of the total area, have HCPC compositional data.

Common name	Taxon	HCPC	Macrobotanical	Historic	Mescalero	Other
Lechuguilla	*Agave lechuguilla*	X	X	X	X	
Prickly pear	*Opuntia* spp.	X		X	X	
Mesquite	*Prosopis glandulosa*	X	X	X	X	
Sundrops	*Calylophus* spp.	X			X	-
Hog potato	*Hoffmannseggia glauca*	X			X	
Evening primrose	*Oenothera* spp.	X			X	
Littleleaf sumac	*Rhus microphylla*	X			X	
Vine mesquite	*Panicum obtusum*	X			X	
Sand dropseed	*Sporobolus cryptandrus*	X			X	
Yucca	*Yucca* spp.	X			X	
Catclaw acacia	*Acacia greggii*	X				X[1,2,3]
Blue grama	*Bouteloua gracilis*	X				X[4,5]
Ocotillo	*Fouquieria splendens*	X				X[6]
Lotebush	*Ziziphus obtusifolia*	X				X[1,7]
Amaranth Family	AMARANTHACEAE	X*	X		X	
Purslane	*Portulaca* spp.	X*	X		X	

Table 7.19. Archaeologically visible, modelled available, and historically known plant foods surrounding 41PC502.

[1]Curtin (1949), [2]Dawson (1944), [3]Weber and Seaman (1985), [4]Buskirk (1986), [5]Reagan (1929), [6]Bean and Saubel (1972), [7]Castetter and Bell (1951)

*HCPC data indicates undifferentiated, annual forbs of which identified taxa may have been present on the landscape

Archaeologically visible macrobotanical remains constituted four plant taxa and included lechuguilla, mesquite, members of the Amaranth Family, as well as purslane (Table 7.18). Of these four taxa, two are definitively on the landscape (i.e., lechuguilla and mesquite) and two others may be present, amaranth and purslane, under the assumption they contribute to the undifferentiated annual forb category from the HCPC data.

When comparing the identified to available foods there was also significant overlap, especially between the archaeological materials and early Historic Period indigenous plant diet. The archaeological diet also matches well with the reported Mescalero Apache plant diet. Only four taxa were present on the foraging catchment landscape but not described among the Mescalero Apache nor the Early Historic hunter-gatherers and farmers of the region. These included catclaw acacia (*Acacia greggii*), blue grama (*Bouteloua gracilis*), ocotillo (*Fouquieria splendens*), and lotebush (*Ziziphus obtusifolia*). These are undoubtedly low ranked plant food resources which, though potentially used by TLP native peoples at 41PC502, are not archaeologically visible, at least with macrobotanical remains. In general though the landscape had a variety of food resources available, though lechuguilla, mesquite, amaranth, and purslane are the only ones with confirmed use.

Tranquil Rockshelter The foraging catchment for Tranquil Rockshelter had five ESs identified from the foraging catchment reconstruction. Of those identified two had HCPC compositional data and account for 68.24% of the area of the catchment. The remaining three ESs makeup 31.76% of the area.

Table 7.20. Archaeologically visible, modelled available, and historically known plant foods surrounding Tranquil Rockshelter.

Common name	**Taxon**	**HCPC**	**Macrobotanical**	**Historic**	**Mescalero**	**Other**
Lechuguilla	*Agave lechuguilla*	X	X	X	X	
Prickly pear	*Opuntia* spp.	X	X	X	X	
Mesquite	*Prosopis glandulosa*	X	X	X	X	
Cholla	*Cylindropuntia imbricata*	X	X		X	
Sotol	*Dasylirion* spp.	X	X		X	
Amaranth Family	AMARANTHACEAE	X*	X		X	
Purslane	*Portulaca* spp.	X*	X		X	
Yucca	*Yucca* spp.	X	X		X	
Juniper	*Juniperus* spp.	X			X	
Sacahuista	*Nolina texana*	X			X	
Skunkbush sumac	*Rhus trilobata*	X			X	
Sand dropseed	*Sporobolus cryptandrus*	X			X	
Buffalo gourd	*Cucurbita foetidissima*	X*	X			X[1,2,3,4]
Knotweed	*Polygonum* spp.	X*	X			X[5]
Canaigre	*Rumex hymenosepalus*	X*	X			X[1,6,7,8]
Catclaw acacia	*Acacia greggii*	X				X[1,9,10,11]
Blue grama	*Bouteloua gracilis*	X				X[12,13]
Ocotillo	*Fouquieria splendens*	X				X[1]

Table 7.20. Continued

Common name	Taxon	HCPC	Macrobotanical	Historic	Mescalero	Other
Lotebush	*Ziziphus obtusifolia*		X			X[9,14]
Pitaya cactus	*Echinocereus* spp.		X		X	
Nipple cactus	*Mammillaria* spp.		X		X	
Mexican piñon	*Pinus cembroides*		X	X	X	
Oak	*Quercus* spp.		X		X	
Maize	*Zea mays*		X		X	
Little walnut**	*Juglans microcarpa*		X			

[1]Bean and Saubel (1972), [2]Jones (1931), [3]Russell (1908), [4]Sparkman (1908), [5]Steward (1933), [6]Castetter and Underhill (1935), [7]Elmore (1944), [8]Zigmond (1981), [9]Curtin (1949), [10]Dawson (1944), [11]Weber and Seaman (1985), [12]Buskirk (1986), [13]Reagan (1929), [14]Castetter and Bell (1951)/
*HCPC data indicates undifferentiated, annual forbs of which identified taxa may have been present on the landscape.
**Lacks historic and ethnographic evidence of use, though archaeological research demonstrates consumption.

Based upon the macrobotanical remains a total of eighteen plant taxa were identified and HCPC data indicated a minimum of eleven of these were present within the rockshelter's foraging catchment (Table 7.19). For the remaining seven taxa, three (lotebush, pitaya cactus, and nipple cactus) are likely present on the landscape but within the missing HCPC data from the NRCS. Two dietary tree species found in the macrobotanical assemblage but missing from the HCPC data included oak (*Quercus* spp.) and piñon. These taxa are present on the landscape but outside of the foraging catchment within an approximately two hour walk to the north of the rockshelter and discussed further on page 245. Like the previously discussed site catchments, the HCPC compositional data included unidentified annual forbs as present within all HCPCs for this catchment. As such the five forb taxa noted within the macrobotanical assemblage but not explicitly identified with the HCPC data may be present within said catchment. Additionally, a cultigen, maize, was also associated with TLP occupation at this rockshelter but not in the ecological data.

When comparing archaeological versus recorded diet there was significant overlap between this archaeological site, early historic groups in the study area, and Mescalero Apache diet. Of these lechuguilla, prickly pear, and mesquite are noted as used by the TLP inhabitants of Tranquil Rockshelter, early Historic Periods peoples, and the Mescalero Apache. A total of eleven plant food taxa were shared between the archaeological remains and that of the Mescalero Apache. Three taxa, all forbs (i.e., buffalo gourd, knotweed, and canaigre), were encountered archaeologically and were not used by the Mescalero Apache but used by other cultural groups.

Analysis of the HCPC data indicated ten of the macrobotanical visible plant foods, as discussed above, in addition to another eight as available. Five of these foods present on the landscape but lacking in the archaeological have recorded use among the Mescalero Apache and included purslane, juniper, skunkbush sumac, sand dropseed, and yucca. An additional three foods from the HCPC were also identified, were not present in the macrobotanical assemblage, but were used by other native cultural groups outside of the study area; these included catclaw acacia, blue grama, and ocotillo.

One taxon, littleleaf walnut (*Juglans microcarpa*), was only identified from macrobotanical analysis but not present on the modelled landscape nor has it been described ethnographically. Within Texas archaeology this is a widely accepted food source and is well represented in the archaeological record of the neighboring Lower Pecos region (ex. Dering 2006a, Maynard 2003). As such this likely fat-rich resource (Maynard 2003) was identified as a food resource within this study. However, this species requires large amounts of water and though the incomplete ES data may present it in the future its spatial distribution may occur outside of the 72 min. foraging catchment used in this model.

Rough Cut Rockshelter Analysis of the reconstructed foraging catchment around Rough Cut Rockshelter yielded six ESs capable of being accessed in 72-minutes. Five of these are shared with the foraging catchment around Tranquil Rockshelter while the midgrass-shrub HCPC of R081DY297TX occurs in this rockshelter's 72-min. catchment and accounted for 0.002% of the area. HCPC data was available for three of the six ESs and identified plant taxa presence for 66.2% of the area while 33.8% of the catchment lacked data at the time of writing.

Common name	**Taxa**	**HCPC**	**Macrobotanical**	**Historic**	**Mescalero**	**Other**
Lechuguilla	*Agave lechuguilla*	X	X	X	X	
Prickly pear	*Opuntia* spp.	X	X	X	X	
Mesquite	*Prosopis glandulosa*	X	X	X	X	
Cholla	*Cylindropuntia imbricata*	X	X		X	
Amaranth Family	AMARANTHACEAE	X*	X		X	
Purslane	*Portulaca* spp.	X*	X		X	
Yucca	*Yucca* spp.	X	X		X	
Buffalo gourd	*Cucurbita foetidissima*	X*	X			X[1,2,3]
Sotol	*Dasylirion* spp.	X			X	
Juniper	*Juniperus* spp.	X			X	
Sacahuista	*Nolina texana*	X			X	
Skunkbush sumac	*Rhus trilobata*	X			X	
Sand dropseed	*Sporobolus cryptandrus*	X			X	
Catclaw acacia	*Acacia greggii*	X				X[1,5,6,7]
Blue grama	*Bouteloua gracilis*	X				X[8,9]
Ocotillo	*Fouquieria splendens*	X				X[1]
Lotebush	*Ziziphus obtusifolia*	X				X[5,10]
Piñon	*Pinus* spp.		X	X	X	
Hackberry	*Celtis* spp.		X		X	
Pitaya cactus	*Echinocereus* spp.		X		X	
Oak	*Quercus* spp.		X		X	
Texas persimmon**	*Diospyros texana*		X			
Littleleaf walnut**	*Juglans microcarpa*		X			

Table 7.21. Archaeologically visible, modelled available, and historically known plant foods surrounding Rough Cut Rockshelter.

[1]Bean and Saubel (1972), [2]Jones (1931), [3]Russell (1908), [4]Sparkman (1908), [5]Curtin (1949), [6]Dawson (1944), [7]Weber and Seaman (1985), [8]Buskirk (1986), [9]Reagan (1929), [10]Castetter and Bell (1951).

*HCPC data indicates undifferentiated, annual forbs of which identified taxa may have been present on the landscape.

**Lacks historic and ethnographic evidence of use, though archaeological research demonstrates use.

Via comparison of the possible dietary species gathered from the HCPC data at Rough Cut Rockshelter five are noted in the archaeological assemblage. Of the six taxa identified from the archaeological record only two are likely to be eventually described within the catchment and included hackberry and pitaya cactus. Much like at Tranquil Rockshelter, acorn and piñon scales, and piñon nut shell fragments, were recovered from Rough Cut Rockshelter and their access is discussed below. The final two taxa identified from macrobotanicals but not present in the current iteration of the foraging catchment were Texas persimmon and littleleaf walnut. As discussed above, littleleaf walnut may be present either in the missing HCPC data or may exist elsewhere on the landscape. The same can be said for Texas persimmon which also requires large amounts of water for growth.

Significant overlap was also noted between the macrobotancial dietary remains at Rough Cut Rockshelter the recorded diet of historic, native inhabitants. Three species, lechuguilla, mesquite, and prickly pear, were utilized as food resources at Rough Cut Rockshelter and were also used by various early Historic Period peoples in the study area. An additional eight archaeologically identified foods have shared use between the inhabitants of this rockshelter and the Mescalero Apache. Of all the macrobotanical foods identified only one, buffalo gourd, was never identified as a historic regional food but was used by other historic native groups.

Historic climax plant community botanical taxa data indicated another nine taxa could have further contributed to diet (Table 7.20). One of these taxa, sotol, was likely present in the macrobotanical assemblage however identification of said taxa is inherently difficult in the Chihuahuan Desert (Dering 2004). Four taxa are present on the immediate landscape and were used by the Mescalero Apache (juniper, sacahuista, skunkbush sumac, and sand dropseed) and the remaining four (catclaw acacia, blue grama, ocotillo, and lotebush) were used by other native groups.

As mentioned above, littleleaf walnut has no recorded ethnographic use though archaeological investigations have determined the widespread use of this nut. The same has also been presented for Texas persimmon which lacks ethnographic description. Though Dering (2006b) notes the astringency of this berry producing plant, Texas persimmon seeds were common in Lower Pecos rockshelter deposits (Alexander 1974, Dering 1979 and present in the coprolites from the area (Williams-Dean 1978).

Arroyo de la Presa The following three site catchment's (Arroyo de la Presa, Cielo Bravo, and Arroyo de las Burras) were unique in the Rio Grande cutting through the middle of each catchment. For the areas on the Texas side, all HCPC data was available and, based on Tobler's First Law of Geography (Tobler 1970), that things closer together are more similar than those further away, it is hypothesized that the botanical assemblages encountered in the Chihuahua portions of the site catchments were similar if not the exact same.

Table 7.22. Archaeologically visible, modelled available, and historically known plant foods surrounding the Arroyo de la Presa Site.

Common Name	**Taxon**	**HCPC**	**Macrobotanical**	**Historic**	**Mescalero**	**Other**
Lechuguilla	*Agave lechuguilla*	X	X	X	X	
Amaranth Family	AMARANTHACEAE	X*	X		X	
Sand dropseed	*Sporobolus cryptandrus*	X	X		X	
Prickly pear	*Opuntia* spp.	X		X	X	
Mesquite	*Prosopis glandulosa*	X		X	X	
Hackberry	*Celtis ehrenbergiana*	X			X	
Cholla	*Cylindropuntia imbricata*	X			X	
Sotol	*Dasylirion* spp.	X	X?		X	
Pitaya cactus	*Echinocereus enneacanthus*	X			X	
Elbow bush	*Forestiera pubescens*	X			X	
Vine mesquite	*Panicum obtusum*	X			X	
Littleleaf sumac	*Rhus microphylla*	X			X	
Yucca	*Yucca* spp.	X			X	
Catclaw acacia	*Acacia greggii*	X				X[1,2,3,4]
Blue grama	*Bouteloua gracilis*	X				X[5,6]

Table 7.22. Continued

Common name	**Taxon**	**HCPC**	**Macrobotanical**	**Historic**	**Mescalero**	**Other**
Sedge	*Carex* spp.	X				X[7,8,9]
Desert willow	*Chilopsis linearis*	X				X[1]
Buckwheat	*Eriogonum* spp.	X				X[7,9,10,11]
Ocotillo	*Fouquieria splendens*	X				X[1]
Singlewhorl burrobrush	*Hymenoclea monogyra*	X				X[3]
Torrey wolfberry	*Lycium torreyi*	X				X[11,12]
Lotebush	*Ziziphus obtusifolia*	X				X[2,13]
Texas persimmon**	*Diospyros texana*	X				

[1]Bean and Saubel (1971), [2]Curtin (1949), [3]Dawson (1944), [4]Weber and Seaman (1985), [5]Buskirk (1986), [6]Reagan (1929), [7]Zigmond (1981), [8]Turner et al. (1990), [9]Wyman and Harris (1951), [10]Elmore (1944), [11]Vestal (1952), [12]Voegelin (1938), [13]Castetterand Bell (1951).
*HCPC data indicates undifferentiated, annual forbs of which identified taxa may have been present on the landscape.
**Lacks historic and ethnographic evidence of use, though archaeological research demonstrates consumption.

Because the Arroyo de la Presa was an open site the recovered macrobotanical remains are understandably sparse. A total of three plant taxa were identified, with a fourth also a possibility but unlikely, and included lechuguilla, members of the Amaranth Family, and sand dropseed. Sotol may have been present but cannot be definitively identified based solely upon leaf cellular structure (Dering 2004). All of these are present in the HCPC data, one (lechuguilla) was used by local indigenous groups, and the remaining two (Amaranth Family and sand dropseed) have recorded used among the Mescalero Apache.

Through the incorporation of HCPC data the possible dietary taxa increased to include 19 plant taxa (Table 7.21). Two of these, mesquite and prickly pear, were used by early Historic Period groups as well as the Mescalero Apache. Eight other plant taxa had recorded use in Mescalero Apache diet and another nine were used by groups outside of the study area. The final taxa identified, Texas persimmon, is also found within the foraging catchment but lacks documented ethnographic use.

Cielo Bravo and Arroyo de las Burras Downstream from Arroyo de la Presa were the Cielo Complex type sites Cielo Bravo and Arroyo de las Burras. Because these sites shared so much of their foraging catchments with one another (Figure 7.11) and so few macrobotanicals were recovered they are described in tandem here.

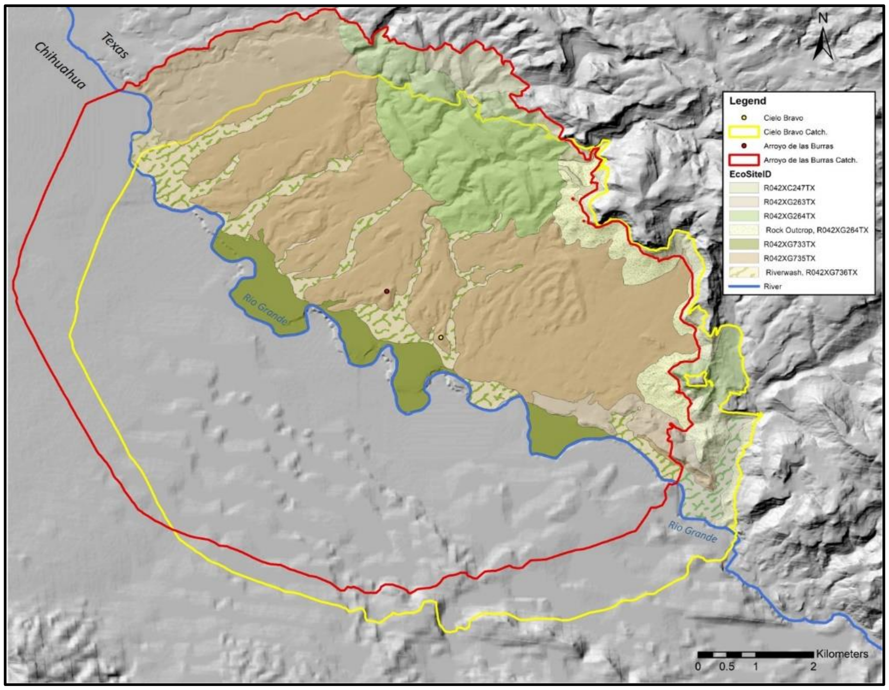

Figure 7.11. Overlap between the 72-min. foraging catchments of Cielo Bravo and Arroyo de las Burras.

Table 7.23. Archaeologically visible, modelled available, and historically known plant foods surrounding Cielo Bravo and Arroyo de las Burras.

Common Name	**Taxon**	**HCPC**	**Macrobotanical**	**Historic**	**Mescalero**	**Other**
Lechuguilla	*Agave lechuguilla*	X	Br	X	X	
Prickly pear	*Opuntia* spp.	X		X	X	
Mesquite	*Prosopis glandulosa*	X	Bu	X	X	
Amaranth Family*	AMARANTHACEAE	X	Bu		X	
Pitaya cactus	*Echinocereus enneacanthus*	X	Br		X	
Hackberry	*Celtis ehrenbergiana*	X			X	
Cholla	*Cylindropuntia imbricata*	X			X	
Sotol	*Dasylirion* spp.	X	X?		X	

Table 7.23. Continued

Common Name	**Taxon**	**HCPC**	**Macrobotanical**	**Historic**	**Mescalero**	**Other**
Elbow bush	*Forestiera pubescens*	X			X	
Juniper	*Juniperus* spp.	X			X	
Sacahuista	*Nolina texana*	X			X	
Vine mesquite	*Panicum obtusum*	X			X	
Littleleaf sumac	*Rhus microphylla*	X			X	
Skunkbush sumac	*Rhus trilobata*	X			X	
Sand dropseed	*Sporobolus cryptandrus*	X			X	
Soaptree yucca	*Yucca elata*	X	X?		X	
Spanish bayonet	*Yucca torreyi*	X			X	
Catclaw acacia	*Acacia greggii*	X				X[1,2,3,4]
Blue grama	*Bouteloua gracilis*	X				X[5,6]
Sedge	*Carex* spp.	X				X[7,8,9]
Desert willow	*Chilopsis linearis*	X				X[1]
Buckwheat	*Eriogonum* spp.	X				X[7,9,10,11]
Ocotillo	*Fouquieria splendens*	X				X[1]
Torrey wolfberry	*Lycium torreyi*	X				X[11,12]
Lotebush	*Ziziphus obtusifolia*	X				X[2,13]
Texas persimmon**	*Diospyros texana*	X				

[1]BEand and Saubel (1972), [2]Curtin (1949), [3]Dawson (1944), [5]Buskirk (1986), [6]Reagan (1929), [7]Zigmond (1981), [8]Turner et al. (1990), [9]Wyman and Harris (1951), [10]Elmore (1944), [11]Vestal (1952), [12]Veogelin (1938), [13]Castetter and Bell (1951).
Br = Cielo Bravo
Bu = Arroyo de las Burras
*HCPC data indicates undifferentiated, annual forbs of which identified taxa may have been present on the landscape.
**Lacks historic and ethnographic evidence of use, though archaeological research demonstrates consumption.

Historic climax plant community data indicated a total of 26 possible dietary taxa based upon historic and ethnographic data (Table 7.22). Four taxa have confirmed use at both sites with lechuguilla, or other caudex producing desert plants, and pitaya cactus present in samples from Cielo Bravo and mesquite as well as a member of the Amaranth Family found at Arroyo de las Burras. Of these two, lechuguilla and mesquite, have documented use among local groups and the remaining two, Amaranth Family and pitaya cactus, were used by the Mescalero Apache

For the remaining taxa one has confirmed use locally, prickly pear, and another 12 were used by the Mescalero Apache across Far West Texas and southern New Mexico. Eight plant taxa, including riparian resources such as sedges, were used by numerous non-local groups and the last, Texas persimmon, is widely considered to have been used prehistorically.

Fulcher Site The following two archaeological sites, the Fulcher Site and Tres Metates Rockshelter, stand-out compared to the other archaeological sites in the study sample when comparing their reconstructed foraging catchments. Unlike the other sites which either do not have HCPC data reported for all ESs or extend into Chihuahua, these two sites have complete HCPC data for their entirety.

Common name	**Taxa**	**HCPC**	**Macrobotanical**	**Historic**	**Mescalero**	**Other**
Agave	Agavoidea	X	X	X	X	
Prickly pear	*Opuntia* spp.	X		X	X	
Mesquite	*Prosopis glandulosa*	X		X	X	
Amaranth Family	AMARANTHACEAE	X*	X		X	
Hackberry	*Celtis ehrenbergiana*	X			X	
Sotol	*Dasylirion* spp.	X			X	
Pitaya cactus	*Echinocereus enneacanthus*	X			X	
Elbow bush	*Forestiera pubescens*	X			X	
Littleleaf sumac	*Rhus microphylla*	X			X	
Sand dropseed	*Sporobolus cryptandrus*	X			X	
Soapweed yucca	*Yucca elata*	X			X	
Spanish bayonet	*Yucca torreyi*	X			X	
Catclaw acacia	*Acacia greggii*	X				X[1,2,3,4]
Desert willow	*Chilopsis linearis*	X				X[1]
Buckwheat	*Eriogonum* spp.	X				X[5,6,7,8]
Ocotillo	*Fouquieria splendens*	X				X[1]
Torrey wolfberry	*Lycium torreyi*	X				X[6,9]
Golden crownbeard	*Verbesina encelioides*	X				X[5]
Lotebush	*Ziziphus obtusifolia*	X				X[2,10]
Texas Persimmon**	*Diospyros texana*	X				

Table 7.24. Archaeologically visible, modelled available, and historically known plant foods surrounding the Fulcher Site.

[1]Bean and Saubel (1972), [2]Curtin (1949), [3]Dawson (1944), [4]Weber and Seaman (1985), [5]Elmore (1944), [6]Vestal (1952), [7]Zigmond (1981), [8]Wyman and Harris (1951), [9]Veogelin (1938), [10]Castetter and Bell (1951).

*HCPC data indicates undifferentiated, annual forbs of which identified taxa may have been present on the landscape.

**Lacks historic and ethnographic evidence of use, though archaeological research demonstrates consumption.

Like the previously discussed archaeological sites, the Fulcher Site had a paucity of macrobotanical remains. When comparing the archaeological record to the HCPC data, both macrobotanical taxa, members of the Amaranth Family and a caudex producing plant which was likely lechuguilla, are found in the foraging catchment. For these one, lechuguilla, was used by historic groups within the study area and the other, a forb in the Amaranth Family, was used by the Mescalero Apache.

The spatial analysis of the landscape surrounding this site indicated a significantly higher plant diet breadth and included eighteen plant taxa would have been available to the occupiers of the Fulcher Site during the TLP. Eight of these, including sotol, have recorded use among the Mescalero Apache, ten were used by extra-local groups, and a single taxon, Texas persimmon, was known to have been used archaeologically (Table 7.23).

Tres Metates Rockshelter As discussed previously, all HCPC data for the foraging catchment surrounding Tres Metates Rockshelter was available at the time of writing. Results of this analysis show high agreement between taxa identified based on macrobotanical plant food remains and those available on the landscape within a 72-min. walk from the rockshelter.

Table 7.25. Archaeologically visible, modelled available, and historically known plant foods surrounding Tres Metates Rockshelter.

Common name	**Taxon**	**HCPC**	**Macrobotanical**	**Historic**	**Mescalero**	**Other**
Lechuguilla	*Agave lechuguilla*	X	X	X	X	
Prickly pear	*Opuntia* spp.	X	X	X	X	
Mesquite	*Prosopis glandulosa*	X	X	X	X	
Tornillo	*Prosopis pubscens*	X	X	X	X	
Oak	*Quercus* spp.	X	X		X	
Cholla	*Cylindropuntia imbricata*	X	X		X	
Sand dropseed	*Sporobolus cryptandrus*	X	X		X	

Table 7.25. Continued

Common name	**Taxon**	**HCPC**	**Macrobotanical**	**Historic**	**Mescalero**	**Other**
Yucca	*Yucca* spp.	X	X		X	
Wild onion*	*Allium* spp.	X*	X		X	
Amaranth Family*	AMARANTHACEAE	X*	X		X	
Buffalo gourd*	*Cucurbita foetidissima*	X*	X		X	
Purslane*	*Portulaca* spp.	X*	X		X	
Plantain*	*Plantago* spp.	X*	X			X[1,2,3,4]
Piñon	*Pinus* spp.	X		X	X	
Sundrops	*Calylophus* spp.	X			X	
Sotol	*Dasylirion* spp.	X			X	
Juniper	*Juniperus* spp.	X			X	
Sacahuista	*Nolina texana*	X			X	
Fragrant sumac	*Rhus aromatica*	X			X	
Skunkbush sumac	*Rhus trilobata*	X			X	
Catclaw acacia	*Acacia greggii*	X				X[4,5,6,7]
Blue grama	*Bouteloua gracilis*	X				X[8,9]
Buckwheat	*Eriogonum* spp.	X				X[10,11,12,13]
Ocotillo	*Fouquieria splendens*	X				X[5]
Lotebush	*Ziziphus obtusifolia*	X				X[6,14]
Common bean	*Phaseolus vulgaris*		X		X	
Maize	*Zea mays*		X		X	
Small Indian breadroot**	*Pediomelum pentaphyllum*	X				

[1]Castetter (1935), [2]Swank (1932), [3]Rea (1991), [4]Weber and Seaman (1985), [5]Bena and Saubel (1972), [6]Curtin (1949), [7]Dawson (1944), [8]Buskirk (1986), [9]Reagan (1929), [10]Elmore (1944), [11]Vestal (1952), [12]Zigmond (1981), [13]Wyman and Harris (1951), [14]Castetter and Bell (1951).
*HCPC data indicates undifferentiated, annual forbs of which identified taxa may have been present on the landscape.
**Lacks historic and ethnographic evidence of use.

Based on the results of the spatial analysis and known ethnographic foods, the HCPC data indicated a minimum of twenty plant foods were present on the landscape surrounding Tres Metates Rockshelter (Table 7.24). An additional seven plant taxa, all annual forbs, were identified in samples from the storage feature and may be present on the landscape as the NRCS reported an undifferentiated annual forb component in all HCPCs within the foraging catchment. If this is the case, the foraging catchment analysis completely described the macrbotanical food record from this site.

When the macrobotancial foods were compared to the plant diet of the Mescalero Apache and early Historic Period cultures of the study area there was also a high degree of similarity. Lechuguilla, prickly pear, mesquite, and tornillo were used by these groups and the remaining ten taxa were consumed by the Mescalero Apache.

Moving beyond the macrobotanical record another twelve plant taxa could have contributed to the diet of the TLP inhabitants of Tres Metates Rockshelter. Seven of these were used by the Mescalero Apache, including piñon which was also used by the farmers in the La Junta de los Rios area (Madrid 1992). The remaining five possible contributors to the site's diet included catclaw acacia, blue grama, buckwheat, ocotillo, and lotebush. The catchment analysis also identified a plant taxon unique to the Tres Metates Rockshelter catchment, small Indian breadroot (*Pediomelum pentaphylum*), which has no documented ethnographic use but is identified here as a possible, currently unknown food source.

7.9 Regional Archaeological Site Catchment Discussion

This analysis constituted a multi-proxy approach to identifying possible botanical dietary elements for TLP peoples in the Eastern Trans-Pecos archaeological region. Macrobotanical remains from eight of the archaeological sites and fossil pollen grains from Granado Cave indicated 31 plant taxa were utilized for food in the study area which included two cultigens, common bean and maize, assuming the undifferentiated annual forb component of the HCPCs does account for the forb species identified from botanical analyses. By comparing ethnographic and historic data to the HCPC composition data, 44 plant taxa were identified which have recorded use by native peoples across North America. In general, this overlap has demonstrated the utility of using a multi-proxy approach to examining available plant foods. However, there were some discrepancies and highlights of this analysis which will be briefly explained below.

7.9.1 Granado Cave

Granado Cave stands apart from the rest of the study sample both in terms of the percent of the area with HCPC data (48.5%) but a moderate number of possible plant foods (n = 19) in comparison to the other archaeological sites. Of the likely 14 plant foods identified from fossil pollen members of the genus *Carya*, likely pecan (*Carya illinoinensis*), stands out as the most unique. According to Powell (1998), pecan is the only member of this genus in the Texas Trans-Pecos but is not a native local species though the tree is grown in yards and orchards. Additionally, the current range of pecan nor any other member of the genus are native to neighboring New Mexico north of Granado Cave (Kartesz 2015). *Carya* pollen was also found in coprolite samples from the neighboring Caldwell Shelter 1 (41CU1) (Holloway 1983). An explanation for the presence of this taxa which is verifiably exotic at the regional scale is sorely lacking. It is in the opinion of this researcher that the consumed hickory/pecan products could have been introduced via trade, were part of the HCPC, or the pollen may have been a contaminant. Review of the historic literature does not indicate nuts were a common trade item, at least among Protohistoric hunter-gatherer groups in Texas, and because members of the genus require significant amounts of water for growth (Powell 1998) it seems unlikely this genus could have been present during the TLP. The contamination hypothesis seems the most likely, but the presence of the genus at two sites for which samples were processed in the same laboratory but almost twenty years apart, lends little possibility, unless the samples were contaminated in the field. In conclusion the presence of *Carya* at Granado Cave lacks an explanation based upon current data.

7.9.2 Tranquil and Rough Cut Rockshelters

Two of the rockshelters within the study sample, Tranquil and Rough Cut Rockshelters, were unique in having lower amounts of possible plant foods (Tranquil = 18, Rough Cut = 17) when compared to the remainder of the study sample, especially to the those south of these sites. However, this was likely due to the missing HCPC data which only described ~60% of the area of both catchments. Though future HCPC data may increase the number of possible botanical food taxa, two tree species likely never occurred within the 72-min. foraging catchments: oak and piñon.

Based upon available HCPC data both of these tree species were present on the TLP landscape of the eastern Trans-Pecos, though beyond the 72-min. reconstructed foraging catchments as presented in Figure 7.12. Patches which include these taxa are located north of both sites atop the Escondido Rim. An expansion of the spatial analysis to 120 minutes demonstrated that with an increase in travel time and effort, locations of these trees could be reached.

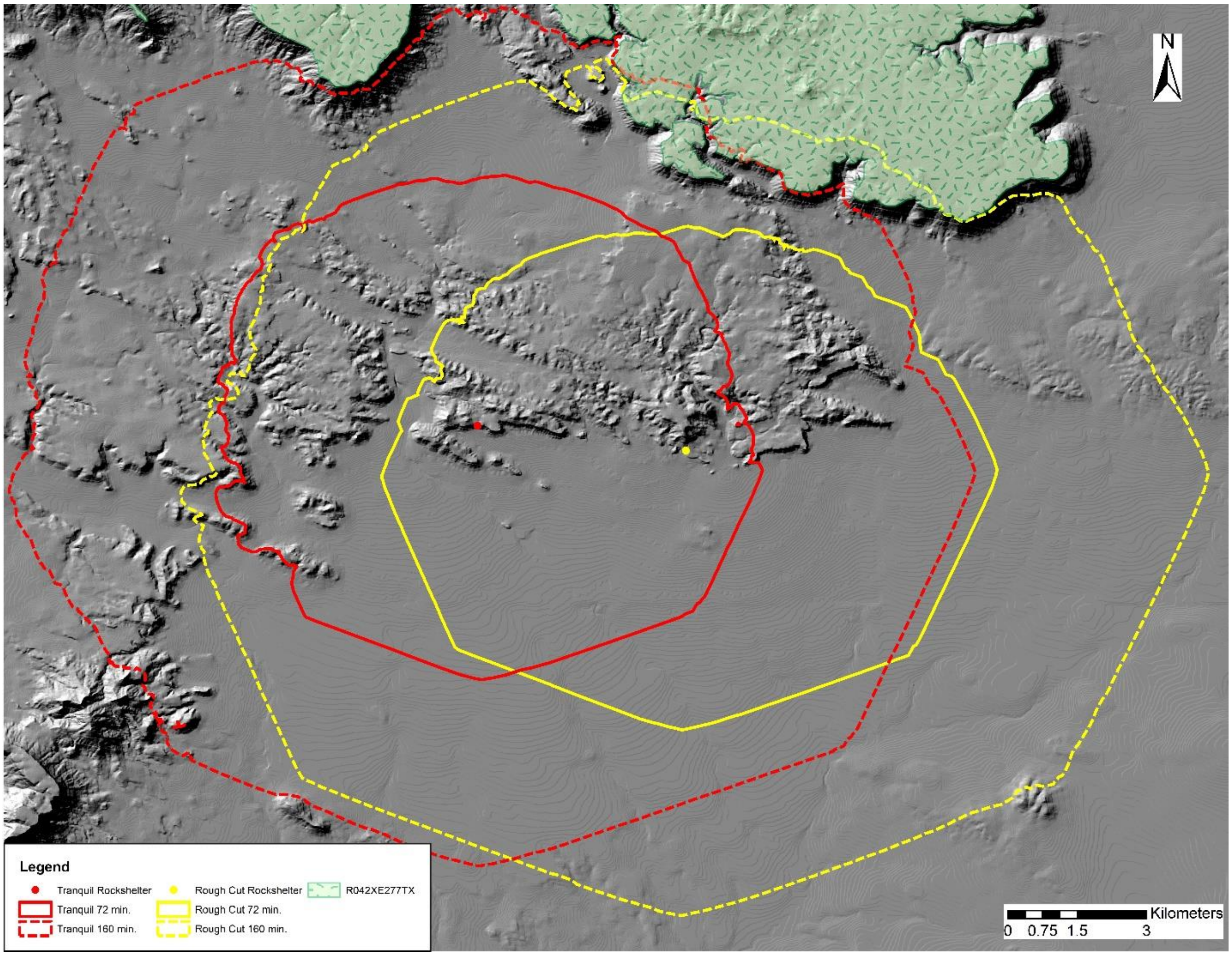

Figure 7.12. Seventy-two and 120 minute catchments for Tranquil and Rough Cut Rockshelters.

As presented in Figure 7.12, modelled travel distance of 120-min. allows access to the grasslands atop the Escondido Rim. Atop this landform, specifically in drainages with north oriented aspects, trees such as Mexican piñon (*Pinus cembroides*), Chisos red oak (*Quercus gravesii*), and gray oak (*Q. grisea*) are present according to the ES Igneous Hill and Mountain (Mixed Prairie), R042XE277TX, HCPC data. Macrobotanical evidence, specifically pine cone scale morphology, indicated Mexican piñon and papershell piñon (*P. remota*, syn. *P. cembroides* Zucc. var. *remota*) as being present at Rough Cut Rockshelter though the latter species is not present in ES data for Brewster County, Texas. This analysis considers both pine taxa to likely be from the same class of resource patches, or HCPCs, given that acorn fragments were recovered from both sites and, when taken in sum, preclude use of this HCPC despite being outside of the reconstructed foraging catchment.

Being the largest test of modelling validity there are two hypothetical reasons why these taxa are found in the macrobotanical record but not within the 72-min. foraging catchment. The first is that the 72-min. catchment was not totally representative of single-day prehistoric foraging behavior. A second hypothesis is that because these were high ranked foods, as evidenced from Basehart (1974), and foragers would seek out said resources even if a multi-day foraging excursion was required.

Results from this analysis type generally debunk the first hypothesis in that a 72-min. foraging area is atypical for the study area. Rather, the vast majority of archaeologically identified foods could be gathered within a reasonable amount time for a single day as demonstrated at Tres Metates Rockshelter.

Ethnographic information from the Mescalero Apache indicated that piñon nut resources were high valued foods and were one of the four wild staple plant foods (Basehart 1974). Basehart (1974) was also informed that when a “good” piñon year was had groups of women would travel away from basecamp for multiple days, a logistical movement related to a gendered resource, to piñon patches for collection and processing. Though the gender makeup of the foraging party/parties from both rockshelters can never be known, it seems likely that such high ranked food products would be actively sought out not only because of caloric contribution but also because these were the last, freshly gathered plant food products in a given annual round. As such it tentatively stands that the presented spatial model is valid. Further, paleoethnobotany and geospatial archaeology in this instance contributed to the archaeological understanding of the study area in that when high value plant foods were available, a logistical mobility strategy was used to access these resources.

7.9.3 Arroyo de la Presa

When compared to the other archaeological site catchments a single attribute of this catchment stands out in that the catchment itself was a landscape with inherent risks associated with encountering botanical resources, whether these were for food, tools, construction, fuel, or medicine. Specifically, patches of floral life would have been in near constant movement owing to the presence of arroyos associated with fast, fluvial action.

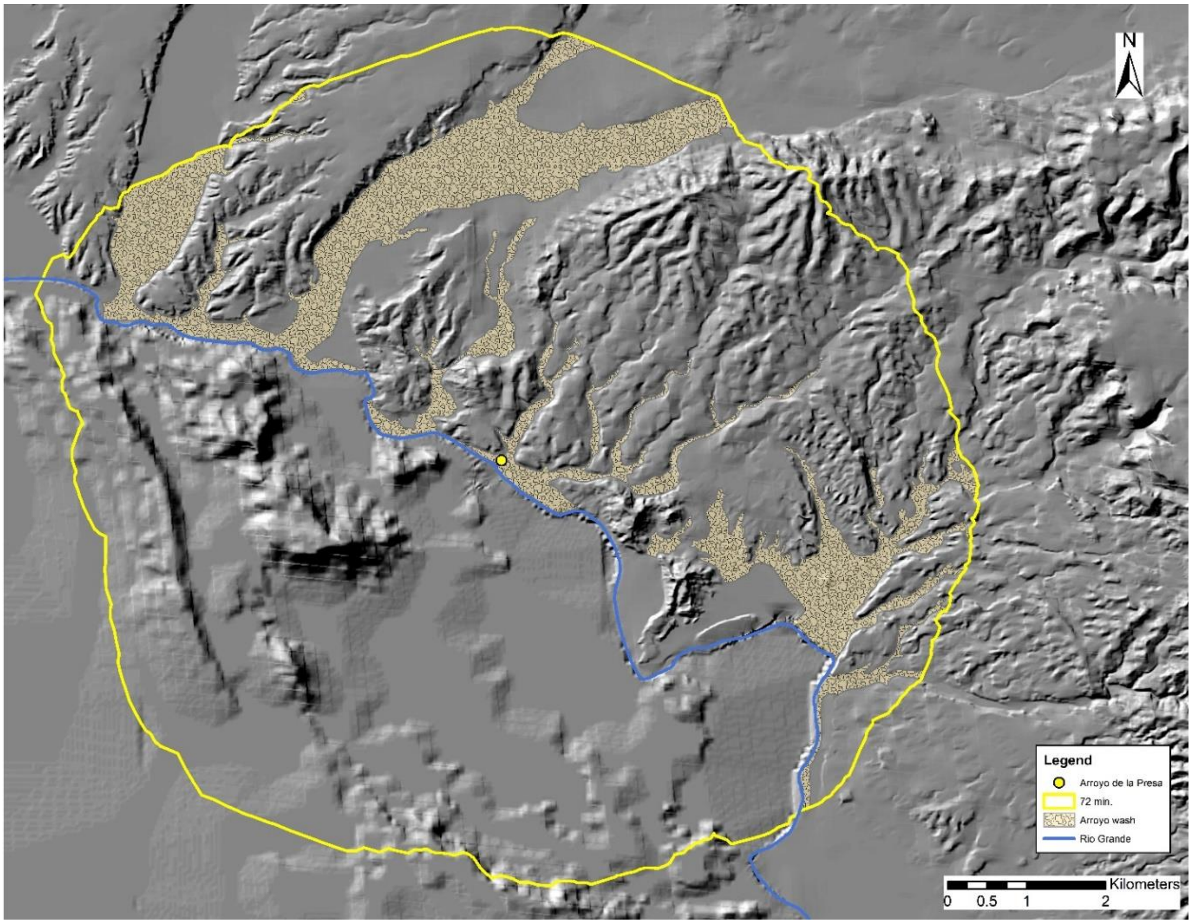

Figure 7.13. Arroyos within the Arroyo de la Presa 72-min. catchment.

As shown in Figure 7.13 a significant portion of the landscape (23.06%) on the Texas side of the Rio Grande was not reliable in terms of the presence or absence of any plant life. Despite likely higher quality rangeland conditions in prehistory compared to the present, fluvial flows within several arroyos could have changed the distribution of a patch of resources within hours or minutes depending on the intensity of flash floods. Because of this the foraging catchment for the Arroyo de la Presa Site is considered to have been a high risk one in comparison to the others within the study sample. Despite this the site had been occupied intermittently from the Late Archaic into the TLP. Rather, this is likely evidence that prehistoric peoples focused more of their time on riparian resource patches associated with the Rio Grande which, though also being flood-prone (ex. Madrid 1992), risks associated with relearning the changed landscape outweighed the collection of important resources.

7.9.4 Cielo Complex Sites

For both Cielo Complex type sites, Cielo Bravo and Arroyo de las Burras, access to possible plant foods was the highest of all reconstructed foraging catchments in the study sample with 26 taxa identified. These rancherías were likely located to ease access for trade with the La Junta District villages in addition to being atop landforms, a hallmark of Cielo Complex sites (Cloud 2004, Mallouf 1999). Here it is assumed that these were the primary considerations for their establishment. This analysis further proposes that the establishment of the rancherías was to provide access to a variety of plant foods from both upland and lowland settings. However, more research is needed to determine how ease of access to other resources (i.e., fauna, fuel, construction materials, and water) contributed to their location.

7.10 Eastern Trans-Pecos Human Foraging Model Assessment

As presented in Chapter 4, a model was proposed regarding foraging behavior of Terminal Late Prehistoric peoples in the eastern Trans-Pecos. Briefly, this model posited that indigenous populations primarily utilized agaves, banana yucca fruits, mesquite bean pods, and piñon nuts were the primary plant foods. Additionally, the model proposed that central place foraging was the norm and that campsites were specifically located on the landscape to access staple plant foods. Results of this work largely validated this model and evidence for this is briefly described below.

Of the four plant taxa noted as staples throughout the Historic Period, all are noted as present in the archaeobotanical assemblages though with varying degrees of ubiquity. Of these piñon nuts had the lowest ubiquity and were only recovered from Tranquil and Rough Cut Rockshelters. Though remains of these plant products appear to have contributed little to archaeological diet, this may be due to a lack of studies in areas with high amounts piñon trees (i.e., all of the central portion of the eastern Trans-Pecos). Rather, because rockshelters were likely preferred habitation sites a different mobility pattern, logistical movements, may have been utilized to access this resource when not immediately locally available. As such piñon nuts may have been a vastly important food resource but unfortunately the dataset is not broad enough to address this.

In terms of staples a fifth, members of the Amaranth Family, should be considered as a staple for Terminal Late Prehistoric peoples. Though not noted in my previous analysis of the region (Riggs 2014) as a staple, this could be due to a lack of division between Early and Terminal sub-periods of the Late Prehistoric Period. Despite this, its high frequency across eight of the archaeological sites in the sample, high frequency in rockshelter features, and sheer quantity at Tranquil Rockshelter provide evidence for reliance upon this low ranked food at least during the TLP sub-period.

Results of the spatial analyses indicated that open campsites were likely located to access the staples identified archaeologically and described historically, with the exception of piñon nuts but this is likely due to a lack of available data. Additionally, the spatial results indicate locations may have been preferred to access other food resources. From these analyses it was also noted that extra effort or logistical foraging may have been used to access calorie dense foods away from preferred rockshelters, thus providing an increased understanding of foraging practices during the Little Ice Age in the study area.

7.11 Overview of Results

Via examination of dietary botancial assemblages from nine archaeological sites dated to the Terminal Late Prehistoric Period in the eastern Trans-Pecos a total of thirty-three plant foods were identified from micro- and macrobotanical remains. Of these the dominant taxa recovered from Tranquil and Rough Cut Rockshelters included members of the Amaranth Family, prickly pear, mesquite, pitaya, purslane, agave, and yucca, though when examining the eight archaeological sites agaves, mesquite, and members of the Amaranth Family were the most common. Of these the most striking was Amaranth Family which had an exceptionally high use at Tranquil Rockshelter. When comparing the plant diets outside of the region all entities had a high amount of overlap largely due to occupations of the Chihuahua Desert, with the exception of Toyah Phase sites that incorporated higher amounts of mast and geophyte resources. The diet breadth modelling at the inter-regional scale also identified that open sites in the study area focused on low ranked resources while El Paso Phase sites had the highest diet breadth. Finally, the results of the spatial model indicated varying use of landscapes with some open sites likely located to access high amounts of ecological edge though logistical movements may have been used at rockshelter settings to gather calorie dense plant foods.

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CHAPTER VIII

SUMMARY, CONCLUSIONS, AND FUTURE RESEARCH

Chapter II defined the boundaries and environmental setting of the eastern Trans-Pecos. Three physiographic areas constitute the study area and consisted of the Toyah Basin, Stockton Plateau, and Basin and Range. The hydrography of the area was also described and demonstrated water was a precious resource in the past, a pattern which continued to the present. Environmental reconstructions showed the region was more mesic during the last glaciation event, though since then the area has become increasingly more arid. Plant communities were also described focusing on the five main plant community types; grassland, riparian communities, conifer forest, oak-juniper-piñon woodland, and Chihuahuan Desert scrub. The chapter also spent time describing the impacts of the Little Ice Age whose shift to late summer focused rains allowed for the expansion of black grama dominated grasslands as well as the mosaic of plant communities experienced by Europeans and detailed in the ecological site descriptions from the USDA-NRCS.

The third chapter, Eastern Trans-Pecos Archaeology, described the archaeological record of the eastern Trans-Pecos. This review noted the primary episodes of archaeological research as well as the formulation of archaeological nomenclature through successive studies. Much emphasis was also placed upon the archaeological constructs referred to as the Castile Phase, Cielo Complex, La Junta Phase, and Concepcion Phase. These groups were elaborated upon more than the previous constructs due to their affiliation with the Terminal Late Prehistoric Period.

“Early Historic Foods and Foraging in the Eastern Trans-Pecos” described the total knowledge of historic Spanish encounters of the area’s native residents in addition to the only ethnographic data regarding indigenous use of the region. This chapter examined the plant foods utilized by the many early historic native peoples in the La Junta district as well as the hunting, gathering, and trading Jumano. Plant diet of the Mescalero Apache was also outlined by season. The foraging practices for all historic groups portrayed a mixed pattern of mobility, specifically for the Mescalero Apache which used residential mobility for hunting game and logistical mobility for the four primary plant foods: agave caudexes, yucca fruits, mesquite bean pods, and piñon nuts. Finally, a model was presented in that the four previously mentioned foods likely constituted the bulk of plant diet for Terminal Late Prehistoric Period peoples and that patches of the resources were readily mapped onto when seasonally available.

Returning to the prehistoric record Chapter Five detailed the nine archaeological sites with botanical bearing components dating to the Terminal Late Prehistoric in the eastern Trans-Pecos. Four of these sites are protected archaeological sites wherein the perishable remains of human activities were readily preserved. Three of these were rockshelters and included Tranquil Rockshelter (41BS1513), Rough Cut Rockshelter (41BS1507), and Tres Metates Rockshelter (41PS915). A sinkhole cave was also included, Granado Cave (41CU8). The five remaining archaeological sites were open campsites and rancherías having evidence of botanical food processing. These included 41PC502, Arroyo de la Presa (41PS800), the Fulcher Site (41BS1495), Arroyo de las Burras (41PS194) and Cielo Bravo (41PS52).

To operationalize this study, Chapter VI describes the various methods used to acquire the relevant archaeobotanical data, analyze said data, and perform the novel spatial modeling technique used in this study. A variety of analytical methods were detailed to determine botanical diet composition and compare the plant diets of sites within the eastern Trans-Pecos to those of surrounding regions. A novel spatial model was presented which would be used to assess landscape access, identify other available plant foods, and analyze the spatial configuration of hypothesized foraging areas.

Chapter VII outlined the findings of each method as applied to the regional and inter-regional datasets. As expected the rockshelter data yielded the most information regarding botanical dietary resources, plant diet breadth, and the dietary importance of constituent taxa. General results showed a broad spectrum of plant foods were utilized by these peoples and the spatial model was not only validated but presented evidence for differing mobility strategies to access high-ranked plant foods. A summarization of dietary and spatial findings is presented below beginning with the interregional dataset and then the general findings of each analysis at a given archaeological sites.

When comparing archaeological groups of the eastern Trans-Pecos to surrounding regions, open sites of the study lacked evidence of high ranked plant food resources and a moderate range of floral diet breadth. Surprisingly village sites of the El Paso Phase had the highest number of macrobotanically visible plant foods as well as the greatest diet breadth which may indicate a lack of task schedule conflicts when compared to raising the most common plant taxa: maize. People of the Toyah Phase utilized a variety of plant food resources including mast producing trees and geophytes. Additionally, this archaeological entity had the highest number of high ranked plant foods as well as the highest frequency of geophytes of all groups included at the interregional scale.

Plant diet breadth modeling of the rockshelters within the eastern Trans-Pecos show the opposite of those identified from open sites in the study area. Rather, a high diet breadth was noted which consisted of high ranked plant foods though low ranked foods were exceedingly common within their features. This is likely due to better preservation as well as a bias in the spatial positioning of these sites compared to open sites. Within this body of work it was demonstrated that rockshelters and other protected sites better reflect dietary composition than open sites largely due to a greater preservation.

Regarding the three open sites nearest the Rio Grande, none of these were metrically analyzed due to a significant portion of the 72-min. foraging catchments lacking ES mapping data. What can be summarized about their locales was that Cielo Bravo and Arroyo de las Burras had catchments with significant spatial overlap. Two botanical taxa were identified at each site and an additional 21 plant taxa could have been available to inhabitants at each site. This was the highest count for available botanical food resources in the study sample and suggest these sites were established in manner to accommodate the required landform for Cielo Complex basecamps, ease of access to La Junta de los Rios villages, and access to a variety of food resources in xeric and riparian ecological settings.

For Arroyo de la Presa a minimum of 19 other plant foods would have been available within the 72-min. foraging catchment. The landscape within this catchment was also considered the most risky of all catchments. Here a series of large arroyos covered 23% of the area and would have made accessing plant resource patches difficult to predict given that said patches could have been removed within a very short period of time due to flash flood scouring and deposition events.

Granado Cave in Culberson County, Texas had the largest foraging catchment and the second highest number of patches which consisted of seven plant communities, all grasslands. Though the 72-min. catchment had the highest geometric complexity it had the lowest diversity of patch types which were not well dispersed. In general, the landscape was the least diverse with the lowest proportional dispersion and evenness of all the catchments. The botanical makeup of this catchment is only known for 48.5% of the area and a comparative analysis identified eight more taxa than the previous fossil pollen analysis. Results of this analysis indicated a grassland landscape and as such it supports the findings of previous work in that grass seeds, a low ranked resource, contributed to the bulk of diet

In western Presidio County, Texas, Tres Metates Rockshelter had the smallest catchment though the highest number of patches to area. Thirty patches were composed of seven plant communities but the landscape lacked geometric complexity and had low patch dispersion. Thirteen wild plant taxa contributed to the makeup of the storage feature in the rockshelter and a comparative analysis identified another twelve plant foods could have been used in recent prehistory. In the correspondence analysis this feature was the least similar to all other Terminal Late Prehistoric rockshelter features and was in the median of botanical dietary taxa diversity between the three rockshelters.

Tranquil Rockshelter included eighteen plant taxa considered to be of dietary importance for the nine features dated or affiliated to the Terminal Late Prehistoric. Amaranth Family seeds and prickly pear were found in all features, pitaya and purslane in 90% of features, mesquite in 80%, and agave in 70%. Seeds of the Amaranth Family were in astoundingly high concentrations with Feature 12 having 2,696 seeds per liter. Forb foods appear to have been the norm for diet at this rockshelter with five features clustering very closely in a correspondence analysis scatterplot. When comparing the three rockshelters on recovered plant food remains, Tranquil Rockshelter had the lowest diversity values despite the highest number of recovered taxa, indicating that a few types dominated the foods archaeologically visible within in its features, here considered to be Amaranth Family seeds. Results of the 72-min. catchment analysis indicated a landscape which was moderately diverse. A high ranked resource, piñon nuts, were not found in the plant community within its foraging catchment despite a single piñon cone scale being found at the site. An expansion of the foraging catchment to 120-min. showed the occurrence of this taxa north of Tranquil and Rough Cut Rockshelters atop the Escondido Rim. This demonstrates that, at least for the protected environs of rockshelters, a logistical mobility strategy may have been utilized to access high ranked plant food resources as has been documented among the historic Mescalero Apache.

Rough Cut Rockshelter was comparable to neighboring Tranquil Rockshelter in many respects. Fifteen plant food taxa were identified in the features of this site with mesquite, Amaranth Family seeds, and pitaya occurring in 100% of features and sub-features. Other likely important foods included prickly pear, agave, and yucca which occurred in 75% of the analyzed sub-features and features. Despite this the diversity of index values for this site were the highest of the three rockshelters analyzed via this method. The 72-min. catchment indicated a moderately diverse landscape though this catchment had the lowest number of patches per area in comparison to all other sites. Two species of piñon were identified in this rockshelter: Mexican piñon and papershell piñon. Like Tranquil Rockshelter, no member of the genus *Pinus* was modelled to have been within 72-min. of this site but were accessible in 120-min. atop the ridgeline to the north of the rockshelter.

41PC502 had the highest diversity of plant foods identified in the open site sample with four identified. The landscape surrounding this plant processing facility had the most plant communities in a 72-min. walk of the sites and had the highest diversity value of patch types.

Comparative analysis identified another twelve taxa which could have been consumed by the site's occupants.

The Fulcher Site stood-out among all of the sites in terms of it's 72-min. foraging catchment makeup. Within 72-min., plant foragers would have an encountered a diverse landscape wherein patches of plant resources were evenly distributed. Only two plant foods were noted from the macrobotanical record at this site though another 17 were available based upon the archaeological record. When compared to all other archaeological sites in the study sample, it can be hypothesized that this probable plant processing locale was specifically oriented to take advantage of a diverse landscape wherein several patches could have been easily accessed.

8.1 Research Questions

Mentioned throughout this work were three primary research questions to address the lack of detailed archaeobotanical and dietary studies within the eastern Trans-Pecos. These included:

1. What plant foods were used by Terminal Late Prehistoric peoples of the eastern Trans-Pecos?
2. Why were these foods consumed and how much did they contribute to diet during this archaeological period?
3. How were these foods accessed and where were they located on a given landscape?

In addressing Research Question 1, this study identified a total of 33 plant taxa which contributed to botanical diet of these past peoples. Of these several could be considered staples and included agaves, yucca fruit, prickly pear tunas, mesquite beans, and members of the

Amaranth Family. Other important plant foods included pitaya fruit and purslane and largely answer Research Question 2. Specific to the “why” portion of that question, these foods were likely incorporated because of their spatial ubiquity, bulk processing capabilities, and inter-annual dependability. This spatial ubiquity is also related to Research Question 3 which was primarily assessed through the use of a novel spatial model. Said model indicated positioning of sites was occasionally undertaken to access landscapes with high amounts of potential plant foods in addition to high measures of ecological edge. This model also indicated that logistical movements may have been utilized to access the highest ranked plant food resources: piñon nuts. As such the botanical diet of Little Ice Age peoples in the eastern Trans-Pecos should be viewed as one of high diversity with concentrated use of low ranked resources though efforts were made to access very high ranked foods.

8.2 Future Research

Much work is left to be done in the eastern Trans-Pecos, at least as it is concerned with understanding plant food use during the Terminal Late Prehistoric. Through the efforts of this study it was noted that the dataset which constituted macrobotancial remains needs broadening. Additionally, spatial studies should also be incorporated to more fully realize the potential of the ecological site data.

When comparing the spatial arrangement of archaeological sites with macrobotanical remains two areas within the eastern Trans-Pecos are notably not included. The Toyah Basin in general is noted for its dearth of archaeological endeavors and no plant remains have so far been reported for this area even predating the Terminal Late Prehistoric. South of the Toyah Basin no botanical remain bearing sites have been reported from the Davis and Glass Mountains, both noted as having piñon resources in modern ecological and botanical resources. Though these two sub-regions may have been investigated for macrobotanical remains before, the lack of negative reported results lends that an attempt should be made in these areas to not only deal with a spatial lacuna but potentially identify otherwise unknown plant foods. This will also serve to determine if the primary plant foods identified in this study are truly representative of the entire area.

In tandem with this it is proposed by this author that ongoing archaeological work also include samples from archaeological sites not affiliated with hot rock cooking activities. Though it is exceptionally difficult to identify features which are not ovens, or "hearths" in the region's archaeological jargon, in open sites of the region, these features primarily represent the processing of agave and sotol caudexes. Rather, this study identified that non-Agavoidea plants also contributed significant calories to prehistoric human diet. As such future work should place greater emphasis on identifying activity surfaces outside of these food processing complexes and incorporate appropriate macrobotanical and microbotanical studies to their endeavors.

At this time little can be quantitatively said regarding plant diet composition at the taxa level for the prehistoric peoples of La Junta de los Rios. Despite having several known prehistoric villages, only the campsite of Arroyo de la Presa had standardized macrobotanical samples and these were gathered from anomalous pit features. Though several villages have been previously excavated and many others may have been lost to the Rio Grande, future endeavors should attempt to identify other villages and include archaeobotanical analyses in their endeavors. As stated previously, these samples should include areas not associated with caudex processing activities which would only further skew the open site data.

As demonstrated in this work rockshelters are near-treasure troves of archaeobotanical data which identify exponentially more remains than open archaeological sites of the region. To better create this dataset it is recommended that protected sites which had been excavated in the early 20th Century and the many others which have been looted through time be investigated to identify any intact deposits. Results from this and complementary studies have shown that even small sample volumes (i.e., 250 ml) yield a staggering amount of data. Not only is it the recommendation of this researcher to specifically sample for botanical remains, an attempt should be made to identify and retrieve human coprolites. Though I have not had much fieldwork experience in protected sites of the study area one aspect I have noted is the lack of these preserved feces, specifically when compared to the neighboring Lower Pecos. The reason for this is currently unknown but may represent a secondary research avenue.

Shifting to spatial studies, it should be noted that though a novel spatial model was developed and undertaken in this study the results of this barely scratch the surface of potential research. Specific to plant diet composition an attempt should be made to develop and test hypotheses regarding the seasonal human carrying capacity of each site catchment as well as the entirety of the study area, at least for plant foods. Other important resources, such as fuels and faunal preference as well as carrying capacity, can be quantified in terms of their productivity and contribution to prehistoric decision making.

8.3 Summary

Prehistoric peoples between A.D. 1250/1300 and 1535 incorporated a diverse diet, at least in terms of botanical resources, to their livelihoods. At least 33 plant taxa were used as foods, though for the archaeological sites which constituted the study a total of 44 could have hypothetically contributed to human diet during the Little Ice Age. Of these plant foods the most important were likely agaves, mesquite bean pods, yucca fruits, prickly pear tunas, and forb seeds especially in the Amaranth Family. Grass seeds were also important but this may have been more restricted to peoples of the Castile Phase in the Rustler Hills. Of the plant foods the highest ranked were piñon nuts but evidence for their use was restricted to two rockshelters. These may have been more important to human diet, though the dataset is not adequate to fully address this. Forb seeds were surprisingly important and may indicate an increase in diet breadth during the Terminal Late Prehistoric when compared to previous periods.

Regarding mobility, both residential and logistical strategies may have been utilized with rockshelters in particular having evidence of a mixture of both. When high ranked plant food resources were in season it appears that logistical parties may have travelled outside of a typical foraging area to access these, at least to gather piñon nuts and potentially other food resources. Finally, positioning of campsites to access diverse landscapes with evenly distributed patches, as well as locations with easy access to trade and a high diversity of plant foods, was likely a key consideration for establishing campsites as well as basecamps of the Cielo Complex.

APPENDIX A

MACROBOTANICAL DATA FROM ORIGINAL ANALYSES

Table A.1. Rough Cut Rockshelter- Matrix Sample Data

Sample No.	**Charcoal/Non-charcoal**	**Common Name**	**Taxon**	**Part**	**Count**	**Weight (g)**
TU3-MS2	Non-charcoal	Acacia	*Acacia* spp.	Seed	1	0.23
		Lechuguilla	*Agave lechuguilla*	Leaf fragments	4	3.808
		Amaranth Family	AMARANTHACEAE	Seeds	1	
		Cholla	*Cylindropuntia* spp.	Seed	3	0.012
		Pitaya	*Echinocereus* spp.	Seeds	52	0.009
		Ephedra	*Ephedra* spp.	Stem	1	
		Little leaf walnut	*Juglans microcarpa*	Fruit fragments	1	
		Piñon	*Pinus* spp.	Seed fragments	1	
		Prickley pear	*Opuntia* spp.	Seeds	103	0.297
		Prickley pear	*Opuntia* spp.	Epidermis fragments	48	2.808
		Purslane	*Portulaca* spp.	Seeds	2	
		Western honey mesquite	*Prosopis glandulosa*	Seeds	39	0.862
		Western honey mesquite	*Prosopis glandulosa*	Endocarp fragments	73	0.513
		Bristlegrass	*Setaria* spp.	Seeds	43	0.027
		Yucca	*Yucca* spp.	Seeds	2	
			Indeterminate	Leaflets	9	
			Unknown 1	Seeds	1	
			Unknown 2	Seeds	1	
	Charcoal	Forestiera	*Forestiera* spp.	Charcoal	7	0.086
		Western honey mesquite	*Prosopis glandulosa*	Charcoal	9	0.1
			Diffuse porous	Charcoal	1	0.037
			Indeterminate	Charcoal	8	0.096
TU6-MS2	Non-Charcoal	Agave	Agavoidea	Fiber bundle	1	
		Amaranth Family	AMARANTHACEAE	Seed, achene fragments	51	0.006
		Pitaya	*Echinocereus* spp.	Seeds, seed fragments	152	0.04
		Juniper	*Juniperus* spp.	Leaf scales	1	
		Prickley pear	*Opuntia* spp.	Seeds, seed fragments	102	0.257
		Piñon	*Pinus* spp.	Seed fragment	1	0.016
		Purslane	*Portulaca* spp.	Seeds	6	
		Western honey mesquite	*Prosopis glandulosa*	Endocarps	19	0.288
		Western honey mesquite	*Prosopis glandulosa*	Seed fragments	2	0.007
		Plains bristlegrass	*Setaria leucopila*	Floret fragments	24	0.012
		Caltrop	Kallstroemia spp.	Seed/achene fragments	9	0.006

Table A.1, Continued.

Sample No.	Charcoal/Non-charcoal	Common Name	Taxon	Part	Count	Weight (g)
			Unknown 8	Seed fragments	33	0.07
			Unknown 12	Seed	1	
			Unidentifiable	Seeds	2	
	Charcoal	Four-wing saltbush	*Atriplex canescens*	Charcoal	1	0.081
		Ocotillo	*Fouquerqia splendens*	Charcoal	1	0.15
		Western honey mesquite	*Prosopis glandulosa*	Charcoal	15	2.638
			Diffuse porous	Charcoal	3	0.053
			Indeterminate	Charcoal	6	1.392
TU7-MS1	Non-charcoal	Amaranth Family	AMARANTHACEAE	Seeds, achenes	12	0.007
		Three-awn grass	*Aristida* spp.	Florets, panicle fragments	5	
		Blue grama	*Bouteloua gracilis*	Spikelets	15	0.004
		Buffalo groud	*Cucurbita foetidisssima*	Seed fragments	2	0.004
		Pitaya	*Echinocereus* spp.	Seeds, seed parts	109	0.018
		Tobosa grass	*Pleuraphis mutica*	Spikelet	1	
		Creosotebush	*Larrea tridentata*	Leaflets	11	0.007
		Prickley pear	*Opuntia* spp.	Seeds, seed parts	16	0.081
		Purslane	*Portulaca* spp.	Seeds	2	
		Western honey mesquite	*Prosopis glandulosa*	Endocarps	5	0.188
		Western honey mesquite	*Prosopis glandulosa*	Seed fragment	1	0.006
		Plains bristlegrass	*Setaria leucopila*	Florets	3	
		Caltrop	*Kallstroemia* spp.	Seed fragments	2	
			Unknown 4	Seed fragments	5	
			Unknown 5	Seed fragments	1	
			Unknown 8	Seed fragments	7	0.019
	Charcoal	Four-wing saltbush	*Atriplex canescens*	Charcoal	1	0.07
		Forestiera	*Forestiera* spp.	Charcoal	1	0.041
		Western honey mesquite	*Prosopis glandulosa*	Charcoal	4	0.101
			Diffuse porous	Charcoal	1	0.028
			Indeterminate	Charcoal	5	0.041
TU-7 MS3	Non-charcoal	Agave	Agavoidea	Leaf fragments-medial	7	0.796
		Amaranth Family	AMARANTHACEAE	Seeds, achenes	92	0.016
		Tree awn grass	*Aristida* spp.	Spikelets	4	
		Blue grama	*Bouteloua gracilis*	Spikelets	4	

Table A.1, Continued.

Sample No.	Charcoal/Non-charcoal	Common Name	Taxon	Part	Count	Weight (g)
		Domesticated gourd	*Lagenaria* spp.	Epicarp fragment	1	0.32
		Buffalo groud	*Cucurbita foetidissima*	Seed fragments	5	0.02
		Nineawn pappusgrass	*Enneapogon desvauxii*	Floret	1	
		Little leaf walnut	*Juglans microcarpa*	Nut fragment	1	0.024
		Juniper	*Juniperus* spp.	Leaf tip	1	0.009
		Prickley pear	*Opuntia* spp.	Seeds, seed fragments	23	0.087
		Piñon	*Pinus* spp.	Seed coat fragments	2	0.03
		Grass Family	POACEAE	Seeds, floret, spikelets	4	
		Western honey mesquite	*Prosopis glandulosa*	Endocarps	49	0.977
		Plains bristlegrass	*Setaria leucopila*	Florets	8	0.006
		Yucca	*Yucca* spp.	Seeds	3	0.116
			Unknown 8	Seed	2	0.018
	Charcoal	Four-wing saltbush	*Atriplex canescens*	Charcoal	5	0.294
		Elbowbush	*Forestiera* spp.	Charcoal	3	0.099
		Western honey mesquite	*Prosopis glandulosa*	Charcoal	9	0.377
			Indeterminate	Charcoal	9	0.299
TU7-MS9	Non-charcoal	Amaranth Family	AMARANTHACEAE	Seeds, Achenes	75	0.01
		Agave	Agavoidea	Leaf fragments	11	0.597
		Three-awn grass	*Aristida* spp.	Panicle fragments	2	0.012
		Pitaya	*Echinocereus* spp.	Seed fragments	2	
		Prickly pear	*Opuntia* spp.	Seeds, Seed fragments	18	0.051
		Prickly pear	*Opuntia* spp.	Epidermis	2	0.032
		Grass Family	POACEAE	Seed	8	-
		Purslane	*Portulaca* spp.	Seed	1	
		Western honey mesquite	*Prosopis glandulosa*	Endocarps	35	0.515
		Western honey mesquite	*Prosopis glandulosa*	Seeds	3	0.026
		Yucca/Sotol	*Yucca*/*Dasylirion* spp.	Leaf fragment-medial	1	0.065
		Yucca	*Yucca* spp.	Seed	1	0.009
		Caltrop	*Kallstroemia* spp.	Seed fragment	1	
			Unknown 4	Seed	1	
			Unknown 9	Seed	1	
	Charcoal	Four-wing saltbush	*Atriplex canescens*	Charcoal	1	0.008
		Forestiera	*Forestiera* spp.	Charcoal	3	0.051

Table A.1, Continued.

Sample No.	Charcoal/Non-charcoal	Common Name	Taxon	Part	Count	Weight (g)
		Ocotillo	*Fouquerqia splendens*	Charcoal	1	0.011
			Indeterminate	Charcoal	2	0.021

Table. A.2. Rough Cut Rockshelter- Screen and In-Situ Macrobotanicals

Test Unit	Common name	Scientific Name	Plant Part	Count
TU 3	Agave/yucca	Agavoidea	Leaf, caudex fragments	35
TU 3	Amaranth Family	AMARANTHACEAE	Seed	3
TU 3	Hackberry	*Celtis* spp.	Seeds, seed fragments	6
TU 3	Buffalo gourd	*Cucurbita foetidissima*	Seed	1
TU 3	Little leaf walnut	*Juglans microcarpa.*	Seed fragments	4
TU 3	Prickly pear	*Opuntia* spp.	Seeds	355
TU 3	Prickly pear	*Opuntia* spp.	Aeroles	2
TU 3	Prickly pear	*Opuntia* spp.	Pad fragments	3
TU 3	Common reed	*Phragmites australis*	Culm fragment	1
TU 3	Piñon	*Pinus* spp.	Seed fragments	4
TU 3	Mexican piñon	*Pinus cembroides*	Scales	3
TU 3	Grass Family	POACEAE	Culm fragments, fiber	12
TU 3	Western honey mesquite	*Prosopis glandulosa*	Seeds, seed fragments, pod fragments	44
TU 3	Oak	*Quercus* sop.	Acorn fragment	1
TU 3	Yucca	*Yucca* spp.	Leaf fragment	4
TU 3	Yucca	*Yucca* spp.	Seed	3
TU 3		Unknown	Berry fruit pedicle?	1
TU 3		Unknown	Epidermis	1
TU 3		Unknown	Follicle fragment	2
TU 3		Unknown	Wood	18
TU 5	Sunflower Family	ASTERACEAE	Pericarp	1
TU 5	Rough cocklebur	*Xanthium strumarium*	fruit	1
TU 6 (NE 50x50)	Agave/yucca	Agavoidea	Leaf, caudex fragments	4
TU 6 (NE 50x50)		Unknown	Wood	1
TU 7	Agave	Agavoidea	Leaf, caudex, infloresence fragments	29
TU 7	Hackberry	*Celtis* spp.	Endocarp fragment	1
TU 7	Domesticated gourd	*Lagenaria* spp.	Exocarp fragments	5
TU 7	Buffalo gourd	*Cucurbita foetidissima*	Seed fragments	4
TU 7	Texas persimmon	*Diospyros texana*	Seed	1
TU 7	Ephedra	*Ephedra* spp.-like	Flower	1
TU 7	Little leaf walmut	*Juglans microcarpa*	Endocarp fragments	13

Table A.2, Continued.

Test Unit	Common name	Scientific Name	Plant Part	Count
TU 7	Prickly pear	*Opuntia* spp.	Seed	20
TU 7	Common reed	*Phragmites australis*	culm fragment	6
TU 7	Piñon	*Pinus* spp.	Endocarp fragment	9
TU 7	Mexican piñon	*Pinus cembroides*	Cone scale	2
TU 7	Grass Family	POACEAE	Stolon fragment	3
TU 7	Western honey mesquite	*Prosopis glandulosa*	Seeds, endocarp fragments	107
TU 7	Western honey mesquite	*Prosopis glandulosa*	Thorn fragment	1
TU 7		Unknown	Fiber (dyed)	1
TU 7		Unknown	Follicle fragment	1
TU 7		Unknown	Wood	13
TU 7	Yucca	*Yucca* spp.	Leaf fragments	2
TU 7	Yucca	*Yucca* spp.	Partially retted leaf fragment	1
TU 7	Yucca	*Yucca* spp.	Seeds	30
TU 7E	Yucca	*Yucca* spp.	Leaf base	1
TU 8	Lechuguilla	*Agave lechuguilla*	Leaf Base	2
TU 8	Papershell piñon	*Pinus remota*	Cone scales	2

Table A.3. Tranquil Rockshelter- Matrix Sample Data

Feature No.	Charcoal/Non-Charcoal	Common name	Taxon	Plant Part	Count	Weight (g)	Volume (ml)
7	Non-Charcoal	Amaranth Family	AMARANTHACEAE	Seed	19		
7		Pitaya	*Echinocereus* spp	Seed	3		
7		Prickly pear	*Opuntia* spp.	Seed	1		
7		Curlycup gumweed	*Grindelia squarrosa*	Seed	1		
7		Purslane	*Portulaca* spp.	Seed	3		
7		Bristlegrass	*Setaria* spp.	lemma	1		
7	Charcoal	Western honey mesquite	*Prosopis glandulosa*	Charcoal	20	5.263	24
7		Forestiera	*Forestiera* spp.	Charcoal	1	0	
7			Vessels up to groups of three which are small. In tangential view there are very distinct "rays"	Charcoal	6	1.973	6
7			Massive vessel pits with rays that intersect them	Charcoal	10	0.782	5
7			Rays create a diamond pattern	Charcoal	2	0.073	

Table A.3, Continued.

Feature No.	Charcoal/Non-Charcoal	Common name	Taxon	Plant Part	Count	Weight (g)	Volume (ml)
7			Diffuse porous	Charcoal	1	0.014	
7			Indeterminate	Charcoal	10	0.256	
11	Non-Charcoal	Southwestern needlegrass	*Achnatherum eminens*	Spikelets, Infloesence fragments	14	0.012	
11		Lechuguilla	*Agave lechuguilla*	Seed	2	0.1	0.25
11		Agave	Agavoidea	Leaf fragments, bundles	11	1.951	8
11		Amaranth Family	AMARANTHACEAE	Seed, Achene	183	0.017	
11		Blue grama	*Bouteloua gracilis*	Florets, Spikelets	5		
11		Buffalo gourd	*Cucurbita foetidissima*	Endocarp fragments	4	0.037	0.25
11		Pitaya	*Echinocereus* spp.	Seed, Seed fragments	26	0.005	
11		Nineawn pappusgrass	*Enneapogon desvauxii*	Florets	4		
11		Nipple cactus	*Mammillaria* spp.	Seed fragment	1		
11		Prickly pear	*Opuntia* spp.	Seed, Endocarp fragments	102	1.196	3.5
11		Purslane	*Portulaca* spp.	Seed	4		
11		Western honey mesquite	*Prosopis glandulosa*	Seed	40	1.165	5
11		Plains bristlegrass	*Setaria leucopila*	Spikelets	67	0.042	
11		Dropseed grass	*Sporobolus* spp.	Inforesence fragments, seeds	74	0.011	
11		Caltrop	*Kallstroemia* spp.	Seeds	7	0.005	
11			Unknown 3	Seed	1		
11			Unknown 6	Seeds	6		
11			Unknown 12	Seeds	4		
11			Unknown 13	Seed	1	0.014	
11			Unknown 14	Seed	1	0.007	
11	Charcoal	Four-wing saltbush	*Atriplex canescens*	Charcoal	2	0.048	0.5
11		Ocotillo	*Fouquerqia splendens*	Charcoal	6	0.155	1
11		Western honey mesquite	*Prosopis glandulosa*	Charcoal	8	0.254	1.5
11			Semi ring porous, no rays, small vessels	Charcoal	5	0.125	1
11			Diffuse porous w/ growth rings	Charcoal	3	0.105	1
11			Indeterminate	Charcoal	2	0.034	
12	Non-Charcoal	Amaranth Family	AMARANTHACEAE	Seed w/ achene	675	0.137	
12		Four-wing saltbush	*Atriplex canescens*	Achene fragment	1		

Table A.3, Continued.

Feature No.	Charcoal/Non-Charcoal	Common name	Taxon	Plant Part	Count	Weight (g)	Volume (ml)
12		Sideoats grama	*Bouteloua curtipendula*	Spikelets	9		
12		Blue grama	*Bouteloua gracilis*	Spikelets	27		
12		Grama grass	*Bouteloua* spp.	Infloresence	1		
12		Buffalo gourd	*Cucurbita foetidissima*	Seed	1	0.038	
12		Buffalo gourd	*Cucurbita foetidissima*	Pericarp fragment	1	0.004	
12		Arizona cottontop	*Digitaria californica*	Spikelets	8		
12		Pitaya	*Echinocereus* spp.	Seeds	20		
12		Nineawn pappusgrass	*Enneapogon desvauxii*	Spikelets	1		
12		Ephedra	*Ephedra* spp.	Stem fragment	1	0.046	
12		Lovegrass	*Eragrostis* spp.	Infloresence fragments	5		
12		New Mexico feathergrass	*Hesperostipa neomexicana*	Spikelet	1		
12		Muhly grass	*Muhlenbergia* spp.	Infloresence	2		
12		Prickly pear	*Opuntia* spp.	Epidermis	1	0.014	
12		Prickly pear	*Opuntia* spp.	Seeds, seed fragments	33	0.235	1
12		Hall's panicum	*Panicum hallii*	Spikelets	3		
12		Grass Family	POACEAE	Spikelets	28	0.035	
12		Purslane	*Portulaca* spp.	Seeds	35		
12		Western honey mesquite	*Prosopis glandulosa*	Seeds, pod fragments	20	0.962	7
12		Oak	*Quercus* spp.	Acorn fragment	1	0.039	
12		Bristlegrass	*Setaria* spp.	Seeds	124	0.074	
12		Plains bristlegrass	*Setaria leucopila*	Infloresence	1		
12		Caltrop	*Kallstroemia* spp.	Seeds	3		
12		Curlycup gumweed	*Grindellia squarrosa*	Seeds	2		
12			Unknown- bristled	Seed	1		
12			Unknown- cone	Seeds	7		
12			Unknown- oval	Seed	1		
12			Unknown- round	Seed	1		
12			Unknown- small circular	Seed	1		
12	Charcoal	Acacia	*Acacia* spp.	Charcoal	1		
12		Four-wing saltbush	*Atriplex canescens*	Charcoal	1	0.006	
12		Ocotillo	*Fouquerqia splendens*	Charcoal	5	0.12	
12		Western honey mesquite	*Prosopis glandulosa*	Charcoal	3	0.61	4
12			Diffuse Porous	Charcoal	3		

Table A.3, Continued.

Feature No.	Charcoal/Non-Charcoal	Common name	Taxon	Plant Part	Count	Weight (g)	Volume (ml)
12			Indeterminate	Charcoal	10	0.198	
17	Non-Charcoal	Amaranth Family	AMARANTHACEAE	Seeds	1065	0.1	
17		Cholla	*Cylindropuntia* spp.	Seed	1	0.004	
17		Pitaya	*Echinocereus* spp.	Seeds	15	0.004	
17		Curlycup gumweed	*Grindellia squarrossa*	Seeds	2		
17		Caltrop	*Kallstroemia* spp.	Seeds	11		
17		Prickly pear	*Opuntia* spp.	Seeds	24	0.035	
17		Canaigre	*Polygonum* spp.	Seeds	4		
17		Purslane	*Portulaca* spp.	Seeds	119	0.009	
17		Western honey mesquite	*Prosopis glandulosa*	Seeds	2	0.028	
17		Bristlegrass	*Setaria* spp.	Seeds	10		
17		Yucca	*Yucca* spp.	Seed	1	0.031	
17			Unknown 8	Seed	1		
17	Charcoal	Four-wing saltbush	*Atriplex canescens*	Charcoal	4	0.116	
17		Condalia	*Condalia* spp.	Charcoal	3	0.155	
17		Forestiera	*Forestiera* spp.	Charcoal	5	0.329	
17		Western honey mesquite	*Prosopis glandulosa*	Charcoal	8	0.192	
17			Ring porous, massive vessels, medium rays	Charcoal	2	0.023	
17			Diffuse porous	Charcoal	10	0.201	
17			Indeterminate	Charcoal	7	0.089	
24	Non-Charcoal	Amaranth Family	AMARANTHACEAE	Seeds	57	0.019	
24		Pitaya	*Echinocereus* spp.	Seeds	5		
24		Caltrop	*Kallstroemia* spp.	Seeds	2		
24		Prickly pear	*Opuntia* spp.	Seed fragments	4	0.004	
24		Grass Family	POACEAE	Seed	1		
24		Purslane	*Portulaca* spp.	Seeds	3		
24		Western honey mesquite	*Prosopis glandulosa*	Seeds, endocarp fragments	13	0.026	
24			Unknown 4	Seeds	2		
24			Unknown 5	Seeds	3		
24			Unknown 8	Seeds	7	0.016	
24	Charcoal	Four-wing saltbush	*Atriplex canescens*	Charcoal	2	0.058	
24		Condalia -like	*Condalia* spp.	Charcoal	5	0.221	
24		Forestiera	*Forestiera* spp.	Charcoal	2	0.027	
24		Juniper	*Juniperus* spp.	Charcoal	1		

Table A.3, Continued.

Feature No.	Charcoal/Non-Charcoal	Common name	Taxon	Plant Part	Count	Weight (g)	Volume (ml)
24		Western honey mesquite	*Prosopis glandulosa*	Charcoal	2	0.047	
24			Diffuse porous	Charcoal	3	0.053	
24			Massive vessels that intersect rays	Charcoal	5	0.158	
24			Indeterminate	Charcoal	4	0.122	
24				Vitrified bark?	2	0.045	
25	Non-Charcoal	Agave	Agavoidea	Leaf and base fragments	13	0.114	1
25		Amaranth Family	AMARANTHACEAE	Seeds, achenes	200	0.018	
25		Pitaya	*Echinocereus* spp.	Seed	3		
25		Curlycup gumweed	*Grindellia squarrosa*	Seeds	3	0.01	
25		Caltrop	*Kallstroemia* spp.	Seed	1		
25		Prickly pear	*Opuntia* spp.	Seed	2	0.005	
25		Purslane	*Portulaca* spp.	Seed	15		
25		Western honey mesquite	*Prosopis glandulosa*	Seed, endocarp fragments	11	0.016	
25			Unknown 4	Seeds	3	0.007	
25			Unknown 5	Seed	1		
25			Unknown 9	Seeds	2	0.007	
25	Charcoal	Four-wing saltbush	*Atriplex canescens*	Charcoal	8	0.179	1
25		Ocotillo	*Fouquieria splendens*	Charcoal	5	0.111	0.75
25		Western honey mesquite	*Prosopis glandulosa*	Charcoal	4	0.1	1
25			Diffuse porous	Charcoal	1	0.083	1
25			Massive vessel pits with rays that intersect them	Charcoal	2	0.043	0.75
25			Semi ring porous with thin, distinct, incontinuious rays	Charcoal	6	0.232	2
25			Semi-ring to diffues porous, no rays.	Charcoal	5	0.186	1
25			Indeterminate	Charcoal	14	0.756	3
27	Non-Charcoal	Acacia	*Acacia* spp.	Pod fragments	2		
27		Lechuguilla	*Agave lechuguilla*	Seed	1		
27		Agave	Agavoidea	leaf fragments	25	0.83	2
27		Amaranth Family	AMARANTHACEAE	Seeds	331	0.053	
27		Four-wing saltbush	*Atriplex canescens*	Achene fragments	2		
27		Blue grama	*Bouteloua gracilis*	Spikelet	1		

Table A.3, Continued.

Feature No.	Charcoal/Non-Charcoal	Common name	Taxon	Plant Part	Count	Weight (g)	Volume (ml)
27		Pitaya	*Echinocereus* spp.	Seeds	68	0.01	
27		Curlycup gumweed	*Grindellia squarrosa*	Seeds	15	0.08	
27		Annual sunflower	*Helianthus annuus*	Seeds	9	0.007	
27		Little leaf walnut	*Juglans microcarpa*	Nut fragment	1	0.068	
27		Caltrop	*Kallstroemia* spp.	Seeds	10	0.008	
27		Prickly pear	*Opuntia* spp.	Seeds	154	0.846	2
27			POACEAE	Seeds	14	0.008	
27		Purslane	*Portulaca* spp.	Seeds	21	0.005	
27		Western honey mesquite	*Prosopis glandulosa*	Seed and endocarp fragments	94	0.961	10
27		Plains bristlegrass	*Setaria leucopila*	Spikelets	6		
27			Unknown 3	Seeds	15		
27			Unknown 4	Seeds	10		
27			Unknown 5	Seeds	7		
27			Unknown 6	Seeds	10		
27			Unknown 7	Seed	1		
27			Unknown 8	Seeds	3	0.012	
27	Charcoal	Four-wing saltbush	*Atriplex canescens*	Charcoal	2	0.009	
27		Allthorn	*Koeberlinia* spp.-like	Charcoal	3	0.126	
27		Ocotillo	*Fouquieria splendens*	Charcoal	4	0.107	1
27			Ring porous, no rays	Charcoal	1	0.017	
27			Indeterminate	Charcoal	10	0.235	2
29	Non-Charcoal	Amaranth Family	AMARANTHACEAE	Seeds	274	0.034	
29		Threeawn grass	*Aristida* spp.	Seed	1		
29		Blue grama	*Bouteloua gracilis*	Seeds	26		
29		Pitaya	*Echinocereus* spp.	Seeds	11		
29		Nineawn pappusgrass	*Enneapogon desvauxii*	Seed	1		
29		Buffalo gourd	*Cucurbita foetdissima*	Endocarp fragments	3		
29		Annual sunflower	*Helianthus annuus*	Achene fragment	2		
29		Caltrop	*Kallstroemia* spp.	Seeds	8	0.009	
29		Creosotebush	*Larrea tridentata*	Leaflet	1		
29		Nipple cactus	*Mammillaria* spp.	Seed	1		
29		Prickly pear	*Opuntia* spp.	Seeds, seed fragments	21	0.096	1
29		Purslane	*Portulaca* spp.	Seeds	11		
29		Western honey mesquite	*Prosopis glandulosa*	Seeds, seed fragments	24	0.563	4

Table A.3, Continued.

Feature No.	Charcoal/Non-Charcoal	Common name	Taxon	Plant Part	Count	Weight (g)	Volume (ml)
29		Plains bristlegrass	*Setaria leucopila*	Spikelets	5		
29			Unknown 3	Seeds	18		
29	Charcoal	Forestiera	*Forestiera* spp.	Charcoal	4		
29		Western honey mesquite	*Prosopis glandulosa*	Charcoal	5		
29			Diffuse porous	Charcoal	4		
29			Ring to semi-ring porous	Charcoal	4		
29			Indeterminate	Charcoal	8		
31	Non-Charcoal	Agave	Agavoidea	Leaf bundles	6	0.104	1
31		Amaranth Family	AMARANTHACEAE	Seeds, achenes, achene fragments	260	0.022	
31		Threeawn grass	*Aristida* spp.	Spikelets	10		
31		Four-wing saltbush	*Atriplex canescens*	Achene	1		
31		Blue grama	*Bouteloua gracilis*	Spikelets	6		
31		Buffalo gourd	*Cucurbita foetidissima*	Epicarp fragment	1	0.05	
31		Arizona cottontop	*Digitaria californica*	Spikelets	2		
31		Pitaya	*Echinocereus* spp.	Seeds, seed fragments	23	0.007	
31		Nineawn pappusgrass	*Enneapogon desvauxii*	Spikelets	2		
31		Ephedra	*Ephedra* spp.	Stem fragment	1	0.011	
31		Curlycup gumweed	*Grindellia squarrosa*	Seed fragment	1		
31		Annual sunflower - like	*Helianthus annuus*	Seeds	3		
31		Little leaf walnut	*Juglans microcarpa*	Nut fragments	5	0.141	0.5
31		Caltrop	*Kallstroemia* spp.	Seed, seed fragments	9		
31		Prickly pear	*Opuntia* spp.	Seed, seed fragments	86	0.786	2
31		Hall's panicum	*Panicum hallii*	Spikelets	3		
31		Tobosa grass	*Pleuraphis mutica*	Spikelet	1		
31		Purslane	*Portulaca* spp.	Seeds	2		
31		Western honey mesquite	*Prosopis glandulosa*	Seed, endocarp fragments	33	0.754	2.5
31		Plains bristlegrass	*Setaria leucopila*	Spikelets	28	0.019	
31		Dropseed grass	*Sporobolus* spp.	Spikelets	63	0.008	

Table A.3, Continued.

Feature No.	Charcoal/Non-Charcoal	Common name	Taxon	Plant Part	Count	Weight (g)	Volume (ml)
31		Dropseed grass	*Sporobolus* spp.	Infloresence fragment	7	0.017	
31			Unknown 12	Seeds	6		
31			Unknown 3	Seeds	2		
31			Unknown 5	Seeds	3		
31	Charcoal	Four-wing saltbush	*Atriplex canescens*	Charcoal	3	0.064	0.75
31		Ocotillo	*Fouquerquia splendens*	Charcoal	6	0.395	2.75
31		Juniper	*Juniperus* spp.	Charcoal	1	0.93	0.75
31		Western honey mesquite		Charcoal	10	0.723	5
31			Abundant mvessels in early wood, none in late wood, thin discontinuous rays	Charcoal	1	0.051	
31			Abundant vessels in early wood, fewer in late wood, no rays	Charcoal	1	0.046	
31			Tiny vessels, tiny rays	Charcoal	1	0.023	
31			Indeterminate	Charcoal	10	0.226	1
32	Non-Charcoal	Lechuguilla	*Agave lechuguilla*	Leaf fragments	6	0.931	5
32		Amaranth Family	AMARANTHACEAE	Seeds and achenes	353	0.073	
32		Four-wing saltbush	*Atriplex canescens*	Achene fragments	2		
32		Blue grama	*Bouteloua gracilis*	Spikelets	24	0.004	
32		Pitaya	*Echinocereus* spp.	Seeds and seed fragments	9		
32		Ephedra	*Ephedra* spp.	Stem fragment	1	0.14	
32		Dropseed grass	*Eragrostis* spp.	Spikelet fragments	3	0.011	
32		Dropseed grass	*Eragrostis* spp.	Inflorescence fragments	4		
32		Annual sunflower - like	*Helianthus annuus*	Seeds	8		
32		Tanglehead	*Heteropogon contortus*	Spikelet	1		
32		Little leaf walnut	*Juglans microcarpa*	Nut fragments	2		
32		Juniper	*Juniperus* spp.	Leaf scales	7	0.014	
32		Caltrop	*Kallestroemia* spp.	Seeds	4		
32		Prickly pear	*Opuntia* spp.	Seeds and seed fragments	22	0.174	
32		Tobosa grass	*Pleuraphis mutica*	Spikelets	2		
32		Grass Family	POACEAE	Spikelets	10	0.007	

Table A.3, Continued.

Feature No.	Charcoal/Non-Charcoal	Common name	Taxon	Plant Part	Count	Weight (g)	Volume (ml)
32		Purslane	*Portulaca* spp.	Seeds and seed fragments	13		
32		Western honey mesquite	*Prosopis glandulosa*	Endocarp fragments	22	0.399	2
32		Bristlegrass	*Setaria* spp.	Seed	36	0.014	
32		Bristlegrass	*Setaria* spp.	Infloresence	1	0.011	
32		Slim tridens	*Tridens muticus*	Spikelet fragments	2		
32		Slim tridens	*Tridens muticus*	Inflorescence fragments	4		
32			Unknown 10	Seed	1		
32			Unknown 11	Seed	1		
32			Unknown 3	Seed	1		
32			Unknown 5	Seeds	6		
32	Charcoal	Four-wing saltbush	*Atriplex canescens*	Charcoal	2	0.021	
32		Ocotillo	*Fouquerqia splendens*	Charcoal	5	0.1	1
32		Western honey mesquite	*Prosopis glandulosa*	Charcoal	8	0.307	1.5
32			Ring to semi-ring porous, vessels solitary and coupled, distinct thin continuous rays	Charcoal	3	0.043	0.5
32			Semi-ring to diffues porous, no rays.	Charcoal	9	0.673	4
32			Indetermiante	Charcoal	10	0.263	2

Table A.4. Tranquil Rockshelter- Screen and In-Situ Macrobotanicals

Feature No.	Common Name	Taxon	Part	Count	Weight (g)
11	Acacia	*Acacia* spp.	Reproductive parts	13	0.114
11	Lechuguilla	*Agave lechuguilla*	Leaf fragments	17	21.106
11	Lechuguilla	*Agave lechuguilla*	Quids	3	15.949
11	Lechuguilla	*Agave lechuguilla*	Flower stalk fragment	1	1.909
11	Agave	Agavoidea	Leaf fragments	5	0.394
11		Charcoal	Charcoal	8	2.93
11	Buffalo gourd	*Cucurbita foetidissima*	Epicarp fragments	3	0.346

Table A.4, Continued.

Feature No.	Common Name	Taxon	Part	Count	Weight (g)
11	Buffalo gourd	*Cucurbita foetidissima*	Seed	1	0.013
11	Sotol	Dasylirion spp.	Leaf fragment	1	0.89
11	Pitaya	Echinocereus spp.-like	Epidermis fragments	5	4.554
11	Ocotillo	*Fouquerqia splendens*	Stalk tip	1	1.138
11	Little leaf walnut	*Juglans microcarpa*	Nut fragments	4	1.437
11	Mexican piñon	*Pinus cembroides*	Scale	1	0.159
11	Prickly pear	*Opuntia* spp.	Tunas, tunas fragments	6	4.028
11	Prickly pear	*Opuntia* spp.	Epidermis, pad fragments	15	7.416
11	Prickly pear	*Opuntia* spp.	Seeds	14	0.239
11	Grass Family	POACEAE	Culm fragments	2	0.021
11	Western honey mesquite	*Prosopis glandulosa*	Seeds, fruit fragments	24	1.748
11	Yucca	Yucca spp.	Leaf fragments	2	0.083
11	Yucca	*Yucca bacatta*	Seed	1	0.124
11		Charcoal	Charcoal	11	4.384
11		Woody plant	Wood fragments	6	5.097
12	Lechuguilla	*Agave lechuguilla*	Leaf fragments	4	3.217
12	Lechuguilla	*Agave lechuguilla*	Quids	6	
12	Buffalo gourd	*Cucurbita foetidissima*	Epicarp fragments	3	0.162
12	Sotol	*Dasylirion* spp.	Leaf fragment	1	0.082
12	Fishhook cactus	*Mammillaria* spp.	Aerole	1	0.069
12	Western honey mesquite	*Prosopis glandulosa*	Pod fragments	4	0.544
12	Yucca	Yucca spp.	Knoted fiber	1	0.035
12	Maize	*Zea mays*	Cob fragment	1	
12		Woody plant	Twigs	5	1.803
12		Charcoal	Charcoal	6	0.391
29	Lechuguilla	*Agave lechuguilla*	Leaf fragments	41	31.419
29	Lechuguilla	*Agave lechuguilla*	Fruit pods	3	0.855
29	Lechuguilla	*Agave lechuguilla*	Quids	3	2.205
29	Common reed	*Phragmites australis*	Culm fragment	3	1.234
29	Buffalo gourd	*Cucurbita foetidissima*	Seed fragment	1	0.009

Table A.4, Continued.

Feature No.	Common Name	Taxon	Part	Count	Weight (g)
29	Buffalo gourd	*Cucurbita foetidissima*	Epicarp fragments	2	0.47
29	Sotol	*Dasylirion* spp.	Leaf fragments	4	1.733
29	Ephedra	*Ephedra* spp.	Stem fragment	1	0.15
29	Ocotillo	*Fouquerquia splendens*	Epidermis fragment	1	0.732
29	Little leaf walnut	*Juglans microcarpa*	Nut, nut fragments	3	1.296
29	Prickly pear	*Opuntia* spp.	Seeds	3	0.02
29	Prickly pear	*Opuntia* spp.	Epidermis fragments	3	0.237
29	Grass Family	POACEAE	Digitate infloresence	1	0.028
29	Grass Family	POACEAE	Culm fragment	1	0.041
29	Western honey mesquite	*Prosopis glandulosa*	Seeds, pod fragments	26	2.434
29	Mexican buckeye	*Ungnadia speciosa*	Seed	1	1.026
29	Yucca	*Yucca* spp.	Leaf fragment	1	0.03
29	Yucca	*Yucca* spp.	Seeds	8	0.554
29		Woody plant	Wood fragments	6	10.724
29		Unknown 8	Seed	1	0.033
31	Lechuguilla	*Agave lechuguilla*	Quids	11?	
31	Prickly pear	*Opuntia* spp.	Pad	1	3
32	Lechuguilla	*Agave lechuguilla*	Quids	3	