THE ECONOMIC CONTRIBUTION OF ROOT FOODS AND OTHER GEOPHYTES

IN PREHISTORIC TEXAS

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CHAPTER I

INTRODUCTION TO THE STUDY

The prehistoric use of geophytes has recently become a subject of interest as more archaeological sites across Texas are producing samples from various contexts. Recently, the 2005 annual meetings of the Society for Economic Botany and the Texas Archeological Society presented symposiums on land use intensification and the role of plant foods. Papers presented by archaeologists examining land use intensification and subsistence strategies in Texas have provided considerable insight on the role of geophytes on the economic patterns of prehistoric people in Texas.

To fully examine the relationship between geophytes and subsistence strategies of hunter-gatherers in Texas, the various cultural contexts in which they are found must be assessed. Most of the geophytes that have been recorded at sites across Texas have been from cooking features and several studies in North America have examined the importance of cooking facilities in the processing of geophytes to alter the chemical composition and increase its digestibility (Thoms 1989, 2003, 2005b, 2006b). In Texas, burned rock features and middens are ubiquitous and abundant, and are the most common archaeological feature observed in Central Texas and the Lower Pecos region (Black, et al. 1997). Their construction, use and preservation in the prehistoric record has been studied by several archaeologists through various cultural resource management projects and academic endeavors (Black, et al. 1997; Clabaugh 2002; Dering 1999; Leach and Bousman 2001; Mahoney, Shafer and Tomka 2003; Mauldin 2003a). This current study focuses on the construction of cooking features with geophytes to understand the nature in which the geophytes were processed for consumption.

The second chapter describes the study area and its culture history. The third chapter provides the theoretical background of the study. It discusses foraging theory and its various models. It also presents other work on the relationship of geophytes and burned rock features. The research questions developed for the study consider foraging theory concepts and previous studies on geophytes. The fourth chapter discusses geophytes and processing facilities. The chapter presents their modern distribution, details the chemical composition of geophytes, their processing requirements as well as the evidence of their ethnographic use in North America. In addition, the chapter discusses cooking facilities used to process geophytes. The fifth chapter presents the methodology used to conduct the current study. Chapter six presents the results and the interpretations to answer the research questions in chapter three.

CHAPTER II

DEFINITION OF STUDY AREAS: CENTRAL TEXAS AND LOWER PECOS

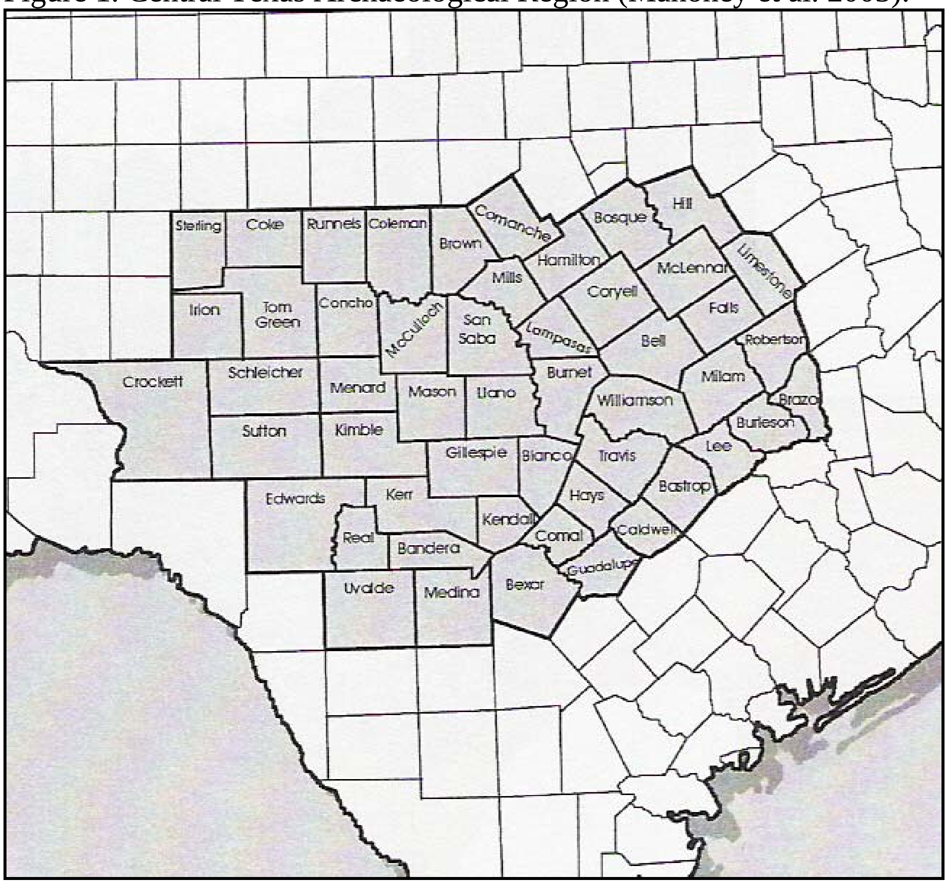
The study areas for the current thesis are the Central Texas and Lower Precos archaeological regions. Although sites with evidence of geophytes exist outside of these regions, this study only examines sites within Central Texas and Lower Pecos. The chapter presents a description of each region as well as the cultural chronology.

CENTRAL TEXAS

Prewitt (1981) and Collins (2004) defined the boundaries of the Central Texas Archaeological region. The delineation of the boundaries is arbitrary and for this study, I will use the general boundaries presented in Mahoney et al. (2003) as it has the counties with evidence of geophytes labeled and includes Prewitt's (1981) delineated boundaries for the region (Fig. 1). Several chronologies have been presented for this region (Collins 1995, 2004; Johnson and Goode 1994; Prewitt 1981, 1985); this study will use the chronology presented by Collins (2004). This section discusses the Archaic and Late Archaic periods since sites with evidence of geophytes are primarily found during these periods.

The Archaic period is divided into Early, Middle and Late Archaic spanning a period from 8800 to 1200 BP. During this period local floral and faunal resources were more intensively utilized after Paleoindian times (Collins 2004). The Archaic material culture was more diverse than the Paleoindian period and the use of cooking facilities utilizing rocks as heating elements increases. The Early to Late Archaic periods are defined by changing projectile point styles and distinctive changes in the archeological record.

Figure 1. Central Texas Archaeological Region (Mahoney et al. 2003).



The Early Archaic period consists of primarily open campsites with some evidence of rock shelter sites concentrated along the southern and eastern margins of the Edwards Plateau ecological region (Collins 1995, 2004). Specialized tools used for woodworking are represented in this period and groups were exploiting small game, deer, fish, turtle, and geophytes. Bison were scarce and the climatic conditions ranged from mesic to xeric (Collins 1995, 2004; Dillehay 1974). After the Paleoindian period, a variety of environmental data sets on the paleoenvironment of Central Texas indicates a warming trend lasting into the Middle Holocene (Bousman 1998; Toomey and Stafford 1994). Some researchers speculate that the warmer weather coupled with a decrease in effective moisture resulted in a more seasonal climate (Mahoney, Shafer, Tomka, et al. 2003)

During the Middle Archaic period spanning from 6000 to 4000 BP, the climate dramatically changed to xeric conditions. The increase in grass pollen in palynological studies indicates a more arid and warmer climate (Bousman 1998). This drying trend occurred throughout North America and is known as the Altithermal or Hypsithermal (Collins 2004). The interval spans from 9500 to 2500 BP, however most archaeologists agree that a shorter period of 7000 to 4500 BP occurs in Texas (Decker, et al. 2000). As the climate shifted, burned rock facilities were utilized to process drought adapted plants, such as sotol, more intensively (Johnson and Goode 1994). The material culture consisted of multi-use bifacial knives, and projectile points were deeply notched and later thick and narrow blades. The deeply notched projectile points, such as Bell-Andice-Calf Creek, were used in the early part of the Middle Archaic and were specialized tools for bison (Johnson and Goode 1994). At the height of the warming trend, the technology shifts to thick, narrow bladed projectile points, such as Nolan and Travis, to reflect a drop in the bison population (Johnson and Goode 1994).

The Late Archaic period dates from 4000 to 1200 BP. Some researchers have divided the Late Archaic period beginning at 2250 BP due complex and diverse archaeological manifestations such as corner tang knives, marine shell ornaments, and caches of bifaces. The subperiods, such as Late Archaic I and II (Johnson and Goode

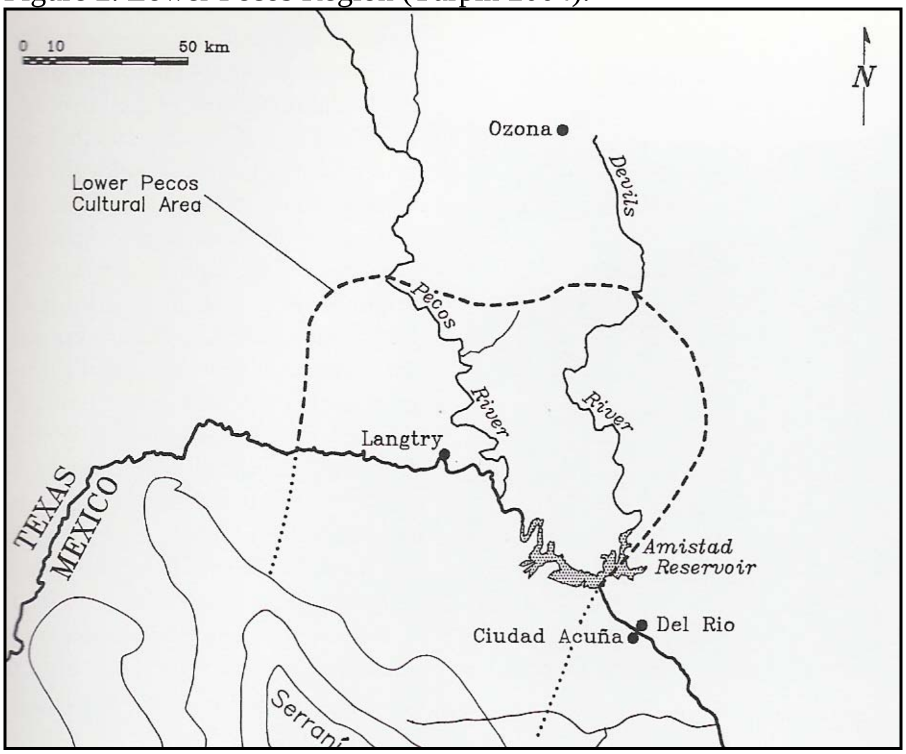
1994) and Transitional Archaic (Turner and Hester 1999) were based on changes seen in projectile points that begin to resemble the earliest arrow points. In addition, researchers believe there was increased interaction between groups and possibly conflict between them (Collins 2004; Johnson and Goode 1994). Collins (2004) states that the number of burned rock middens is at its greatest in the eastern parts of Central Texas and gradually decreases around 3500 to 2500 BP. The climate shifts once again to more mesic conditions and the processing of xeric vegetation disappears (Collins 2004).

The Late Prehistoric period saw the introduction of the bow and arrow, and begins at 1200-1250 BP and extends to 260 BP. The period is divided into Austin and Toyah intervals (Jelks 1962; Suhm 1960) and these may represent distinct societies (Johnson 1994). During the Austin interval, 1200 BP to 800 BP, there is evidence of greater arrow-wound fatalities and burned rock midden use may have peaked (Black and Creel 1997; Collins 2004). During the Toyah interval, 800 BP to 250 BP, plain bone-tempered ceramics appear and bison returned to the area after 750 BP due to a drying trend (Collins 2004; Dillehay 1974). Researchers debate whether the Toyah cultural manifestations are from a single ethnic group (Johnson 1994) or that it is technocomplex (Ricklis 1994). As more intact Toyah sites are discovered and excavated, the debate will continue to grow (Collins 2004).

LOWER PECOS

The Lower Pecos is part of the Trans-Pecos region in Chihuahuan Desert, whose boundaries begin west of the Pecos River (Miller and Kenmotsu 2004; Turpin 2004). The Lower Pecos region is located at the mouth of the Pecos River and extends 1500 meters north and south of the Rio Grande (Figure 2). The region is traditionally defined but not limited to four distinct rock art styles and material culture. Sites are primarily in rock shelters and caves and the preservation of artifacts is remarkable. The following cultural chronology begins with the Archaic period and follows Turpin (2004).

Figure 2. Lower Pecos Region (Turpin 2004).



The Archaic period is divided into Early, Middle and Late periods with six sub-periods between them. The Archaic period begins around 8900 BP and ends at 1300-1000 BP. The Early Archaic period, 9000 BP to 6000 BP, consists of the Viejo sub-period. The rock shelters are used as habitation sites and burned rock middens are found within them. The food resources utilized include small fauna and desert succulents such as sotol and agave (Brown 1991; Turpin 2004). Materials recovered from deposits include a variety of early-barbed and early stemmed points, fiber artifacts, painted pebbles and clay figurines. Usually perishable items include clothing, basketry, twine and even sandals. However, the period is considered to be too long and amorphous to be a meaningful cultural unit (Turpin 2004).

The Middle Archaic period dates from approximately 6000 BP to 3000 BP and contains two sub-periods (Turpin 2004). During the earlier Eagle Nest sub-period, it appears that groups intensified their use of desert succulents due to a shift in the environment to a hotter and dryer climate. A dramatic change from mesophytic plants to xerophytic plants occurs around 5000 BP indicating a critical climatic change known as the Ozona Erosional (Bryant 1966). Bryant (1966) noted an increase in desert herb pollen and a decrease in arboreal pollen. Distinct projectile point styles emerged to coincide with the change in climate. In the later San Felipe sub-period, local projectile point styles increased and the first evidence of rock art emerged. This rock art is the most complex of the pictograph styles of the Lower Pecos. It is considered to be the related to religions and shamanistic experiences. Based on the archaeological components of sites and the number of project point styles, researchers suggest that two shifts in settlement pattern occur. First, a increase in population density along rivers and second, more upland sites for the exploitation of resources. Various models have been presented to account for the social complexity of this time period (Turpin 2004).

The Late Archaic period lasts from 3000 BP to 1000 BP and contains three sub-periods. At the beginning of the period, more mesic conditions return. Along with the climatic change, shifts in economics, technology and site distributions in the Lower Pecos occur. The earlier Cibola sub-period is characterized by open terrace campsites correlating with the in-migration bison and other large game. The Red Linear pictographs, related to this period, depict deer hunters. A drier climate returns during the

Flanders and Blue Hills sub-periods and exploitation strategies are similar to the Early and Middle Archaic periods. The Flanders period, characterized by Shumla dart points and Serpentine style petroglyphs, is the most elusive time period in the chronology of the Lower Pecos. The Blue Hills sub-period overlaps with the Flanders sub-period and also suggests a reliance on desert plants based on the number of upland sites and increase in the number of unifaces that are thought to be used for the processing of plants (Turpin 2004).

The Late Prehistoric period dates from 1000 to 350 BP. The earlier Flecha sub-period is characterized by mortuary practices and the introduction of the bow and arrow (Turpin 2004). Ring middens located on open sites consistently date to this period, although rock shelters are still being used. The mortuary practices and two pictograph styles, Red Monochrome and Bold Line Geometrics, suggest the migration of new people into the Lower Pecos. Mortuary customs consisted of bundling and internments in rock shelter deposits. Bundling declined and other practices such as cairn burials and cremation burials were observed (Turpin 2004). The Infierno sub-period consists of specific tool kit found at sites and tipi rings. The tool kit consisted of small triangular stem arrow points, steeply beveled end scrapers, four beveled knives, and plain ceramics. Some evidence of rare ceramic sherds have been found at sites that are of an unknown origin. This sub-period is clearly distinguished by these features and some have suggested it overlaps with Toyah culture of Central Texas (Turpin 2004).

The regions discussed for this thesis each contain sites that have evidence of geophytes in archaeological contexts. The following chapter will discuss the theoretical background and present research questions related to this study.

CHAPTER III

THEORETICAL BACKGROUND

To understand the practices of resource procurement strategies of hunter-gatherers researchers and scholars have relied on foraging theory and models to explain the economic subsistence practices. Foraging theory is derived from evolutionary ecology (Smith and Winterhalder 1992a; Winterhalder and Smith 1981, 2000) as well as economic principles (Earle 1980; Jochim 1976). The models and approach developed to understand non-human foraging. Anthropologists and archaeologists have adopted the theory to aid them in formulating hypothesis on the adaptive and economic strategies of hunter-gatherers. The analysis of human interaction with the environment to develop economic strategies for food and non-food resources is termed human behavioral ecology (Winterhalder and Kennett 2006; Winterhalder and Smith 2000).

Human behavioral ecology has been applied to ethnographic and archaeological research to explain domestication and agricultural origins, field processing and central place foraging, diet-selection, technological strategies, division of labor, and resource intensification (Winterhalder and Kennett 2006; Winterhalder and Smith 2000). Foraging theory and its models have been presented in literature related specifically to anthropological and archaeological studies of hunter-gatherers

(Bettinger 1991; Earle and Christenson 1980; Jochim 1976; Kelly 1995; Smith and Winterhalder 1992a; Winterhalder and Smith 1981). It's application to archaeological and ethnographic research of hunter-gatherers has provided useful and relevant results over the last 20 years (Winterhalder and Kennett 2006; Winterhalder and Smith 2000). The models can be adapted to new problems and settings, and allow researchers to expand ideas and concepts of the theory to explain economic strategies (Winterhalder and Kennett 2006).

THE OPTIMIZATION ASSUMPTION OF FORAGING THEORY

The premise of foraging theory is the optimization assumption which was developed from evolutionary ecology and economic principles (Jochim 1976; Winterhalder and Smith 1981). Early discussions of hunter-gatherer strategies adopted the concept to explain the changes and patterns in subsistence practices (Earle 1980; Jochim 1976; Winterhalder and Smith 1981). Jochim (1976) described procurement strategies as conscious choices of obtaining food and non-food resources to satisfy the caloric needs of the population with limited effort. The decisions made by hunter-gatherers are within a secure level of food and manufacturing needs, and maintenance of energy expenditure within a preferred range (Jochim 1976). Earle (1980) describes the concept as evaluating various costs and benefits that will minimize effort rather than maximize profits, while still fulfilling energy requirements for a population within biological, ecological, and cultural constraints.

The optimization premise or assumption had several criticisms, one being that organisms are never truly optimal (Winterhalder and Kennett 2006; Winterhalder and

Smith 1981). There is a disjuncture between modeled optimization and observed behaviors. However, the behaviors or decisions of foragers have a tendency for optimization, or constrained optimization, that allows hunter-gatherers to engage in fitness related activities because of their efficient procurement strategies (Winterhalder and Kennett 2006). The optimization analysis can be used in any case to test hypothesis on the economic decisions and behaviors of foragers and it can be altered and revised (Smith and Winterhalder 1992b).

The optimization assumption also includes several economic concepts to study the adaptive behaviors and the decision-making process of hunter-gatherers (Winterhalder and Kennett 2006). These fundamental concepts of foraging theory and optimization models consist of marginal valuation, opportunity costs, discounting and risk-sensitivity. The concepts have aided foraging theory and models in assessing the costs and benefits of various subsistence strategies under a range of environmental conditions (Winterhalder and Kennett 2006). Marginal valuation considers the option of a forager to pursue one item over another. Although an item’s intrinsic value may not change, its immediate value to the forager will change based on quantity and yield. The marginal value and return rates or yield of a particular resource is related to opportunity costs (Winterhalder and Kennett 2006).

Foragers make decisions or choose one option over another based on the net return rate gained from the available alternatives. That is, the benefits of pursuing one option may be greater than another. The relationship between marginal value and opportunity costs are often analyzed together to observe how foragers interact with their natural environment (Winterhalder and Kennett 2006). Discounting behaviors are also analyzed along with marginal value and opportunity costs to assess the decision making process of foragers. When foragers assign a future reward or outcome less value than if it were immediately available, it is called discounting. Foragers have to consider actions or behaviors from immediate to delayed reward activities (Winterhalder and Kennett 2006). Delayed activites include harvesting agricultural resources or wild foods with peak growth periods.

Another important concept is risk-sensitivity (Winterhalder and Kennett 2006). Risk has two components: the probability of loss and the cost of loss (Bamforth and Bleed 1997). In evaluating risk for certain behaviors, the probability of loss may be high and the cost of that loss may be low or vice-versa. In subsistence risk, the risk is inadequate food intake. Risk-sensitivity behavior entails the stochastic elements of the environmental variables that effect the decision making process of foragers. Introducing risk-sensitive behaviors allow researchers to account for the long term average and short fall periods of the environment in optimization models. The models that are developed consider different subsistence strategies designed to deal with the different risk components. The models developed for foraging theory have common fundamental concepts to understand the decisions and behaviors within a foragers subsistence economy (Winterhalder and Kennett 2006).

FORAGING MODELS AND THEIR FUNDAMENTAL FEATURES

The optimal foraging models all have four fundamental concepts or features that come together under the optimization assumption. They consist of the alternative set, constraints, currency, and goals (Kaplan and Hill 1992; Winterhalder and Kennett 2006).

Each model has alternative set or a range of behavioral possibilities, that can be a very simple or very complex set of options or decisions (Kaplan and Hill 1992). Under the optimization premise, the alternative set are behaviors that will usually favor the best strategies (Smith and Winterhalder 1992b). Stochastic elements, or constraints, such as environmental, biological, and social factors influence the alternative set or mixed strategies foragers will choose. Constraints can either be intrinsic, abilities and requirements of the foragers, or extrinsic, factors that are beyond the foragers control. Intrinsic constraints include the age and experience of a forager. Extrinsic constraints include environmental or social factors (Smith and Winterhalder 1992b).

The cost and benefit of foraging activities must be measured by a currency. Food energy, such as kilocalories, protein, or fat is usually the most common and important attribute to use as currency, as well as time. However, it can be any feature or resource that has value (Winterhalder and Kennett 2006). The goal is determined by the analyst and is different for each foraging model. For example, the goal of a forager avoiding short falls would involve a risk-sensitive model, or energy maximization would involve optimization analysis (Winterhalder and Kennett 2006). The following highlights the most commonly used models in foraging theory.

The most commonly recognized model is the prey choice or diet-breadth model (MacArthur and Pianka 1966; Smith and Winterhalder 1992b; Winterhalder and Kennett 2006; Winterhalder and Smith 1981). Developed by MacArthur and Pianka (1966), the model predicts diet breadth by balancing search and handling costs of resources. The resources are ranked as either high-rank resources, most preferred, or low-rank resources, least preferred (Smith and Winterhalder 1992b; Winterhalder and Kennett 2006). Search costs refer to a forager spending the time looking for prey or waiting for it, and handling costs refer to the time involved in pursuing, catching, and processing. The model assumes that prey encounter is random and that the forager knows the encounter rate for all potential prey, handling costs, and energy for each resource. In addition, researchers assume that as high-ranked resources become scarce due to environmental factors, low-ranked resources will added to the diet. Factors that affect search and handling costs of preferred resources can increase the profitability of other resources, changing their rank among the diet of foragers (Smith and Winterhalder 1992b; Winterhalder and Kennett 2006).

Patch models follow the same general principles as prey models, however the resources are clumped together in one area and can be ranked like individual resources (MacArthur and Pianka 1966; Smith and Winterhalder 1992b; Winterhalder and Kennett 2006; Winterhalder and Smith 1981). One aspect of predicting patch choice is dependent on the marginal value theorem or patch residence time (Winterhalder and Kennett 2006). Essentially, the more time a forager spends in a patch, the resource rates or yields will diminish for that patch. The forager must then chose when to abandon one patch and search for another based on the return rates of multiple patches. The model predicts that a forager will leave a patch when the rate of return drops below the foraging rate. The foraging rate is the travel costs to and from a patch in addition to the harvest time. The costs and benefits of staying longer at one patch with diminishing return rates is weighed against leaving to another patch reducing return rates as well due to costs of traveling (Kaplan and Hill 1992; Winterhalder and Kennett 2006). Foragers really never completely diminish a patch and exploit patches at their highest return rates during initial patch use spending less time searching or traveling between patches. As search time increases between patches, foragers will spend more time at a given patch to account for the increased search costs (Kaplan and Hill 1992). Combined prey and patch models are more appropriate and applicable to foraging societies as both prey and patch resources are encountered in an unsystematic manner within a given environment (Kaplan and Hill 1992).

Central place foraging model addresses the practice of foraging from a central place or attractive habitation site in a radial pattern (Winterhalder and Kennett 2006). The central place can be near a water hole, a dry rock shelter, or a location near dense resources. The model considers travel time to and from the central place and selection harvest. The model predicts that foragers will be more selective in resources as travel costs in and out from the central place increases. In other words, the most profitable resources will be selected at longer travel distances. The model also considers field processing of selective resources to increase travel efficiency and which is likely to occur during longer foraging travels (Winterhalder and Kennett 2006).

Other considerations for foraging models such as prey/patch models and central place foraging include information acquisition, risk-sensitivity behaviors, and time allocation (Kaplan and Hill 1992). Most of the models assume that the forager has complete knowledge of resource distributions and return rates. In information acquisition, foragers will engage in behaviors that increase their knowledge of resources and their distributions that will increase the long-term gain while reducing the short-term return rates. The cost and benefits of information acquisition include time spent traveling and sampling patches to ascertain the return rates to later increase the foraging return rate on a long term basis (Kaplan and Hill 1992).

Risk-sensitive behaviors, as mentioned earlier, take into account those stochastic elements that affect the resource base in an environment (Kaplan and Hill 1992). Foragers perform these to address the variation of the resource base due to climate or other factors. Since the productivity of various resources changes, the forager will alter their behavior to account for the variability. Foragers will perform risk-sensitive behaviors that change in response to an expected variation change in return rates. Behaviors that reduce the variation are risk-averse, and those that increase variation are risk-prone. However, Bamforth and Bleed (1997) state that risk-sensitive behaviors should be viewed under “risk as a probability of loss” definition rather than “probability of variance.” Although risk-prone behaviors may increase variation, it may introduce the possibility of a windfall rather than shortfall, therefore reducing the probability of loss. They suggest that behaviors should be referenced as “variance-prone” and “variance-averse,” instead of “risk-prone” and “risk-averse” (Bamforth and Bleed 1997). Overall, humans develop means to reduce or prevent risk or shortfalls in food supply. For example, foragers can reduce the risk in four ways, such as increasing diet breadth or diversify diet, storage, information sharing, and direct food sharing (Kaplan and Hill 1992).

Time allocation assesses the cost and benefits of various behaviors that a forager must choose to enhance fitness or survival (Hames 1992). The activities foragers allocate their time to are either reproductive, somatic, social or technological. The goal is to achieve time minimization or resource maximization permitted by optimal allocation of time (Hames 1992). The importance of foraging theory and its models is that they are flexible and versatile. They are modified and elaborated to account for the variability in human subsistence strategies and the numerous factors that affect them.

THE APPLICATION OF FORAGING THEORY ON GEOPHYTE USE IN TEXAS

Although the field of archaeology has utilized and even developed some foraging theory and models, it has been primarily tested on living human populations and non-human species (Winterhalder and Kennett 2006). But as the analysis of floral and faunal residues are improved and expanded, studies have shown that, changes in the foraging behavior can be observed (Winterhalder and Kennett 2006). The following thesis aims to examine the role of geophytes in the foraging activities of prehistoric people in Texas. By examining evidence of these resources in their archaeological contexts I hope to determine if the use of geophytes was intensified.

Geophytes are wild foods that are not easily digestible and have some degree of toxicity. It is evident that hunter-gatherers incorporated geophytes into their diet because these resources exist in the archaeological record. What lead to their use? Other models developed for the chemical ecology of the use of wild foods suggest that human populations will encounter toxic chemicals or plants due to fluctuating environments (Johns 1990). Because food shortages exist in the long term procurement strategies of foragers, they will seek out resources that are resistant to the climactic extremes or are adaptable to those conditions (Huss-Ashmore and Johnston 1994). According to the model of human chemical ecology, as humans seek out alternative resources due to shortfalls, they will seek to minimize toxins and increase the effects of ingested components through behavioral, physiological mechanisms developed through natural selection and culture (Johns 1990).

This parallels the foraging models and theory mentioned previously. The short term temporal variability of preferred resources due to climate change or other factors will often dictate the expansion of other less-profitable resources to the diet such as plant foods. In doing so, Johns (1990) states that humans will come “into greater contact with noxious secondary compounds in their search for nutrients.” Geophytes can be considered less desirable foods within the range of available resources to hunter-gatherers within a given habitat. They are buried and some are severely toxic. However, as the following chapter discusses, geophytes are able to adapt to severe conditions due to their physiological and chemical compositions. They grow in patches and horticultural practices, such as selective harvesting, are known to enhance productivity of some geophytes (Anderson 1997; Thoms 1989).

Previous work performed in areas across Central Texas have increased our knowledge on the importance of geophytes in the subsistence practice of hunter-gatherers in Texas. The work reported from the Fort Hood (Mehalchick, Boyd, et al. 2004) and Camp Bowie (Mauldin, et al. 2003a) sites present discussions on the role of geophytes. In Mehalchick et al. (2004), the Paluxy sites were examined to determine how the prehistoric use of oven features are correlated with geophyte processing.

Mehalchick et al. (2004) speculate whether the hunter-gatherers were harvesting geophytes as groups in the Pacific Northwest based on the increasing evidence of sites with geophytes across Texas. Prehistoric hunter-gatherer groups may be possibly performing managing practices such as selective harvesting and fire to propagate the available geophyte resources. Unfortunately, there is no way to determine if the practices were actually done since there is no direct ethnographic evidence in Central Texas. Yet, evidence of geophyte use exists in cooking facilities observed in the archaeological record. Although geophytes require intensive processing, hunter-gatherers possibly adopted the use an optimal subsistence strategy.

At Camp Bowie (Mauldin, et al. 2003a), numerous sites were tested and contained evidence of geophytes. Mauldin (2003b) argues that geophyte processing is directly related to midden use. The discussion presented in their study suggests that eastern camas and other similar geophytes found at Camp Bowie sites were “low” rank resources with “high” costs. Mauldin et al. (2003a) suggests their use may reflect seasonality of geophyte resource availability for use during periods of food stress when groups will turn to alternative resources. In addition, the consumption of geophytes that are high in carbohydrates may have other nutritional benefits other than caloric return (Mauldin 2003b).

Thoms (2005a) determined that a carbohydrate revolution occurred, beginning with the early Holocene that led to land-use intensification. He asserts that the appearance and increased number of burned rock features and ovens across the landscape are evidence of subsistence intensification of plant food, such as geophytes, that require extensive periods of cooking. He suggests that the increase of use of usually unused or under-used foods, or low ranked foods, is indicative of land-use intensification (Thoms 2005a). It’s been stated that intensive strategies were not adopted Central Texas, such as agriculture, due to the rich resource base (Collins 2004). However, the presence of geophytes, which require intensive processing may indicate that hunter-gatherers are adopting a different form of intensive strategy.

RESEARCH QUESTIONS RELATED TO CURRENT STUDY

Based on the previous work conducted in Central Texas and foraging theories related to hunter-gatherer practices, the following research questions are presented for this study:

1. Is geophyte use and processing facilities intensified through time as Thoms (2005a) suggests? For this thesis, intensification means an increase of use. Several factors, such as climate change, population increase, mobility and technology, determine intensification of a particular resource. As subsistence strategies are designed to account for these factors, the search and handling cost of available resources are varied.
2. Are certain facilities an optimal choice for specific geophyte utilization in Central Texas and Lower Pecos? The processing facilities require a coordinated effort by hunter-gatherers for obtaining materials and construction. Hunter-gatherers must allocate their time searching not only for geophytes but for the construction materials of processing facilities. Labor is allocated between certain members of the group for search time of materials and construction. The feature capacity determines how much can be processed and the amount of food is either needed for immediate consumption, storage, or feasting.

This study will aim to answer these questions based on the data collected from the sites that contain evidence of geophytes. Overall, this study will add to the current knowledge of geophytes in the subsistence practices of hunter-gatherers in Texas. The following chapters will examine geophyte resources in depth and the cooking facilities used to process them.

CHAPTER IV

GEOPHYTES AND PROCESSING FACILITIES

Although the prehistoric distribution of geophytes cannot be determined, an overview of a representative modern sample that occur in Central Texas and the Lower Pecos regions provide a general idea to the types of available geophyte resources for prehistoric people in Texas. This chapter will provide the definition of geophytes in depth, identify a sample of geophytes in Central Texas and the Trans Pecos Regions, determine their modern distributions and growing seasons. The chapter will also review the processing facilities related to geophyte utilization. The list of geophytes presented in this chapter in no way represents all the geophytes in the regions, however, it presents the types of geophytes that are the same species or similar to specimens found in archaeological contexts and likely to be found at archaeological sites (Dering 2003b). The listed species of geophytes were used by Native American (Moerman 1998). In addition, the importance of the chemical composition of geophytes, specifically that of inulin and inulin-type will be examined and present how it relates to the processing of geophytes for consumption.

DEFINITION OF GEOPHYTES

Geophytes are herbaceous plants that contain underground storage organs (De Hertogh and Le Nard 1993; Dering 2003b). These underground storage organs contain nutrients, carbohydrates, and water. The underground storage organs consist of bulbs, corms, tubers, tuberous roots, rhizomes, and enlarged hypoctyls. The primary storage tissue and the plant part from which the organ originated from define the different types of storage organs. De Hertogh and Le Nard (1993) define the different classes as:

> Bulb - Bulbs consist of a compressed stem or basal plane with modified leaves or leaf bases known as scales. The leaves or scales are the primary storage tissue. They are tunicated (dried out papery outermost scale), or non-tunicated. The enlarged fleshy tissues store food and water.

> Corm - Modified or enlarged stem or basal plate with distinct nodes, or swellings, and internodes. The stem tissue, specifically the basal plate, serves as the primary storage organ. It may also be tunicated or non-tunicated.

> Tuber - Thickended underground stem. The stem serves as the primary storage organ. Above ground stems sprout from one or more apical buds, or shoot meristems known as “eyes”.

> Rhizome - Modified specialized horizontal stem. The stem tissue serves as the primary storage organ.

Tuberous root – Enlarged fleshy root tissue. Root tissue serves as the primary storage tissue.

Enlarged hypocotyls – Portion of stem below cotyledon and above the roots. The roots enlarge in some plants as they develop and become fleshy storage organs.

Seasonal growth and development allow geophytes to overwinter and survive long periods of drought or prolonged periods of shade in arboreal environments (De Hertogh and Le Nard 1993; Dering 2003a; Pate and Dixon 1982). The above ground portion of the geophyte may die during extreme environmental conditions such as fires or droughts and then re-grow with favorable climate and temperatures. The above ground portion of the plant flowers or grows during spring or summer and rests during summer or winter. However, the underground organ never truly rests and continues to develop and change as physiological and biochemical changes occur internally. Temperature is the primary factor affecting bulb growth, especially its physiological state at harvest, and moisture a secondary factor. For example, geophytes produced under different environmental conditions and appear to be externally mature may not be physiologically the same even if they were harvested at the same calendar date every year. In addition, geophytes that appear to externally mature, but grown in different areas may be physiologically different (De Hertogh and Le Nard 1993).

However, natural disturbances are known to increase the productivity and size of some geophytes (Anderson 1997). Lightning fires help recycle nutrients and increase the size of tuber or geophyte. Animal disturbances of geophytes aid in increasing production by growing new offsets or bulbs from the damaged portion (Thoms 1989). Harvest and tillage also benefit productivity as digging aerates the soil and prepares it for seed germination (Anderson 1997; Thoms 1989). Based on ethnographic data, geophytes that are harvested for consumption are usually harvested before the maximum amount of energy from the plant is directed towards reproduction, or just after flowering (Wandsnider 1997). Thoms (1989) summarized in detail the annual yields and harvest rates of camas (*Camassia quamash*) grounds for Native American groups in the Pacific Northwest. The camas was harvested just after flowering and groups were able to determine the size of the bulb based on the size of the observable portion of the plant to selectively harvest it (Thoms 1989).

MODERN DISTRIBUTION AND ETHNOGRAPHIC USES

The general distribution of plants in Texas is provided on an on-line data base as *A Checklist of the Vascular Plants of Texas* (Herbarium 2002). The checklist was compiled to provide researchers, naturalists, and the lay people with a general regional distribution of plant species in Texas as well as their common names, origin, their growing season, and phenelogy. The data were generated from numerous checklists and contributions by ecologists and botanists working and documenting plants in Texas. The on-line checklist is not complete and is continuously being updated and expanded.

The ecological regions of these Texas have been defined in the Terrestrial Ecoregions of North America (Ricketts 1999) and the Ecoregions of Texas (Griffith, et al. 2004). These resources were produced for conservation efforts (Ricketts 1999) and regional environmental management (Griffith, et al. 2004). The ecological regions under each resource are similar in range and size, but some have slightly different designations or names. For example, the Cross Timbers region defined in Griffith et al. (2004) is designated as Central Forest/Grassland Transition in Ricketts (1999). The on-line database used for the distribution of geophytes described the ecological regions as vegetation areas (Herbarium 2002). For purposes of this research, the vegetation areas will be used to discuss distribution of geophytes within the Central Texas and Lower Pecos regions. Table 1 represents the vegetation areas used on the on-line database correlating with the ecological regions outlined by Ricketts (1999) and Griffith et al. (2004).

Table 1. Ecological regions correlating with vegetation areas of on-line database.

Ricketts (1999) Ecological Regions	**Griffith, et al. (2004) Ecological Regions**	**Herbarium (2002) Database Vegetation Areas**
#81: Chihuahuan Desert	#24: Chihuahuan Desert	#10: Trans-Pecos
#63: Western Short Grasslands	#25: High Plains	#9: High Plains
#64: Central and Southern Mixed Grasslands	#26: Southwestern Tablelands #27: Central Great Plains	#8: Rolling Plains
#65: Central Forest/Grassland Transition	#29: Cross Timbers	#5: Cross Timbers and Prairies
#66: Edwards Plateau Savannas	#30: Edwards Plateau	#7: Edwards Plateau
#67: Texas Blackland Prairie	#32: Texas Blackland Prairies	#4: Blackland Prairies
#21: East Texas Central Forests	#33: East Central Texas Plains	#3: Post Oak Savannah

The list in Table 2 represents a small sample of geophytes recorded by researchers in the vegetation areas of Central Texas and Lower Pecos regions. The vegetation areas within Central Texas and Lower Pecos regions are Trans-Pecos, Rolling Plains, Edwards Plateau, Cross-Timbers and Prairies, Blackland Prairies, and portions of the Post Oak Savannah. The table was generated with the aid of the on-line database and other

Table 2. Modern distribution of a Sample of Geophytes in Central Texas and Lower Pecos Regions.

Family/Species	Vegetation Region	Growing Season/Habitat	Documented Native American use per Moerman (1998)	Evidence in archeological contexts in CT/LP
Liliaceae Family				
Wild onion, wild garlic (*Allium* sp.)	Across Texas	Variable	yes	yes-Trans Pecos area
Wild onion, *(Allium canadense)*	Edwards Plateau, Blackland Prairie, Cross Timbers, Post Oak Savanna	March-May/ meadows, woods, and fields	yes	
Allium canadense var. *mobilense*	Edwards Plateau, Blackland Prairie, Post Oak Savanna	April-May/ woods, prairies, sandy or rocky soils, rarely in limestone or in clay	yes	no
Garden onion *(Allium cepa)* *Old World plant	Edwards Plateau, Blackland Prairie, Cross Timbers, Rolling Plains, Post Oak Savanna, Trans Pecos	May-June	yes	no
Nodding onion *(Allium cernuum)*	Edwards Plateau, Trans Pecos	July-August/ Rocky soil, open woods, slopes	yes	no
Drummond's *(Allium drummondii)*	Edwards Plateau, Trans Pecos	March-May/ plains, hills, prairies, limestone soils	yes	no
Geyer onion*(Allium geyeri)*	Trans Pecos	July/ most open slopes, meadows, or stream banks in Guadalupe Mts.	yes	no
Allium macropetalum	Edwards Plateau, Trans Pecos	March-May/ desert plains, hills	yes	no

Table 2. Modern distribution of a Sample of Geophytes in Central Texas and Lower Pecos Regions continued.

Family/Species	Vegetation Region	Growing Season/Habitat	Documented Native American use per Moerman (1998)	Evidence in archeological contexts in CT/LP
Eastern camas, wild hyacinth *(Camassia scilloides)*	Edwards Plateau, Blackland Prairie, Cross Timbers, Post Oak Savanna	March-May/ sandy rocky soils, in fields, meadows, prairies, open woodlands	yes	yes
Dog-tooth violet *(Erythronium mesochoreum)*	Edwards Plataue, Blackland Prairie, Cross Timbers	March-April/ prairies, pastures, and dry open woods	yes	yes
False garlic, crow poison *(Northoscordum bivalve)*	Edwards Plateau, Blackland Prairie, Cross Timbers, Rolling Plains, Post Oak Savanna, Trans Pecos	March-May, Sept.-Oct./ grasslands, prairies, disturbed soil, low sandy woods, rocky open or wooded slopes	no	yes
Amaryllidaceae Family				
Rain lily, cebolleta *(Cooperia drummondii)*	Edwards Plateau, Blackland Prairie	Feb.-April/ sandy soil in rich woods, thickets and clearings	no	no
Fabaceae Family				
Prairie turnip, prairie peanut, snakeroot, scurfpea *(Pediomelum* sp.)	Across Texas	Cool-season	yes	yes, outside study area
Indian turnip, tallbread scurfpea *(Pediomelum cuspidatum)*	Edwards Plateau, Blackland Prairie, Cross Timbers, Rolling Plains	April-May/ clayey rocky or sandy prairies	yes	no

Table 2. Modern distribution of a Sample of Geophytes in Central Texas and Lower Pecos Regions continued.

Family/Species	Vegetation Region	Growing Season/Habitat	Documented Native American use per Moerman (1998)	Evidence in archeological contexts in CT/LP
Pediomelum hypogaeum var. *hypogaea*	Rolling Plains	May-June/ sandy, rocky areas, roadside, prairies, woods	yes	no
Iridaceae Family				
Prairie celestial, celestial lily *(Nemastylis geminiflora)*	Edwards Plateau, Blackland Prairie, Cross Timbers, Rolling Plains, Post Oak Savanna	March-May/ clayey soils and limestone areas	no	no
Portulacaceae Family				
Spring beauty *(Claytonia virginica)*	Edwards Plateau, Blackland Prairie, Cross Timbers, Rolling Plains, Post Oak Savanna	May-Sept./widely distributed	yes	no
Asteraceae Family				
Dotted gayfeather *(Liatris punctata)*	Trans Pecos, Rolling Plains	Late summer/ rare on calcareous uplands	yes	no
Typhaceae Family				
Narrowleaf cattail *(Typha angustiflora)*	Edwards Plateau	April-May/ coastal and inland marshes	yes	no
Tule, narrowleaf cattail *(Typha domingensis)*	Edwards Plateau, Trans Pecos	April-May/ brackish or fresh marshes, pools	yes	no
Common cattail, tule espadilla *(Typha latifolia)*	Edwards Plateau, Trans Pecos	March-May/ marshes or shallow water	yes	no

Table 2. Modern distribution of a Sample of Geophytes in Central Texas and Lower Pecos Regions continued.

Family/Species	Vegetation Region	Growing Season/Habitat	Documented Native American use per Moerman (1998)	Evidence in archeological contexts in CT/LP
Nymphaeaceae Family				
Yellow lotus, water-chinauapin *(Nelumbo lutea)*	Edwards Plateau, Blackland Prairie, Cross Timbers	May-July/ ponds and sluggish streams	yes	no
Agavaceae Family				
Yucca sp.				
Texas yucca, twist-leaf yucca *(Yucca rupicola)*	Edwards Plateau, Blackland Prairie, Cross Timbers	April-June/ limestone ledges, grass covered plains of dense brush and open woodlands	no	yes

publications (Correll and Johnston 1979; Diggs, et al. 1999; Hatch and Pluhar 1993; Lehman, et al. 2005).

The geophytes are listed under their particular family, species name, common name, vegetation region, growing season and habitat. The list includes species that are known to be edible, or possibly edible (Couplan 1998; Dering 2003b; Peterson 1977; Thoms and Mandel 2006). The densities of each type of geophyte at any given habitat or location is variable. Thoms (Thoms and Mandel 2006) observed over 100 plants of *Allium* spp. and false-garlic (*Northoscordum bivalve)* per square meters across a widespread area near the Richard Beene site in Bexar County. Although it is a modern observation, it can indicate the high densities of such resources in an area in prehistoric times given favorable environmental conditions.

In addition, the table marks those species that have been documented to have been used by Native Americans in North America per Moerman (1998) and those that have been found in archaeological contexts in Central Texas and Lower Pecos (Boyd, et al. 2004; Dering 2003b). Of the species presented in the table, sixteen are used by Native Americans in North America (Moerman 1998). Moerman (1998) compiled a comprehensive listing of plants utilized by Native Americans from various ethnographies, research studies, and observations. Table 3 indicates the uses of the various geophytes listed under Moerman’s (1998) compilation. Although there are several ethnographic sources on the uses of specific geophytes for a particular group, Moerman’s (1998) study is the most comprehensive for the general discussion of the various uses of geophytes.

Table 3. A Sample of Geophytes used by Native Americans (Moerman 1998).

Geophyte	Native American group	Food	Drug	Other
Wild onion, *(Allium canadense)*	Cherokee, Iroquois, Meskwaki, Potawatomi	raw, boiled, cooked, dried, season soups	diuretic, respiratory aid, stimulant, dermatological	
Allium canadense var. *mobilense*	Dakota, Omaha, Pawnee, Ponca, Winnebago	raw, flavor soups		
Garden onion *(Allium cepa)* *Old World plant, introduced post-contact	Havasupai, Navajo, Seminole	raw, singed, dried, stored, roasted, spice other foods	cold remedy, disinfectant, ear ache, febrifuge	dye
Nodding onion *(Allium cernuum)*	Apache, Blackfoot, Cherokee, Cree, Flathead, Navajo	raw, flavor soups and other foods, roasted, dried, singed, stored, baked or cooked in pits	cold remedy, dermatological, febrifuge, gastrointestinal, kidney aid, pulmunary aid	incecticide
Drummond's *(Allium drummondii)*	Cheyenne, Lakota, Navajo	boiled with meat		
Geyer onion*(Allium geyeri)*	Apache, Hopi, Okanagan-Colville	raw, flavor soups, dried, pit cooked		
Allium macropetalum	Navajo	raw, spice other foods, rubbed in hot ashes, dried, stored, singed		
Eastern camas, wild hyacinth *(Camassia scilloides)*	Blackfoot, Coeur d'Alene, Comanche, Thompson	raw, baked or roasted in pits with stones, boiled, stored	unknown medicinal use	
Dog-tooth violet *(Erythronium mesochoreum)*	Winnebago	raw		
Prairie turnip, prairie peanut, snakeroot, scurfpea *(Pediomelum* sp.)	Blackfoot, Cheyenne, Dakota, Lakota, Pawnee	raw, spice, dried, season soups	Various	

Table 3. A Sample of Geophytes used by Native Americans (Moerman 1998) continued.

Geophyte	Native American group	Food	Drug	Other
Indian turnip, tallbread scurfpea *(Pediomelum cuspidatum)*	Lakota		unknown medicinal use	
Pediomelum hypogaeum var. *hypogaea*	Cheyenne, Comanche	raw, dried and saved for winter food, spice		
Spring beauty *(Claytonia virginica)*	Iroquois, Algonquin	raw, spice other foods, steam cooked in pits	anticonvulsive, contraceptive, pediatric	
Dotted gayfeather *(Liatris punctata)*	Blackfood, Lakota, Comanche	baked over fire, pulverized, raw	dermatological, gastrointestinal, veterinary, urinary aid	
Narrowleaf cattail *(Typha angustifolia)*	Hopi, Pima, Malecite, Micmac	pollen used	kidney aid, urinary aid	ceremonial item-spiritual rituals, decorative body and face paint
Tule, narrowleaf cattail *(Typha domingensis)*	Havasupai, Kawaiisu, Paiute, Pima	raw, roots dried and ground into flour for mush, other plant parts used		face paint, fiber
Common cattail, tule espadilla *(Typha latifolia)*	Apache, Cheyenne, Cree, Paiute, Pomo, Sioux	boiled, cooked with other foods, roasted, dried and ground for mush and cakes, baked, other parts used	dermatological, gastrointestinal, burn dressing, pediatric aid, veterinary aid	ceremonial item-spiritual rituals, fiber
Yellow lotus, water-chinauapin *(Nelumbo lutea)*	Comanche, Dakota, Huron, Omaha, Pawnee, Potawatomi	boiled, flavor soup, dried, roasted, and cooked with other foods		ceremonial item-mystic powers

Almost all geophytes were used for food and some were used as medicinal drugs. Several species were used for dermatological purposes, respiratory, cold remedies, and even for burn dressings. A few species were used as dye (*A. cepa*), incecticide (*A. cernuum*), face paint and as fiber (*T. domengensis*). Some species were even used as ceremonial items in spiritual rituals or thought to have mystic powers (Moerman 1998). When roots were utilized as foods, almost all were processed or cooked by boiling, baking, and steaming. The Native American groups listed on the table represent a sample of those documented in Moerman's (1998) study.

In Texas, ethnographic evidence of geophyte processing is limited, and evidence of geophyte or root utilization is provided by the 16th century chronicles of Cabeza de Vaca of Native Americans along the Gulf Coast. He documents that people were dependent on roots that were "like nuts, some larger or smaller" during extreme periods of food stress or winter (Krieger 2002). He noted that " their food supply consisted principally roots of two or three kinds" that "take two days to roast…and on top of this it is with great labor that they are dug out" (Krieger 2002: 194). In North America, ethnographic accounts, primarily from Thoms (1989) work in the Pacific Northwest, provide the harvest rates, annual yields, and processing costs of geophytes, specifically that of *Camassia quamash*. His research on ethnographic and enthnohistoric data indicates that some groups intensively managed camas grounds in variable degrees. Groups practiced "incidental domestication" adopting practices such as burning camas grounds, selective harvest, and weeding to enhance productivity (Thoms 1989).

In California, Anderson (1997) investigated the regional patterns of geophyte use of California Indian tribes and the horticultural practices that contributed to ecological effects at the species, population, community and landscape level. The study indicates the deliberate management of geophyte resources increases the quantity and quality of certain plants. The California Indian groups mimicked the natural disturbances of geophyte resources that improve its production, such as lightning fires and animal disturbances, through horticultural activities, such as burning and tillage (Anderson 1997).

INULIN AND INULIN TYPE FRUCTANS IN GEOPHYTES

The processing of geophytes by cooking is necessary to make them more digestible for consumption, reduce their toxicity and acidic flavor (Thoms 1989; Wandsnider 1997). The carbohydrates in geophyte resources vary in types and quantities. Geophytes such as eastern camas (*Camassia scilloides*) and wild onion (*Allium* spp.), consist of non-reducing sugars, like inulin or non-inulin fructans, that require intensive cooking to hydrolyze geophytes and break down complex carbohydrates into simple sugars (Thoms 1989, 2005a; Wandsnider 1997). Hydrolysis is the process of breaking down complex molecules to smaller ones through the uptake of water molecules (Thoms 1989; Wandsnider 1997). Fructans, carbohydrates that consist of fructose, naturally occur in plants as reserve carbohydrates and may protect plants against cold-induced desiccation (Roberfroid 2005:43). Inulin, a nondigestible oligosaccharide, is type of fructan that occurs in different plant species and in diverse types. Inulin functions as long term reserve carbohydrates and possibly for cryoprotection and osmotic regulation in plants, which allows plants to survive during harsh environmental conditions such as droughts or low temperatures (Roberforid 2005: 46). However, inulin functioning as cryoprotection and osmotic regulation is still under debate (Roberfroid 2005).

Inulin and inulin-type fructans provide various nutritional benefits including improving gastrointestinal functions (Roberfroid 2005). The digestive functions of the gastrointestinal system make sure foods are completely or partially hydrolyzed. The digestive organs perform various functions of decomposition including mixing, solubilization, digestion and fermentation, absorption, and excretion. Lipids, proteins, and some carbohydrates are broken down into smaller units for the absorption of minerals, nutrients, and water into the body. However, carbohydrates that contain complex sugars are resistant to digestion and absorption (Roberfroid 2005).

Inulin rich foods increase bulk and water content in fecal biomass, thus increasing fiber content and improve gastrointestinal functions. Inulin is characteristic of dietary fiber as it resists digestion and absorption in the gastrointestinal system. However, too much may work as a laxative and cause intestinal discomfort (Roberfroid 2005). As documented by Cabeza de Vaca in his chronicles, the roots eaten by the Indians, “are very bad and swell the men that eat them” (Krieger 2005: 194). Based on Moerman’s (1998) data, some geophytes listed have been used as diuretics. In addition, these types of fructans affect the transit time of other nutrients by influencing the absorptive functions of the small intestine. This may interfere with the digestion of protein and fats and induce a reduction in body fat deposition (Roberfroid 2005: 142).

Carbohydrates, proteins, and fats are hydrolyzed in the gastrointestinal tract at low temperatures by digestive enzymes of the body (Wandsnider 1997). However, as inulin is resistant to digestion, the more fructose units inulin has the less digestible it is

(Roberfroid 2005). The net energy of a fructose unit in an inulin or inulin-type fructan in its raw or fresh state is 1.5 kcal/g (Roberfroid 2005). Cooking or thermal processing of inulin rich foods physically and chemically alters the food source to enhance digestibility, reduce water content, and increase nutrient density (Konlande and Robson 1972; Wandsnider 1997). Almost 100 percent of the nutritional value of inulin and inulin-type rich foods is obtained when they are thermally processed (Konlande and Robson 1972; Wandsnider 1997). Experiments performed specifically on *Camassia quamash* indicate that inulin is completely converted into a simple sugar, fructose, when cooked (Konlande and Robson 1972). It also detoxifies the food source as well as enhances its flavor, as fructose is sweeter than glucose or sucrose (Wandsnider 1997). Cooking or thermal processing initiates hydrolysis from the water contained in the food itself or the addition of water while cooking (Thoms 1989). This releases the digestible fructose units increasing its nutritional food value thus increasing the energy density of tissues.

IDENTIFICATION OF GEOPHYTES IN ARCHAEOLOGICAL CONTEXTS

The identification of geophyte resources in archaeological contexts was not common until after the 1990s when the analysis of flotation samples was emphasized and investigations at the Wilson-Leonard site in Williamson County recovered several complete bulbs and bulb fragments from burned rock features (Dering 1998, 2003b). The specimens recovered from the Wilson-Leonard site was the first instance in Texas where geophytes were identified in archaeological contexts other than from coprolite evidence (Dering 2003b). Coprolites reflect the food ingested by a group or population, and coprolites analyzed from several dry rock shelters in the Lower Pecos region contained high frequencies of onion bulbs (Sobolik 1991). The samples from Baker Cave were not charred and nearly complete indicating they were eaten raw (Sobolik 1991).

The identification of geophytes is challenging because the characteristics of roots and bulbs are not related to the classification scheme of the plant, therefore it is difficult to recognize external diagnostic features at low magnification (Dering 1998). Geophytes may have been overlooked as macrobotanical analysis used a lower magnification than is required to identify geophytes (Dering 2003b). Although geophytes are very diverse physiologically and morphologically, the gross morphology of various types of storage organs looks very similar. Its difficult to distinguish species in their fresh state, and identification is even more difficult when geophytes have been processed or charred (Dering 2003b). The overall shape of the geophyte will change under the heat and pressure of processing and geophytes will become amorphous and friable when carbonized due to their high water content (Dering 1998, 2004; King 1994).

Dering (2003b) stressed the need to establish a reference collection for the identification of geophytes in archeological contexts with an emphasis on regional collections specific to a study area. Dering (2003b:61) established a step-by-step procedure for identifying and examining geophytes beginning with gross morphology and ending with microscopic analysis of specimens. With this improved procedure combined with increased floatation collection and analysis efforts, more geophytes have been identified at sites in Central Texas (Dering 2003b). As the current study will show, most of the geophytes identified in cultural contexts are recovered from burned rock features.

It is evident that thermal processing geophytes was necessary in prehistoric times as evidence of geophytes is found primarily in cooking features of archaeological sites

(Chapter 6). Their distribution, seasonal availability, and chemical composition are factors that play an important role in the utilization of geophytes as food. To fully understand the relationship between geophytes and prehistoric people in Texas, the cooking facilities or features in which they are found must be examined. Since determining the distribution of geophytes in prehistoric times cannot be estimated at this time, the location of sites within the Central Texas and Lower Pecos regions that contain geophytes will be examined.

ETHNOGRAPHIC BASIS OF BURNED ROCK FEATURES AND GEOPHYTES

Wandsnider (1997) performed a survey of traditional populations that utilized heat treatment, particularly pit-hearth cooking, to alter chemical compositions of the food they consumed. Her study determined that many indigenous groups from around the world relied heavily on pit-hearth cooking for processing foods rich in complex carbohydrates and high lipids (Wandsnider 1997). Out of the 110 ethnographic accounts researched, 72 groups used oven or pit baking for foods high in inulin. Oven or pit-hearth cooking is essential for processing foods high in non-reducing sugars, such as inulin and inulin-like fructans, in large quantities for storage or immediate consumption (Wandsnider 1997).

Since thermal processing of inulin rich food is necessary for inulin hydrolysis to occur, the length of time required for hydrolysis depends on the number of fructan units in the resource and also its tissue structure (Wandsnider 1997). Oven or pit-heart processing can maintain high temperatures for extended periods, especially when utilizing rocks as heating elements. Of the 72 groups that used pit-processing for inulin rich foods, 61 utilized rocks as heating elements. Wandsnider's (1997) study, as well as Thoms (1989) extensive ethnographic and archaeological research in the Pacific Northwest, highlights the importance of utilizing cooking facilities such as earth ovens with rocks as heating elements for processing inulin rich foods such as geophytes.

COOKING SYSTEMS

A variety of cooking techniques used for processing plant and animal foods have been discussed and presented in various studies and most are documented from ethnographic studies and analysis (Driver and Massey 1957; Ellis 1997; Thoms 2003, 2006a, 2006b; Wandsnider 1997). Ellis (1997: Table 3, 55) described 15 different cooking techniques and the processes used. The techniques range from broiling, baking, roasting, grilling, and boiling. Facilities are not unique to each cooking method and are highly variable.

Several factors, such as food type, cooking materials and labor investment, influence cooking systems and techniques. The utilization of various food resources by foragers and processed in cooking facilities is dependent on its abundance, availability, accessibility, and distribution (Thoms 2006b; Wandsnider 1997). As Wandsnider's (1997) study revealed, the chemical composition of the food source is also a factor in food procurement, as it determines the amount investment required to process it. The composition and chemistry of various foods require different cooking times and techniques to improve digestibility, reduce toxicity, and dehydrate food source for storage (Thoms 1989; Wandsnider 1997: 4). Although many foods do not require long cooking times to make them digestible, as stated earlier, ethnographic and archaeological evidence indicate that certain foods such as inulin and fructan-rich foods are processed for long periods of time (Thoms 2006a, 2006b; Wandsnider 1997). As discussed in the previous chapter, there is a 100 percent increase in the energy obtained of fructan bearing foods once they have been thermally processed. Pit or oven cooking is essential for processing moderate to large quantities of fructan-bearing foods. Whether processing large quantities is for storage or for immediate consumption for numerous people, the relationship of oven cooking with plant foods requires a significant amount of investment. It involves not only procuring and harvesting the food source but obtaining the materials needed to process the food (Thoms 1989, 2003, 2006b; Wandsnider 1997).

Cooking materials used in ovens and other facilities include fuel, water, and rocks. Fuel for cooking facilities used to produce coals, or ashes and to heat rocks is not always readily available and sometimes scarce, such as in desert environments. Using hot rocks, or what Thoms (2003, 2006b) terms as cook stone, retains heat at higher temperatures than hot coals and for longer periods of time. Fast-burning fuel used to heat stones usually looses heat quickly. Because stones retain heat for long periods, it is effective to use them for foods that require long cooking times for digestibility, in baking or roasting cooking facilities. In addition, hot rocks are effective in steam cooking or moist baking. Adding water to the cooking process aids in the hydrolysis of the food source. The cook stones also have the potential to be used for water boiling foods in pits or containers. Various cooking facilities that require hot rocks allows for utilizing foods that require longer cooking periods that may have been normally ignored (Thoms 2006a, 2006b).

The cooking facilities constructed to perform various techniques are highly variable and different types of facilities have been described for different areas (Ellis 1997; Thoms 2006a, 2006b; Wandsnider 1997). Cooking facilities, documented ethnographically, range from open hearths, closed oven pits, steam oven pits, and stone boiling in containers and pits. The “types” of facilities described in ethnographies and ethnohistories are universal with slight modifications. Baking occurs in pit ovens or closed surface ovens. Roasting can occur in hot ashes, coals or rocks on the surface or in shallow pits. Boiling foods can be processed by hot stones that are heated elsewhere and then added to containers or pits. Specific resources may dictate the type of facility that is used. In addition, a variety of cooking techniques are used simultaneously (Thoms 2003; 2006b).

The amount of labor invested in the construction of various cooking facilities depends on the amount of food to be cooked, the type of food, and cooking technique. For example, small amounts of meat and certain plant foods can be cooked in open coal hearths or on hot rocks (Thoms 2006b). However, as discussed earlier, carbohydrates such as inulin and fructan-rich plants require longer cooking times at higher temperatures. Therefore, the cooking technology constructed to perform baking and roasting activities are more labor intensive than direct fire cooking (Thoms 2003, 2006b). Constructing oven facilities with hot rocks for baking requires a pit or basin to be dug, a fire built beneath or atop rocks, food placed within pit and then covered with earth and rocks. In addition to excavating a pit for the oven, other pits and holes are dug to obtain soil for the oven earthen cap; this prevents heat from escaping (Leach, et al. 2005; Leach and Bousman 2001). Due to the intensive labor invested in constructing oven facilities, it is more efficient to process larger quantities of food at one time (Wandsnider 1997). Based on archaeological and ethnographic records, most oven facilities are large enough to process medium to large quantities of plant foods (Thoms 2006a, 2006b; Wandsnider 1997). In addition, some groups further process cooked geophytes into cakes or loaves. As in the case of camas in the Pacific Northwest where groups prepared cooked bulbs by pulverizing them and baking them a second time as cakes, which Thoms (1989) termed as "twice-cooked camas."

COOKING PROCESSES

To be able to identify cooking facilities requires basic knowledge of cooking processes. The morphology, construction technique, size, and rock type of cooking facilities is highly variable based on the ethnographic reports and studies (Ellis 1997; Thoms 2006b; Wandsnider 1997). Although Ellis (1997) described 15 different kinds of cooking techniques, methods utilized in the western parts of North America were commonly roasting, baking, and boiling using stones as heating elements (Thoms 2006b). Although these facilities do not require the use of hot stones as heating elements, they are often related to the burned rock features observed in the archaeological record. In addition, inulin and non-inulin fructan plants are more commonly associated with pit cooking features utilizing rocks as heating elements. The following will briefly describe the basic construction of these features and their presumed manifestations in the archaeological record.

Roasting technology requires hot coals, ashes or hot rocks to cook foods on all sides. Food is arranged within the hot coals or rocks. It involves direct contact with heating elements in a closed oxygen depraved environment. Heating elements are usually on a flat surface and do not require secondary facilities. Ellis (1997) states that the archaeological signature for this facility is represented as a rockless pit or basin with oxidized sediments and charcoal, or a bed of burned rock slabs or layers.

Ellis (1997) defined three baking techniques as baking, steam baking, and baking in clay. Like roasting, baking occurs in an enclosed environment, however baking requires a formal preparation of a facility such as a pit or basin. Some baking facilities constructed on flat surface contain a soil and/or vegetal material cap creating a mound. In addition, food is likely wrapped or packaged in vegetal material to insulate it from the surrounding heating elements. Rocks are sometimes heated in a nearby surface fire or hearth, and then transferred to a shallow basin with packaged food added and covered (Thoms 2006a: 8). For foods that require longer cooking periods, pits or basins are constructed. Although baking pits (a.k.a. earth ovens) do not necessarily need rocks, these types of facilities with rocks are able to retain the heat for a longer period. Documented ethnographic evidence also shows an additional fire built on top of the oven. The procedures for constructing a baking pit is variable, such as rocks then fire or fire then rocks, based on the ethnographic record (Ellis 1997).

Steam baking or moist baking occurs when water is added into the baking facility. Water is added through an opening at the top of the covered oven or along its edges. Although some steaming may occur with the water content of the food itself and the packing material, additional water facilitates hydrolysis and it also prevents food from burning (Thoms 1989: 159; 2006a:8). Archaeological evidence for steam baking facilities in the archaeological record includes burned rock bed or layers on a surface or in a pit with an adjacent burned rock scatter (Ellis 1997).

Water boiling in non-ceramic containers such as gourds, baskets, or hides, and even pits lined with hides is accomplished with heated stones (Thoms 2006b). Stones are heated in a hearth then transferred to the non-ceramic containers or pits. Stone boiling is effective for rendering fat or bone grease, and even necessary for pemmican processing (Thoms 2006b:8). With the introduction of ceramics, boiling foods can occur with direct-container boiling. Ceramic containers may have reduced the need for ovens and hearths in some areas in Texas in the Late Prehistoric period (Thoms 2006b: 9). The evidence of stone boiling in the archaeological record is difficult to determine and are usually associated with small piles of burned rock. Intensive analysis of the burned stones observed in archaeological contexts is necessary to determine which stones were used for stone boiling activities and which were used for other facilities (Ellis 1997: 63). Palaeomagnetic studies of burned rocks reveal if stones in archaeological features are in situ, moved, or discarded (Gose 2000). In addition, the cooling history of boiled stones can be reconstructed (Gose 2000).

Burned rock features, or cook stone features (Thoms 2003, 2006a, 2006b), are the most prominent archaeological signature of cooking facilities. However, the presence of burned or fire-cracked rocks does not necessarily mean they were utilized for cooking (Ellis 1997: 77). They may be evidence used in a hearth for heat or sweat bathing (Thoms 2003, 2006a). Burned rock features can occur as small piles of burned stones or large burned rock middens. The systematic excavation of these features can determine its function or the type of cooking facility. The matrix within and surrounding the features are examined for charcoal, oxidation, and food remains. The analysis of cooking facilities from the ethnographic record have aided in the identification of facilities in the archaeological record. In addition, experiments in cooking facilities have also helped determining the processing costs and signatures (Clabaugh 2002; Dering 1999; Leach, et al. 2005; Leach and Bousman 2001; Thoms 1989, 2006a).

CHAPTER V

RESEARCH METHODOLOGY

Archaeobotanist Phil Dering compiled a list of sites across Texas with evidence of geophytes that has been published in reports of site investigations (Dering 2003a, 2003b, 2004). I read the literature and reports from Central Texas and Lower Pecos sites in the list compiled by Dering to examine and record the contexts geophytes were encountered. Dering and archaeobotanist Leslie Bush also provided analysis reports from excavated sites that have not been published. Since most of the geophytes samples recovered from sites were from burned rock features, a system of analysis was developed to record and document geophyte contexts.

IDENTIFICATION AND ANALYSIS IN THE ARCHAEOLOGICAL RECORD

Burned rock feature types in Texas have been identified and discussed in various reports and research studies (Ellis 1997; Clabaugh 2002; Mahoney, et al. 2003). Since burned rock features in Texas range from small clusters to large midden accumulations, a system of identification and recording has been developed by various researchers to standardize methods of documenting features (Black and Ellis 1997; Clabaugh 2002; Clabaugh and Thoms 2006). In addition, other features that do not contain burned rocks, such as oxidized soil patches or charcoal concentrations, are incorporated into the system of identification of cooking facilities in the archaeological record.

Black and Ellis (1997) published methods of documenting and recording burned rock features and middens in Texas. Similarly, Clabaugh (2002) developed standards for recording the various features at the Richard Beene site and produced the Feature Evaluation and Analytical System (FEAS). Each describe methods of documenting non-metric and metric data, morphology, characteristics, sediments, and burned rock attributes, for cultural features that appear to be related to cooking activities. Developing the standards of recording and documentation of features helps in identifying the types of burned rock features represented at a particular site. The burned rock feature type usually refers to the function or cooking facility, such as oven or hearth. Determining the burned rock feature type depends on the analyzing the morphology and defining characteristics of the feature.

Based on the methods developed by Clabaugh (2002) and Black and Ellis (1997), a system of identification and analysis was formulated to examine the features from numerous sites in Texas that contain evidence of geophytes. Borrowing several elements and designations from their analysis methods, I developed a classification system. The information documented for the features, such as rock counts, weights, and various characteristics has been inconsistent due to the way the features were recorded or reported in the field. The current study aimed to account for these factors in the development of the feature classification form (Table 4). The features examined were divided into four classes.

Table 4. Feature Classification Form.

Class I-Feature with burned rock	
Site	Site Trinomial
Feature	Feature Number
Cultural Time Period	Early Archaic Middle Archaic Late Archaic Late Prehistoric
Ecological Region	Post Oak Savannah Blackland Prarie Edwards Plateau Trans-Pecos
Type	hearth scatter/cluster
Rocklined	Yes No
Profile view	flat lens-shaped basin-shaped concave pit flat based pit
Profile boundary	abrupt gradual diffused

Class II-Feature without burned rock	
Site	Site Trinomial
Feature	Feature Number
Cultural Time Period	Early Archaic Middle Archaic Late Archaic Late Prehistoric
Ecological Region	Post Oak Savannah Blackland Prarie Edwards Plateau Trans-Pecos
Type	charcoal stain burned/oxidized soil ash stain organic residue
Profile view	flat lens-shaped basin-shaped concave pit flat based pit
Profile boundary	abrupt gradual diffused
Feature shape Planview	circular oblong irregular linear amorphous

Class III-Burned Rock Midden and Ovens		
Site	Site Trinomial	
Feature	Feature Number	
Cultural Time Period	Early Archaic Middle Archaic Late Archaic Late Prehistoric	
Ecological Region	Post Oak Savannah Blackland Prarie Edwards Plateau Trans-Pecos	
Type	dome ring sheet buried	Oven (using Class I attributes)
Midden Shape	circular oblong linear irregular amorphous	
Midden Profile	lens-shaped basin-shaped concave pit	
central cooking feature	none 1 2	

Table 4. Feature Classification Form continued.

Class I-Feature with burned rock		Class II-Feature without burned rock		Class III-Burned Rock Midden and Ovens	
Feature shape Planview	circular oblong irregular linear amorphous	Planview boundary	distinct diffused unclear	Charcoal staining	none throughout rocks atop rocks below rocks around rocks within cooking feature
Planview boundary	distinct (clast or matrix defined) diffused unclear	Feature Length	Length in cm	Oxidized/burned soil	none throughout rocks atop rocks below rocks around rocks within cooking feature
Charcoal staining	none throughout rocks atop rocks below rocks around rocks	Feature Width	Width in cm	Ash	none throughout rocks atop rocks below rocks around rocks within cooking feature
Oxidized/burned soil	none throughout rocks atop rocks below rocks around rocks	Feature Depth- Thickness	Exact depth in cm	Burned rock type	limestone chert quartzite caliche sandstone mixed other
Ash	none throughout rocks atop rocks below rocks around rocks	Volume Floated	In liters	Burned Rock Condition	fragmented in situ highly fragmented intact
Burned rock type	Limestone caliche chert sandstone quartzite mixed other	Geophytes from flotation	None Number	Burned Rock shape- primary	angular rounded flat/slabs mixed

Table 4. Feature Classification Form continued.

Class I-Feature with burned rock		**Class II-Feature without burned rock**		**Class III-Burned Rock Midden and Ovens**	
Burned rock Coherence-Patterning	dispersed clumped stacked	Geophytes from charcoal samples	None Number	No. of Burned Rock	
Burned rock Density	adjoining (less than 50% touch) adjacent (more than 50% touch) overlapping (rocks touch and overlap) combination	Geophytes	List Types	Weight of Burned Rock	
Burned Rock Condition	fragmented in situ highly fragmented intact	Weight of geophytes	Total wieght of geophytes in grams	Max Burned Rock	Maximum dimension of rock in cm
Burned Rock shape-primary	angular rounded flat/slabs mixed	Fauna- found in feature	None Types	Min Burned Rock	Minimum dimension of rock in cm
No. of Burned Rock	Estimated total number of FCR	Flora-found in feature	None Types	Feature Length	Length in m
Weight of Burned Rock	Weight in kg	Projectile Points-found in feature	None Types	Feature Width	Width in m
Max Burned Rock	Maximum dimension of rock in cm	Tools-found in feature	None Types	Overall thickness- top of midden to base	
Feature Length	Length in cm	Debitage-found in feature	Yes No	Volume Floated	In liters
Feature Width	Width in cm	Other		Geophytes from flotation	None Number

Table 4. Feature Classification Form continued.

Class I-Feature with burned rock		**Class II-Feature without burned rock**		**Class III-Burned Rock Midden and Ovens**	
Feature Depth-Thickness	Exact depth in cm	Radiocarbon sample	Geophyte sample* Feature related sample Context related sample**	Geophytes from charcoal samples	None Number
Volume Floated	In liter	Radiocarbon date range		Geophytes	List Types
Geophytes from flotation	None Number			Weight of geophytes	Total wieght of geophytes in grams
Geophytes from charcoal samples	None Number			Fauna- found in feature	None Types
Geophytes	List Types			Flora-found in feature	None Types
Weight of geophytes	Total wieght of geophytes in grams			Projectile Points-found in feature	None Types
Fauna- found in feature	None Types			Tools-found in feature	None Types
Flora-found in feature	None Types			Debitage-found in feature	Yes No
Projectile Points-found in feature	None Types			Other	
Tools-found in feature	None Types			Radiocarbon sample	Geophyte sample* Feature related sample Context related sample**
Debitage-found in feature	Yes No			Radiocarbon date range	
Other					
Radiocarbon sample	Geophyte sample* Feature related sample Context related sample**				
Radiocarbon date range					

Class I consists of small features with burned rock, Class II consists of features without burned rock, Class III consists of burned rock middens and ovens, and Class IV are non-feature contexts. Table 4 lists the attributes examined and reported for each class. The variables for each class are slightly different to account for the variability of recording methods and the features from various. Class I, features with burned rock, are those features that range in size from 1 to 4 m in size. This class includes hearths and scatter/clusters. Class II, are features without burned rock, such as burned or oxidized soil stains. Class III, burned rock middens and ovens, are distinguished from Class I because of their size and function. Based on the analysis of attributes of burned rock middens across Texas, middens range in size from 5 to 40 m (Black and Creel 1997). Burned rock middens have a greater density of rocks and their accumulation occurs because of re-use of central cooking facilities such as ovens, intersecting hearths, or as secondary deposits of burned rock debris (Black 1997c). The repeated use of burned rock ovens result in burned rock middens and therefore ovens are lumped in Class III. Class IV are non-feature contexts such as stratigraphic layers, excavation levels, and trenching profiles.

The reports and excavations records from the sites were evaluated to perform the study. Individual site and feature descriptions are detailed in Appendix B. The descriptions will provide a general overview the site, feature descriptions, and types of geophytes recovered from the site. Due to the various recording and documenting methods of the sites examined, not all attributes were recorded under the classification system devised for this study. Some sites had the number of rocks recorded for the features and their weight, while others didn’t. However, relative size in meters and depth were recorded for almost all features as well as the type of sample from which the geophyte specimen was recovered from. These attributes as well as the ecological region and general radiocarbon date will be reported. The analysis will include determining the number of site features with geophytes represented in each cultural time period. The cultural time periods assigned to the site features are according to Collins' (1995, 2004) divisions for Central Texas and Turpin (2004) for Lower Pecos. In addition, not all radiocarbon dates reported for the features were corrected or calibrated. The conventional radiocarbon dates for all dated features are used and the average mean radiocarbon date is calculated for features with multiple dates. The interpretation of the results of feature types and geophytes encountered at the various sites will be presented in the next chapter.

CHAPTER VI

RESULTS AND DISCUSSION

There are 50 sites with evidence of geophytes in Texas and 45 sites in the Central Texas and Lower Pecos regions (Appendix A). Five sites are outside of the cultural study area for this thesis. Seven sites are located in the Lower Pecos and 38 are in the Central Texas region. Undoubtedly, other sites may have evidence geophytes, but due to issues of organic preservation, identification, and sampling methods, sites with documented evidence of geophytes have been limited. In addition, the process of obtaining botanical remains from flotation samples was not a frequent practice for analysis of archaeological sites prior to the nineties (Dering 1997). The list of sites was compiled from previous lists reported in cultural resource reports for Camp Bowie (Dering 2003a) and Fort Hood (Boyd, et al. 2004), as well as reports from archeobotanists Phil Dering and Leslie Bush. Of the 45 sites in Central Texas and the Lower Pecos region, only 41 have been examined for this current study. For five sites, only the site name and type of geophyte could be obtained. The reports for these sites have not been published and information was obtained from the archeobotanist.

Individual site and feature descriptions for the 40 sites are provided in Appendix B. The following results will be reported by cultural time period to determine if any patterns emerge for each period. The cultural time period designations for the sites were determined based on how it was reported and radiocarbon dates. The individual radiocarbon dates and sample numbers are provided in Appendix B.

EARLY ARCHIC

There are five sites that contain geophyte specimens that date to the Early Archaic period in Central Texas and the Lower Pecos with samples recovered from four features and three non-feature contexts (Table 5). The Armstrong Site (41CW54) is located within the Blackland Prairie ecological region, the Wilson-Leonard site (41WM235) is located in the Edwards Plateau, and Conejo Shelter (41VV162), Eagle Cave (41VV167) and Hinds Cave (41VV456) are located in the Tran-Pecos region. The features represented in this time period consist of one Class I feature and two Class III feature. The geophyte samples identified from the Trans-Pecos sites were recovered from stratigraphic layers. The geophyte samples identified during this time period include eastern camas and wild onion. Most of the samples were identified from macrobotanical samples recovered during the excavations of the site. However, those identified at Hinds Cave were identified from coprolites.

The Class I feature is one hearth feature from the Armstrong Site. The small flat hearth consisted of caliche rocks from which an eastern camas bulb was recovered. Other resources encountered in the feature consist of mussel shell and a hackberry nutlet. The three Class III features consisted of an oven and midden.

The Wilson-Leonard site contained ten eastern camas bulbs in a large oven feature measuring approximately 2.6 m in diameter. This is the first recorded account of geophytes specimens encountered within a burned rock feature in Central Texas (Dering

1998). The Wilson-Leonard feature had a distinct rock-lined basin. Other resources processed within these feature include mussel shell, small mammals, reptiles, and deer.

In addition to the large oven feature, an eastern camas sample was recovered from a small burned rock midden at the Wilson-Leonard site. The midden accumulated from the construction and use of three surrounding cooking features. The accumulation was approximately 4 m by 2 m. The geophyte sample encountered in the midden is likely the result of the use and re-use of the surrounding features. Additional resources encountered within the feature include mussel shell, turtle, snake, and deer.

The geophyte specimens recovered from the Trans-Pecos sites were primarily from stratigraphic lenses and consisted of wild onion bulbs. Most of the samples from these sites were macrofossil or macrobotanical samples collected during excavations. The analyst of most of the Trans-Pecos sites in the study did not clarify if the samples were carbonized or not (Irving 1966). However, complete bulbs were identified from coprolite specimens recovered in Hinds Cave. The samples found within the coprolites were not carbonized suggesting that they were eaten raw and whole (Williams-Dean 1978). In addition, archeobotanist Phil Dering has discovered rain lily specimens in collected macrobotanical samples from the site that have not been previously analyzed (Dering 2003d).

From the 41 sites examined for this study, only five date to the Early Archaic period and only one Class I features and two Class III features are represented. Other resources utilized or processed with the feature consist of small game animals. The non-feature contexts from the Lower Pecos sites also contained other flora such as agave, prickly pear, yucca, and sotol.

Table 5. Early Archaic sites with geophytes in feature and non-feature contexts.

Feature Class	No.	Site	Name	Feature # or Context	Ecological Region	Feature or Context Type	Feature Description	Feature size (m)	Feature thickness (m)	Geophytes	Type of recovery	Radiocarbon date range in BP
Class 1-Feature/Burned Rock	16	41CW54	Armstrong Site	2	Blackland Prairie	hearth	flat circular hearth with caliche rocks	0.6 x 0.5	0.1	*Camassia* bulb	flotation	8490±40**
Class 4-Non-Feature Context	30	41VV162	Conejo Shelter	Lenses	Trans-Pecos	Stratigraphic Layer		n/a		*Allium* sp.	charcoal	6650**
Class 4-Non-Feature Context	31	41VV167	Eagle Cave	Stratum V	Trans-Pecos	Stratigraphic Layer		n/a		*Allium drummondii*	charcoal	8343**-average
Class 4-Non-Feature Context	34	41VV456	Hinds Cave	Lens 13	Trans-Pecos	Stratigraphic Layer		n/a		*Allium drummondii*	coprolites	5710±80**, 5590±80** 5650-average
Class 3-Burned Rock Midden and Ovens	36	41WM235	Wilson-Leonard	181	Edwards Plateau	oven	circular basin-shaped limestone lined oven	2.6 x 2.6	0.5	*Camassia*	charcoal	7997±60*-average
Class 3-Burned Rock Midden and Ovens	36	41WM235	Wilson-Leonard	8	Edwards Plateau	sheet midden	midden accumulated from surrounding hearth and oven features	4 x 2	0.4	*Camassia* bulb	charcoal	8250±80*

MIDDLE ARCHAIC

Four sites in the Lower Pecos region and one on the Edwards Plateau have evidence of geophytes that date to the Middle Archaic period (Table 6). Evidence of geophytes encountered for this time period were at the Conejo Shelter, Fate Bell Shelter (41VV74), Coontail Spin (41VV82), Zopilote Shelter (41VV216), and the Holt site (41HY341). The Lower Pecos sites contained Class IV conexts and the Holt site consisted of a Class III feature. The geophytes identified in the Lower Pecos sites were wild onion. The specimen at the Holt site was an indeterminate bulb.

The specimens recovered from the Lower Pecos sites were from macrobotanical samples removed from stratigraphic layers. Other resources identified from the layers include agave, prickly pear and yucca. A variety of fauna was also identified from the Conejo Shelter that includes deer, fox, raccoon, rabbit, snake, and turtle. The specimens recovered from the Coontail Spin site were from mixed deposits that contained artifacts dating to the Middle and Late Archaic periods.

The Holt site contained and unidentified bulb specimen from a large feature measuring approximately 3.5 m in diameter. The Holt site feature contained a basin and evidence of a clean out event. The site was reported to be part of the Early Archaic period based on Tuner and Hester's (1999) chronology. However, the conventional radiocarbon date places the feature from which the unidentifiable bulb was recovered within the Middle Archaic period under Collin's (1995, 2004) chronology. Other resources processed within the feature include chenopodium and amaranth.

Table 6. Middle Archaic sites with geophytes in feature and non-feature contexts.

Feature Class	No.	Site	Name	Feature #	Ecological Region	Feature or Context Type	Feature description	Feature size (m)	Feature thickness (m)	Geophytes	Type of recovery	Radiocarbon date range in BP
Class 3-Burned Rock Midden and Ovens	20	41HY341	Holt Site	4	Edwards Plateau	oven	irregularly shaped oven with a basin of limestone rocks	3.6 x 3.5	0.42	Indeterminate bulb	charcoal	4950-average
Class 4-Non-Feature Context	29	41VV82	Coontail Spin	Area B: 3-6'	Trans-Pecos	Stratigraphic Layer				*Allium drummondii*	charcoal	Based on artifacts
Class 4-Non-Feature Context	30	41VV162	Conejo Shelter	Lenses	Trans-Pecos	Stratigraphic Layer				*Allium* sp.	charcoal	5020**,4950**, 3310** 4426-average
Class 4-Non-Feature Context	33	41VV216	Zopilote Cave	Various	Trans-Pecos	Stratigraphic Layer				*Allium drummondii*	charcoal	Based on artifacts
Class 4-Non-Feature Context	35	41VV74	Fate Bell Shelter	Various	Trans-Pecos	Stratigraphic Layer				*Allium* sp.	charcoal	3330**

The Middle Archaic period contains only five sites with evidence of geophytes. The macrobotanical specimens obtained from the stratigraphic layers of the Lower Pecos sites were wild onion bulbs. Other resources represented in this time period include mussel shell and small to large sized mammals.

LATE ARCHAIC

In the Late Archaic period, fourteen sites, twelve from the Central Texas region and two from the Lower Pecos region, contain evidence of geophytes (Table 7). Eight Class I features and nine Class III features are represented. The Jonas Terrace site (41ME29), the Woodrow Heard site (41UV88), the Wilson-Leonard site and the Firebreak Site (41CV595) are in the Edwards Plateau, Rice’s Crossing (41WM815), site 41BL1214, and site 41BL797 are in the Blackland Prairie, Paluxy sites (41CV1553 and 41CV988) and site 41BR228 are in the Rolling Plains, the McKinney Roughs site (41BP627) is in the Post Oak Savannah, and the Siren site (41WM1126) is in the Cross Timbers region. The geophyte samples identified at the Coontail Spin and Conejo Shelter were recovered from stratigraphic layers. The geophyte samples identified in the Late Archaic consist of eastern camas, wild onion, undetermined bulb species from the Lily family, a corm fragment, and unanalyzed bulbs. The specimens were identified from flotation and macrobotanical samples. Specimens were also identified from coprolite samples at Conejo Shelter.

The Class I features consist of three hearths and five scatters/clusters. The feature at site 41BL1214 consisted of a small hearth 0.50 in diameter with indeterminate bulbs. The Siren site also had a hearth feature as well as 41CV988. The features were

Table 7. Late Archaic sites with geophytes in feature and non-feature contexts.

Feature Class	No.	Site	Name	Feature #	Ecological Region	Feature or Context Type	Feature Description	Feature size (m)	Feature Thickness (m)	Geophytes	Type of recovery	Radiocarbon date range in BP
Class 1-Feature/Burned Rock	1	41BP627	Mckinney Roughs	12	Post Oak Savannah	scatter/ cluster	circular diffused scatter	0.6-x-0.6	0.2	Indeterminate bulb	flotation	2080**, 1840** 1960-average
Class 3-Burned Rock Midden and Ovens	2	41BL797		1	Blackland Prairie	tallus midden	tallus midden	12-x-4	0.5	Indeterminate bulbs	flotation	1510±50
Class 1-Feature/Burned Rock	3	41BL1214		4	Blackland Prairie	scatter/ cluster	amorphous flat scatter	0.5-x-0.5	0.16	Indeterminate bulb	flotation	1210±40**, 1760±40** 1745-average
Class 1-Feature/Burned Rock	3	41BL1214		5	Blackland Prairie	hearth	circular basin-shaped hearth	0.88-x-0.98	0.17	Indeterminate bulb fragments	flotation	1760±40, 1730±40 1745-average
Class 3-Burned Rock Midden and Ovens	7	41BR228	Camp Bowie	4	Rolling Plains	midden	disturbed oval midden	20-x-10		*Camassia* bulb	charcoal	2980±40, 1210±50 2095-average
Class 3-Burned Rock Midden and Ovens	17	41CV1553	Paluxy Site	6	Rolling Plains	oven	basin-shaped oven	0.63-x-0.62	0.19	Indeterminate bulbs	flotation	2090±50
Class 3-Burned Rock Midden and Ovens	18	41CV595	Firebreak Site	15	Edwards Plateau	oven	lens-shaped oven	2.1-x-2.06	0.29	*Camassia* sp.	flotation and charcaol	1870±40*, 1910±70 1890-average
Class 1-Feature/Burned Rock	18	41CV595	Firebreak Site	7	Rolling Plains	scatter/ cluster	cluster formed from various clean-out events from nearby features			*Allium* and *Camassia*	flotation	1890**-average
Class 1-Feature/Burned Rock	19	41CV988	Paluxy Site	2A	Rolling Plains	hearth	circular basin-shaped rocklined hearth	1.1-x-1.0	0.34	Indeterminate corm frags.	flotation	1280±40
Class 3-Burned Rock Midden and Ovens	26	41ME29	Jonas Terrace	BRM	Edwards Plateau	dome midden	large oblong dome midden	10-x-12	0.5	Liliaceae sp. bulb	flotation	2600±70, 1295±55 1947-average
Class 1-Feature/Burned Rock	26	41ME29	Jonas Terrace	Unit 23	Edwards Plateau	Scatter/ cluster	amorphous diffussed flat scatter			Liliaceae sp. bulb	flotation	2420±60**, 2400±60** 2410-average

Table 7. Late Archaic sites with geophytes in feature and non-feature contexts continued.

Feature Class	**No.**	**Site**	**Name**	**Feature #**	**Ecological Region**	**Feature or Context Type**	**Feature Description**	**Feature size (m)**	**Feature Thickness (m)**	**Geophytes**	**Type of recovery**	**Radiocarbon date range in BP**
Class 3-Burned Rock Midden and Ovens	28	41UV88	Woodrow Heard	Midden 3	Edwards Plateau	dome midden	circular midden with evidence of re-use and possible multiple cooking features	16-x-16	0.5	*Allium* sp.	charcoal	3500±60, 3320±60 3410-average
Class 4-Non-Feature Context	29	41VV82	Coontail Spin	Zone A-3	Trans-Pecos	Stratigraphic Layer				*Allium drummondii*	charcoal	2300**
Class 4-Non-Feature Context	29	41VV82	Coontail Spin	Transitional	Trans-Pecos	Stratigraphic Layer				*Allium drummondii*	charcoal	Based on artifacts
Class 4-Non-Feature Context	30	41VV162	Conejo Shelter	Lenses	Trans-Pecos	Stratigraphic Layer				*Allium* sp.	coprolites and charcoal	2690±80
Class 3-Burned Rock Midden and Ovens	36	41WM235	Wilson-Leonard	BRM2	Edwards Plateau	dome midden	circular midden, with upper layers disturbed by construction activities and looting, and evidence of central cooking features	20-x-18	1	*Camassia*	charcoal	3780±70*
Class 3-Burned Rock Midden and Ovens	37	41WM815	Rice's Crossing	9	Blackland Prairie	oven	circular basin-shaped rocklined oven	2.13-x-2.03	0.22	*Camassia* sp. bulbs	charcoal	2340-average
Class 1-Feature/Burned Rock	39	41WM1126	Siren Site	30	Cross Timbers	hearth	circular rocklined basin-shaped hearth	1.62-x-1.5	0.16	Unanalyzed bulb	charcoal	2370**
Class 1-Feature/Burned Rock	39	41WM1126	Siren Site	23	Cross Timbers	scatter/ cluster	oblong flat scatter	1.46-x-4.25	0.2	Unanalyzed bulbs	charcoal	2370**
Class 3-Burned Rock Midden and Ovens	39	41WM1126	Siren Site	35	Cross Timbers	oven	circular rocklined basin-shaped hearth	1.8-x-1.8	0.53	Unanalyzed bulb	charcoal	2370±40

approximately 1 to 1.5 m in diameter. The bulb samples from the Siren site have not been analyzed, but the 41CV988 hearth contained indeterminate corm fragments. Other resources encountered in the features along with the geophytes include mussel shell and unidentified bone fragments.

The McKinney Roughs site contained a scatter/cluster measuring 0.6 m in diameter with indeterminate bulbs as well. The Firebreak Site also contained a scatter/cluster, whose feature designation was later dropped, that contained eastern camas and wild onion bulbs. The scatter was determined to be a result of clean-out events from surrounding burned rock features. The scatter of site 41BL1214 consisted of a small cluster measuring approximately 0.5 m in diameter with indeterminate bulb specimens. The scatter from the Siren site was a large oblong scatter measuring 1.4 m by 1.25 m with bulb-like charcoal samples. They were recovered during excavation and have not yet been analyzed.

The scatter/cluster at the Jonas Terrace site was within a plaza like area of the site that was interpreted to be an place where numerous processing, cooking, and knapping activities occurred. There was a large area of scattered burned rock that was possibly a result of numerous cooking activities. The unidentified bulb specimens were recovered from a unit excavated from within the scatter.

The Class III features consist of five middens and four ovens. The Class III feature from the Wilson-Leonard site was a large dome midden measuring 20 m by 18 m and contained evidence of a central cooking features. Although the upper .60 m of the midden was impacted by construction activities, a eastern camas bulb was recovered from the lower layers. Other resources encountered in the midden include mussel shell and large mammal bones. The feature from the Woodrow Heard site was a dome midden measuring 16 m by 16 m. Although no central cooking feature was encountered, there were several cluster and concentrations of burned rock indicating multiple use. The wild onion sample from the midden was collected from its periphery. Other resources include mussel shell, bison, and deer bone. The midden from 41BR228 was severely disturbed and its morphology could not be determined. It measured 20 m by 10 m and contained a single eastern camas bulb. The dome midden at the Jonas Terrace site was 10 m by 12 m in size and contained bulb fragments of an unknown species of the Lily family. The tallus midden at 41BL797 measuring 12 m by 4 m contained unidentified bulb fragments. Other resources represented in the middens include mussel shell, faunal remains, and floral remains of primarily wood charcoal and prickly pear, and sotol.

Rice’s Crossing and the Firebreak Site contained oven features that were approximately 2 m in diameter and each contained evidence of eastern camas. Site 41CV1553 contained one small oven feature measuring approximately 0.80 m in diameter and contained an indeterminate bulb fragment. Along with the hearth and scatter, the Siren site, also contained a large oven feature measuring 1.8 m in diameter. The oven was a deep basin-shaped slab lined feature with flat limestone rocks oriented vertically towards the center at the margins.

In the Trans Pecos sites, wild onion bulbs were recovered from the stratigraphic layers within the rockshelters. Coprolite samples recovered from a lens at Conejo Shelter contained samples of wild onion bulbs. The bulbs were not carbonized which suggest they were eaten raw and whole. The floral remains encountered within the coprolites include prickly pear, sotol, yucca, and agave. The analyst observed consistent correlation of onion bulbs, yucca flowers, and cactus stems (Bryant 1974).

As stated earlier the specimens were analyzed from flotation and macrobotanical samples. To note, most of the samples from Rice's Crossing were from the perimeter of the feature. Flotation samples were recovered from the center of the feature and yielded no evidence of geophytes. The bulbs recovered from the scatter/cluster features were from flotation samples.

The Late Archaic period contained fourteen sites with evidence of geophytes with eight Class I and nine Class III features in Central Texas region and two in the Lower Pecos. The Class I features consisted of three hearths and five scatter/clusters. The Class III features consisted of five middens and four ovens. Geophytes from this period consist of eastern camas, some unidentifiable bulb species from the Liliceae family wild onion, a corm fragment, and unanalyzed bulbs. Other resources represented during this period include bison, deer, mussel shell and turtle in the Central Texas region, and deer, squirrel, snakes, agave, sotol and yucca in the Lower Pecos region.

LATE PREHISTORIC

The Late Prehistoric period contained the most sites with evidence of geophytes. There were a total of 25 sites with 22 from the Central Texas Region and three from the Lower Pecos region (Table 8). The Mustang Branch site (41HY209), Blockhouse Creek site (41WM632), Corn Creek sites I and II (41MK8 and 41MK9), and the Honey Creek site (41MS32) are all within the Edwards Plateau. The Toyah Bluff site (41TV441) and the Brushy Creek site (41WM1010) are in the Blackland Prairie. Kyle Shelter (41HI1) and Horn Shelter (41BQ47) are in the Cross Timbers region. McKinney Roughs (41BP627) is in the Post Oak Savannah, and Conejo Shelter (41VV162), Coontail Spin (41VV82) and Baker Cave (41VV213) are in the Trans-Pecos. The Paluxy site 41CV1553 and eleven sites from Camp Bowie dating to this period are in the Rolling Plains region. The geophytes represented consist of wild onion, eastern camas, dog's tooth violet, indeterminate bulbs and storage roots, and tuber fragment. The specimens were recovered from both flotation and macrobotanical samples. In this period, five Class I features and twenty-six Class III features are represented. Trans-Pecos sites' and Kyle Shelter specimens were from Class IV contexts.

The Class I features consist of one hearth and four scatter/clusters. The McKinney Roughs site and the Honey Creek site contained a scatter/cluster as well as the Mustang Branch site and site 41BR253 from the Rolling Plains. The scatters measured approximately 1 m to 50 m in diameter. The scatter from the Honey Creek site was actually a lid-removal or clean-out event associated with the oven feature that contained geophytes. The hearth feature from Paluxy site 41CV1553 was a basin-shaped hearth measuring approximately 0.8 m in diameter. The geophytes from the scatters consisted of wild onion, indeterminate bulbs and indeterminate root fragments.

The Class III features consisted of eight ovens, five dome middens, twelve ring middens, and one general midden. The Toyah Bluff site had four ovens, the Honey Creek site had two, and the Brushy Creek site and the McKinney Roughs site each had one. They ranged in size from 2.5 m in diameter to 0.75 m in diameter. The geophytes recovered from these features include wild onion, indeterminate bulbs, and an indeterminate root fragment. Other resources within these features include mussel shell at

Table 8. Late Prehistoric sites with geophytes in feature and non-feature contexts.

Feature Class	No.	Site	Name	Feature #	Ecological Region	Feature Type	Feature Description	Feature size (m)	Feature Thickness (m)	Geophytes	Type of recovery	Radiocarbon date range in BP
Class 3-Burned Rock Midden and Ovens	1	41BP627	McKinney Roughs	11	Post Oak Savannah	oven	basin-shaped oven	2.3-x-2.5		Indeterminate bulbs	flotation	850**, 940** 895-average
Class 1-Feature/Burned Rock	1	41BP627	McKinney Roughs	15	Post Oak Savannah	scatter/ cluster	circular diffused scatter	0.64-x-0.46	0.14	Indeterminate bulb	flotation	1220±40
Class 3-Burned Rock Midden and Ovens	4	41BQ47	Horn Shelter	Midden	Cross Timbers	midden	midden attributes and description not reported		not reported	*Allium* sp.	charcoal	590±60
Class 3-Burned Rock Midden and Ovens	5	41BR65	Camp Bowie	BRM1	Rolling Plains	ring midden	circular ring midden with one central cooking feature	14-x-14	1	*Camassia* sp. bulbs	flotation and charcoal	970±40, 1140±40, 1160±40 1090-average
Class 3-Burned Rock Midden and Ovens	6	41BR87	Camp Bowie	BRM	Rolling Plains	ring midden	circular ring midden with one central cooking feature	15-x-15	0.55	indeterminate bulb	charcoal	860±40, 1290±40, 1160±40 1103-average
Class 3-Burned Rock Midden and Ovens	7	41BR228	Camp Bowie	BRM1	Rolling Plains	ring midden	circular ring midden with one central cooking feature	15-x-15	0.7	*Camassia* sp., indeterminate bulb	flotation and charcoal	850±30, 1040±40 945-average
Class 3-Burned Rock Midden and Ovens	8	41BR246	Camp Bowie	BRM	Rolling Plains	ring midden	circular ring midden with one central cooking feature	13-x-13	1.7	Tuber, indeterminate bulb	flotation and charcoal	650±40, 860±40 755-average
Class 3-Burned Rock Midden and Ovens	9	41BR250	Camp Bowie	BRM1	Rolling Plains	ring midden	circular ring midden with one central cooking feature and evidence of re-use	15-x-10	1.4	*Camassia* sp., *Allium* sp., undetermined bulb	charcoal	790±40
Class 3-Burned Rock Midden and Ovens	10	41BR253	Camp Bowie	1	Rolling Plains	dome midden	irregular shaped midden with multiple cooking features	10-x-8	0.5	*Allium*, *Camassia*, Indeterminate bulb	charcoal	730±40, 750±40 740-average

Table 8. Late Prehistoric sites with geophytes in feature and non-feature contexts continued.

Feature Class	No.	Site	Name	Feature #	Ecological Region	Feature Type	Feature Description	Feature size (m)	Feature Thickness (m)	Geophytes	Type of recovery	Radiocarbon date range in BP
Class 3-Burned Rock Midden and Ovens	10	41BR253	Camp Bowie	2	Rolling Plains	ring midden	circular ring midden with one central cooking feature	16-x-16	2.75	*Camassia*, indeterminate	charcoal	850±40, 1120±40 985-average
Class 1-Feature/Burned Rock	10	41BR253	Camp Bowie	6	Rolling Plains	scatter/ cluster	flat irregular-shaped scatter	0.8-x-0.4	not reported	Indeterminate bulb	charcoal	985**-average
Class 3-Burned Rock Midden and Ovens	11	41BR420	Camp Bowie	BRM	Rolling Plains	ring midden	circular ring midden with one central cooking feature	10-x-9	1.8	Dog's tooth, indeterminate bulb	charcoal	930±70, 1500±40 1215-average
Class 3-Burned Rock Midden and Ovens	12	41BR441	Camp Bowie	BRM	Rolling Plains	dome midden	irregular shaped midden with one cooking feature	10-x-6	0.65	Indeterminate bulb	flotation	none
Class 3-Burned Rock Midden and Ovens	13	41BR493	Camp Bowie	BRM	Rolling Plains	ring midden	circular ring midden with one central cooking feature and evidence of re-use	16-x-13	1.7	*Camassia* sp. bulbs	flotation and charcoal	880±40, 970±40 925-average
Class 3-Burned Rock Midden and Ovens	14	41BR392	Camp Bowie	BRM	Rolling Plains	ring midden	oblong ring midden with central cooking feature and evidence of re-use	15-x-12	1.3	Indeterminate bulb	charcoal	1110±50, 1150±50, 1180±40 1146-average
Class 3-Burned Rock Midden and Ovens	15	41BR522	Camp Bowie	BRM	Rolling Plains	ring midden	circular ring midden with one central cooking feature and evidence of re-use	15-x-14	0.4	*Camassia* sp, bulbs, unidentified	charcoal	810±40, 750±40 780-average
Class 1-Feature/Burned Rock	17	41CV1553	Paluxy Site	3	Rolling Plains	hearth	basin-shaped circular hearth	0.8-x-0.78	0.15	Indeterminate bulbs	flotation	240±50

Table 8. Late Prehistoric sites with geophytes in feature and non-feature contexts continued.

Feature Class	No.	Site	Name	Feature #	Ecological Region	Feature Type	Feature Description	Feature size (m)	Feature Thickness (m)	Geophytes	Type of recovery	Radiocarbon date range in BP
Class 1-Feature/Burned Rock	21	41HY209	Mustang Branch	12	Edwards Plateau	scatter/ cluster	flat amorphous scatter-bulb from fire stained patch 50 cm south of feature	0.6-x-0.5	not reported	*Allium* sp. bulb	charcoal	640±80, 790±50 715-average
Class 4-Non-Feature Context	22	41HI1	Kyle Shelter	unknown	Cross Timbers	Unknown	context of specimens not reported			*Allium* sp.	charcoal	389**, 684**, 659** 577-average
Class 3-Burned Rock Midden and Ovens	23	41MS32	Honey Creek	BRM	Edwards Plateau	ring midden	circular ring midden with multiple cooking features	14-x-13	0.5	Liliaceae sp. bulb	flotation	870±60, 280±70 547-average
Class 3-Burned Rock Midden and Ovens	23	41MS32	Honey Creek	3	Edwards Plateau	oven	rocklined basin-shaped oblong oven	2.2-x-1.6	0.25	Indeterminate root	flotation	270±60, 180±60 225-average
Class 3-Burned Rock Midden and Ovens	23	41MS32	Honey Creek	7	Edwards Plateau	oven	rocklined basin-shaped circular oven	1.75-x-1.7	0.25	Liliaceae sp. bulb	flotation	260±50, 290±50 275-average
Class 1-Feature/Burned Rock	23	41MS32	Honey Creek	8	Edwards Plateau	scatter/ cluster	flat irregular-shaped scatter	1-x-0.8	0.1	Indetermiate root	flotation	275**-average
Class 3-Burned Rock Midden and Ovens	24	41MK8	Corn Creek I	Midden 1	Edwards Plateau	ring midden	circular ring midden with multiple cooking features and evidence of re-use	11.5-x-10.85	0.75	Indeterminate storage root	flotation	1220±60, 440±60* 830-average
Class 3-Burned Rock Midden and Ovens	25	41MK9	Corn Creek II	Midden A	Edwards Plateau	dome midden	circular dome midden with multiple cooking features and evidence of re-use	8.7-x-8.5	0.35	Indeterminate storage root	flotation and charcoal	774-average
Class 3-Burned Rock Midden and Ovens	27	41TV441	Toyah-Bluff	12	Blackland Prairie	oven	rocklined basin-shaped oblong oven	0.85-x-0.5	0.2	*Allium* sp.	charcoal	800±60*
Class 3-Burned Rock Midden and Ovens	27	41TV441	Toyah-Bluff	9	Blackland Prairie	oven	rocklined basin-shaped oblong oven	0.75-x-0.75	0.3	*Allium* sp.	flotation	800±60**

Table 8. Late Prehistoric sites with geophytes in feature and non-feature contexts continued.

Feature Class	No.	Site	Name	Feature #	Ecological Region	Feature Type	Feature Description	Feature size (m)	Feature Thickness (m)	Geophytes	Type of recovery	Radiocarbon date range in BP
Class 3-Burned Rock Midden and Ovens	27	41TV441	Toyah-Bluff	11	Blackland Prairie	oven	rocklined concave pit circular oven	1-x-4	0.3	*Allium* sp.	flotation	710±50
Class 3-Burned Rock Midden and Ovens	27	41TV441	Toyah-Bluff	2	Blackland Prairie	oven	rocklined basin-shaped oblong oven	2.2-x-1	0.27	*Allium* sp. bulbs	flotation and charcoal	520±60*
Class 4-Non-Feature Context	29	41VV82	Coontail Spin	Zone A-3	Trans-Pecos	Stratigraphic Layer				*Allium drummondii*	charcoal	1270**, 600** 935-average
Class 4-Non-Feature Context	30	41VV162	Conejo Shelter	Lenses	Trans-Pecos	Stratigraphic Layer				*Allium* sp.	possibly charcoal	1810±70
Class 4-Non-Feature Context	32	41VV213	Baker Cave	Stratum 2	Trans-Pecos	Stratigraphic Layer				*Allium* sp.	coprolites	1100±100
Class 3-Burned Rock Midden and Ovens	38	41WM632	Blockhouse Creek	BRM4	Edwards Plateau	dome midden	midden with multiple cooking features	12-x-12	0.72	*Allium*, unidentifiable bulb	flotation	710±60, 670±60, 590±60 656-average
Class 3-Burned Rock Midden and Ovens	38	41WM632	Blockhouse Creek	BRM 3	Edwards Plateau	dome midden	cicular midden with one central cooking feature	12-x-11	0.4	*Allium* sp. bulb	flotation	996±60, 950±50 970-average
Class 3-Burned Rock Midden and Ovens	40	41WM1010	Brushy Creek	D56	Blackland Prairie	oven	rocklined cicular oven	0.65-x-0.77	0.42	Indeterminate bulbs	flotation	1110

McKinney Roughs site, bison bone at the Toyah Bluff site, and various faunal and floral remains at the Honey Creek site.

The Blockhouse Creek site had two dome middens, Camp Bowie site 41BR253 had one, as well as the site 41BR441 and Corn Creek Site II (41MK9). The middens ranged in size from 8 m to 12 m in diameter. Along with the two ovens and scatter, the Honey Creek site also had a ring midden. Site 41BR253 had a ring midden along with the dome midden and scatter. Corn Creek I site (41MK8) and the Camp Bowie sites contained ring middens. The geophytes represented in this period include wild onion, eastern camas, indeterminate root fragments, indeterminate bulb fragments, dog's tooth violet, and one tuber fragment. Additional resources identified from the midden features include mussel shell and mammal bones. Slag was identified in almost all of the Camp Bowie midden features. Slag is carbonized sap that is released from plant material, such as bulbs, agave/sotol, and nuts, when it is thermally processed (Mauldin 2003b). The wild onion bulbs recovered from Horn Shelter were only described as being retrieved from atop of a midden deposit.

In addition to the Class I and Class III features, geophytes were recovered from the stratigrpahic layers of Conejo Shelter during this time period as well as an unknown context from Kyle Shelter. The type of feature the wild onion bulbs recovered and identified from Kyle Shelter was not reported. In Conejo Shelter, over 300 specimens were recovered from a stratigraphic lens of Conejo Shelter. The specimens from 41VV213 were primarily identified from coprolite samples. The coprolite samples were recovered from a latrine area of the rock shelter. Like previous specimens from coprolites, most of the bulbs were not carbonized and therefore eaten raw or whole.

Overall, the Late Prehistoric period has more sites than any other period with evidence of geophytes studied in this sample. There were a total of five Class I features, twenty-six Class III features, and three Class IV. The geophytes represented consist of wild onion, eastern camas, dog's tooth violet, indeterminate storage root, indeterminate bulbs, and one tuber fragment.

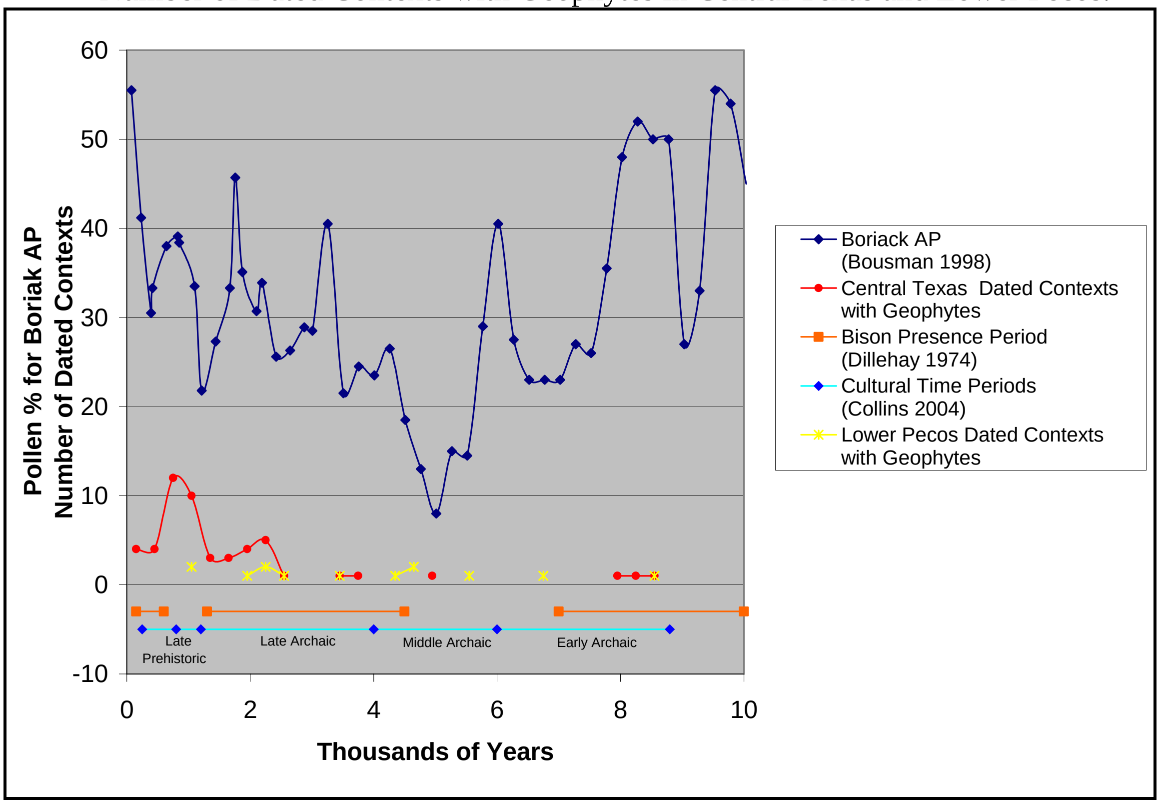
DISSCUSSION

Based on the results of this study, there are 65 feature and non-feature contexts with evidence of geophytes across Central Texas and the Lower Pecos region. Thirteen are non-feature contexts and fifty-two are feature contexts. The thirteen non-feature contexts were primarily from the Lower Pecos region, with the exception of Kyle Shelter (41HI1), whose context was not reported. The fifty-two feature contexts include of fourteen Class I features and thirty-eight Class III features. Class I features consisted of five hearths and nine scatter/clusters. Class III features consisted of fourteen ovens and twenty-four midden features.

The data were sorted by cultural time period to answer the research questions presented in Chapter 3. The first research question posed: Is geophyte use and their processing facilities intensified through time as Thoms (2005a) suggests? The number of sites and features with geophytes increases through time; however, this may reflect differential preservation rather than intensification. For example, there are more Late Prehistoric sites recorded than earlier sites because of better preservation. To be able to quantify the utilization of geophytes and their contribution to the economy of hunter-gatherers, I will correlate my data with paleoenvironmental data (Bousman 1998) and bison presence/absence data (Dillehay 1974).

Figure 3 shows the palynological data of Boriak Bog which indicates the fluctuations of arboreal pollen (AP). A high value for AP indicates mesic conditions; whereas, low values indicate dryer conditions. Incorporated into the graph are Collins' (1995, 2004) cultural time periods for Central Texas from the Archaic to the Late Prehistoric, and the bison presence/absence long term periods as reported by Dillehay (1974).

Figure 3. Boriak Bog AP, Bison Presence/Absence, Cultural Time Periods, and Number of Dated Contexts with Geophytes in Central Texas and Lower Pecos.



The number of dated contexts with geophytes was incorporated into the graph to determine if any patterns correlate with the paleoenvironmental and bison data. It appears that the number of contexts with geophytes increase during mesic conditions, especially in the absence of bison. In the Archaic period, bison are present from 8800-7000 BP and 4500-1300 BP (Dillehay 1974). There are few contexts represented in the Early Archaic period during the presence of bison, which incidentally correlates with a mesic period.

During the Middle Archaic, the Boriak AP indicates extreme dry conditions after 6000 BP, which is during the Altithermal period. The number of contexts is approximately one per thousand years. The contexts represented during this period are four from the Lower Pecos region and one from Central Texas. The paucity of sites from Central Texas during this period suggests that geophytes may have been too scarce to be utilized. The extreme dry conditions may have been too severe for the presence of geophytes. Although geophytes may be drought resistant, it is likely that these resources cannot withstand long-term xeric conditions.

During the Late Archaic, as mesic conditions gradually return so does the bison population around 4500 BP. The numbers of contexts with geophytes increase during mesic intervals that occur around 3500 to 3100 BP and 1600 to 2400 BP. Geophytes appear to be a higher-ranked resource when climatic conditions are favorable. The numbers drastically increase in the early part of the Late Prehistoric Austin phase when conditions are wetter and bison are absent. They drop once again during a brief dry period in the Toyah phase, when bison return.

The following tables indicate the number of feature and non-feature contexts during Archaic and Late Prehistoric in bison presence/absence periods (Table 9), the radiocarbon time span of bison presence/absence in Archaic and Late Prehistoric periods (Table 10) and finally the number of contexts per 1000 years in the Archaic and Later Prehistoric during bison presence/absence (Table 11).

Table 9. Number of Feature and Non-Feature Contexts

No. of Feature and Non-Feature Contexts	Bison Presence	Bison Absence
Archaic	28	5
Late Prehistoric	8	24

Table 10. Radiocarbon time span years.

Radiocarbon time span years	Bison Presence	Bison Absence
Archaic	6200	2500
Late Prehistoric	450	700

Table 11. Number of Contexts with Geophytes per 1000 years.

No. of Contexts per 1000 yrs.	Bison Presence	Bison Absence
Archaic	5	2
Late Prehistoric	18	34

The intensification of geophytes occurs when wetter conditions are present and especially in the absence of bison. Although the processing of geophytes require intensive labor and materials, they are still utilized in the presence of bison when they are available during wetter periods, such as in the Early Archaic and Late Archaic. This may indicate that hunter-gathers are diversifying their diet with geophytes to reduce or prevent risk or short falls in food supply. Some sites contained evidence of bison and geophytes within the same feature. As such, hunter-gatherers are allocating their time between hunting and processing bison, as well as searching, collecting, and processing geophytes. This may indicate division of labor within the hunter-gatherer groups in Central Texas or perhaps represent periods when bison are scarce.

During extremely xeric conditions in the Middle Archaic, evidence of use of geophytes is scarce in Central Texas and is relatively low in the Lower Pecos region. This may be due to the limited number of Middle Archaic sites recorded or conditions during this period are too severe for some species of geophytes to survive. In the Lower Pecos, hunter-gatherers shift to utilizing more drought resistant plants such as sotol, agave, and yucca (Brown 1991; Johnson and Goode 1994). Although Johnson and Goode (1994) suggest burned rock middens in Central Texas were also used to process sotol, there is no archaeological evidence of sotol processing in Central Texas during the Altithermal (Phil Dering, personal communication).

In the absence of bison during favorable mesic conditions, the utilization of geophytes increases. In the early part of the Late Prehistoric the number of contexts jumps considerably. The increased exploitation of geophytes and cooking facilities used to process them indicates groups are using an intensive strategy that is optimal for them in spite of processing costs. Geophytes become the high-rank resource, in the absence of bison. In addition, these resources can be cultivated and managed to increase productivity. The intensification of resources like geophytes that were previously been ignored or under-used indicates that hunter-gatherers developed a greater knowledge about the growing patterns, seasons, and availability of geophytes within their resource range.

The second research question posed in Chapter 3: Are certain facilities an optimal choice for geophyte utilization in Central Texas and Lower Pecos? The current study indicates that the most common features with evidence of geophytes are ovens and burned rock middens. Burned rock ovens are smaller in size and represent a single or low number of processing episodes. A burned rock midden is a result of numerous processing episodes of a single or multiple oven features. Approximately 73 percent of feature contexts are Class III features and 68 percent of those are represented during the Late Prehistoric period.

Although smaller features such as hearths are being used to process geophytes, oven features are the preferred facility to process geophytes in Central Texas. Unfortunately, the contexts with geophytes in the Lower Pecos were from non-feature contexts. The oven features averaged approximately 1 to 3 m in diameter. The oven features consisted of a stone-lined basin or pit with an associated lid-removal or clean out event. Large oven facilities, approximately 2 m or more in diameter, can process a moderate amount of food for 48 to 72 hours. Smaller facilities, 0.5 m to 1 m, last 24 hours or less (Thoms 2006b; Wandsnider 1997).

Burned rock middens examined during this study averaged approximately 10 to 12 m in diameter. Burned rock middens accumulate through the repeated use of a central cooking feature or features (Black 1997c; Mauldin and Nickels 2003). Most of the burned rock middens at Camp Bowie were ring middens with evidence of a central cooking feature. The ring portion of the midden contained the higher concentrations of rock, a result of multiple clean out events. The evidence of geophytes in burned rock middens suggest that they are being processed in large quantities and repeatedly, perhaps on a seasonal basis when conditions are favorable. However, the utilization of oven and burned rock midden features for processing geophytes is costly and construction involves a large amount of time, materials, and labor.

Mauldin and Nickels’ (2003) study of burned rock features at Camp Bowie examined the use parameters of burned rock middens. Their experimental studies show that almost equal amount of rocks and firewood are necessary to process root foods and semi-succulents in oven facilities (Black 1997c; Leach and Bousman 2001; Thoms 1989). By studying the volume of midden debris it is possible to estimate the number of cooking episodes that have occurred (Black 1997c; Dering 1999). Burned rock middens may represent up to 500 firing episodes depending on their size. A substantial amount of wood and fuel must be available to go through these many episodes, especially when the use life of rocks may be limited to two to four firings (Black 1997c; Leach and Bousman 2001).

In examining the features of the current study, in particular the Camp Bowie sites, it is important to note that most of the geophyte samples were recovered from the discard or ring portion of the middens. At Rice's Crossing (41WM815), the geophyte samples were obtained as carbon specimens from the perimeter of the oven feature rather than its center. Thus, methodology may be a factor in identifying the types of resources being processed within a particular feature. Geophyte specimens may be lost in unanalyzed soil if only a portion or the center of the feature is sampled for analysis.

It appears that when climate conditions are favorable, geophytes are incorporated into the diet and processed in oven facilities in large quantities. Other resources such as mussel shell, small game, and other plants were cooked within the same facilities. However, not all resources require cooking facilities that can cook foods for long periods of time. Bulbs, roots, and succulents require long processing periods in facilities such as ovens to obtain their nutritional value. As Mauldin's (2003b) study in the Camp Bowie area determined, burned rock features and middens may be directly correlated to the processing of geophytes. Forty-six percent of the Class III features in the Late Prehistoric period are at Camp Bowie sites. The use of these facilities increases because hunter-gatherers are intensifying their use of geophytes when bison are absent.

Following foraging theory, hunter-gatherers in Central Texas and the Lower Pecos are expanding their diet-breadth to include geophytes when climate conditions are favorable. When bison are present, geophytes are utilized to diversify their diet, possibly on a seasonal basis, to reduce risk and food supply short falls. As Chapter 4 indicated, most geophytes have spring and summer growing seasons. In extremely dry periods, such as the Altithermal during the Middle Archaic, the evidence of geophytes is scarce in Central Texas. Some species of geophytes may not withstand long-term severe xeric conditions. In the Lower Pecos, hunter-gatherers shift to searching and processing drought resistant plants such as sotol, agave, and yucca in cooking facilities. When wetter conditions return, geophytes are reintroduced into the diet, and then intensified when bison are scarce.

CONCLUSIONS

Based on the current study it is evident that geophytes played a significant role in the subsistence strategies of hunter-gatherers. By considering pollen data and bison presence/absence, it is evident that hunter-gatherers expanded their resource base to include geophytes when climate conditions were favorable, and especially when bison were not available. During the presence of bison, geophytes were utilized, possibly on a seasonal basis, to supplement the diet and reduce food supply short falls. Geophyte use almost disappears during the Middle Archaic in Central Texas during extremely dry conditions. Some geophytes appear unable withstand long-term xeric conditions. During such times, hunter-gatherers shifted to drought resistant plants such as sotol, agave, and lechuguilla, at least in the Lower Pecos region.

This study revealed that geophytes are primarily processed in oven facilities in Central Texas, which supports the assertion that ovens are designed for processing inulin-rich and/ or high starch plants (Mauldin and Nickels 2003; Thoms 2006a; Wandsnider 1997). Burned rock features at sites should be thoroughly excavated to obtain sufficient soil and carbon samples for macrobotanical analysis. Because geophytes are poorly preserved and need to be identified in a higher resolution, feature contexts should undergo through a thorough soil analysis by means of flotation. Carbon specimens recovered from features should all be analyzed as well.

In the sites examined from Central Texas and Lower Pecos, the utilization of geophytes and the cooking facilities used to process them appear to increase is an intensive strategy to cope in periods when high ranked resources such as bison disappear. As more sites are excavated throughout Central Texas the number of sites geophyte evidence is surely to increase. Overall, the contribution of geophyte resources in the economic strategies in Central Texas and Lower Pecos is evident.

APPENDIX A

SITES WITH EVIDENCE OF GEOPHYTES

No.	County	Site	Name	Eco Region
1	Bastrop	41BP627	Mckinney Roughs	Post Oak Savannah
2	Bell	41BL797		Edwards Plateau
3	Bell	41BL1214		Blackland Prairie
4	Bosque	41BQ47	Horn Shelter	Edwards Plateau
5	Brown	41BR65	Camp Bowie	Rolling Plains
6	Brown	41BR87	Camp Bowie	Rolling Plains
7	Brown	41BR228	Camp Bowie	Rolling Plains
8	Brown	41BR246	Camp Bowie	Rolling Plains
9	Brown	41BR250	Camp Bowie	Rolling Plains
10	Brown	41BR253	Camp Bowie	Rolling Plains
11	Brown	41BR420	Camp Bowie	Rolling Plains
12	Brown	41BR441	Camp Bowie	Rolling Plains
13	Brown	41BR493	Camp Bowie	Rolling Plains
14	Brown	41BR392	Camp Bowie	Rolling Plains
15	Brown	41BR522	Camp Bowie	Rolling Plains
16	Caldwell	41CW54	Armstrong Site	Blackland Prairie
17	Coryell	41CV1553	Paluxy Site	Edwards Plateau
18	Coryell	41CV595	Firebreak Site	Edwards Plateau
19	Coryell	41CV988	Paluxy Site	Edwards Plateau
20	Hays	41HY341	Holt Site	Edwards Plateau
21	Hays	41HY209	Mustang Branch	Edwards Plateau
22	Hill	41HI1	Kyle Shelter	Edwards Plateau
23	Mason	41MS32	Honey Creek	Edwards Plateau
24	McCullouch	41MK8	Corn Creek 1	Edwards Plateau
25	McCullouch	41MK9	Corn Creek 2	Edwards Plateau
26	Medina	41ME29	Jonas Terrace	Edwards Plateau
27	Travis	41TV441	Toyah-Bluff	Edwards Plateau
28	Uvalde	41UV88	Woodrow Heard	Edwards Plateau
29	Val Verde	41VV82	Coontail Spin	Trans-Pecos
30	Val Verde	41VV162	Conejo Shelter	Trans-Pecos
31	Val Verde	41VV167	Eagle Cave	Trans-Pecos
32	Val Verde	41VV213	Baker Cave	Trans-Pecos
33	Val Verde	41VV216	Zopilote Cave	Trans-Pecos
34	Val Verde	41VV456	Hinds Cave	Trans-Pecos
35	Val Verde	41VV74	Fate Bell	Trans-Pecos
36	Williamson	41WM235	Wilson-Leonard	Edwards Plateau
37	Williamson	41WM815	Rice's Crossing	Blackland Prairie

No.	County	Site	Name	Eco Region
38	Williamson	41WM632	Blockhouse Creek	Edwards Plateau
39	Williamson	41WM1126	Siren Site	Cross Timbers
40	Williamson	41WM1010	Brushy Creek	Blackland Prairie
41	Coryell	41CV117		Edwards Plateau
42	Milam	41MM341		Edwards Plateau
43	Williamson	41WM989		Edwards Plateau
44	Coryell	41CV1415		Edwards Plateau
45	Bell	41BL788		Edwards Plateau
	Sites outside study area			
46	Grimes	41GM224		
47	Navarro	41NV177	Adams Ranch	Post Oak Savannah
48	Dallas	41DL391		Cross Timbers
49	Freestone	41FT201	Bird Point Island	Post Oak Savannah
50	Hopkins	41HP137		Post Oak Savannah

APPENDIX B

SITE AND FEATURE DESCRIPTIONS

The following site and feature descriptions are in numerical order according to the list in Appendix B. The cultural time periods, ecological region, number of features, feature class, feature numbers, geophytes, and radiocarbon dates are presented in a table before each written description. The radiocarbon dates include the sample number and the average mean date for features with multiple reported dates. The radiocarbon dates represent the date of the feature. Dates with one asterisk (*) are dated geophyte samples and dates with two asterisks (**) are context samples. The text includes a brief site description and detailed descriptions of the features and non-feature contexts with geophytes. The raw data for each of the features and non-feature contexts recorded under the classification form devised for the study were abundant. These data are not presented in this thesis due to its numerous amount of pages. A CD-ROM of the data was given to the committee chairs, Dr. C. Britt Bousman and Dr. Phil Dering. For further reference or future research, these data may be obtained by these individuals and the author.

1. 41BP627-McKinney Roughs

Time Period	Late Archaic Late Prehistoric
Ecological Region	Post Oak Savannah
No. of Features	3
Class of Features/ Feature #s	Class I/ Features 12, 15 Class III/ Feature 11
Geophytes	Indeterminate bulb
Radiocarbon Dates in B.P.	Beta 169225–850±110**, Beta 195847-940±70** Average–895 (Feature 11) Beta169226–2080±40**, Beta 195849–1840±40** Average–1960(Feature 12) Beta 195850–1220±40 (Feature 15)

Site 41BP627 is situated on a floodplain rise on the terraces of the Colorado River. The site contains occupational surfaces than span from the Late Archaic to the Late Prehistoric periods. Geophyte samples were identified from Feature 11, 12, and 15 (Carpenter, et al. 2006).

Feature 11 is a circular basin-shaped hearth or oven that was divided into two sub-features. The cluster of rocks and basin were designated as 11a and measured 1.0 m by 1.3 m. The scatter of rock extending from the basin and cluster was designated as 11b and measured 1.3 by 1.2 m. Feature 11a was interpreted to be a heating locale and Feature 11b was the toss zone, or lid removal event. The burned rock consisted primarily of quartzite. An unidentifiable bulb fragment weighing 0.05 grams was recovered from the flotation samples. Other botanical materials include elm, yaupon, and ash wood charcoal. Only 24 debitage flakes were encountered in the feature.

Feature 12 was a burned rock cluster measuring .60 m by .60 m. Most of the rock was quartzite and the thin layer of rock was approximately 20 cm thick. The basal configuration could not be determined. One unidentifiable bulb weighing 0.01 grams was recovered from flotation samples as well as elm wood charcoal. Twelve pieces of debitage were also recovered.

Feature 15 was a cluster of fragmented burned rock measuring .64 cm by .46 cm and 14 cm thick. The rocks were primarily quartzite and almost half were less than 3 cm in diameter. The basal configuration could not be determined from cross-sectioning. Three unidentifiable bulbs were recovered from the flotation samples as well as wood charcoal and nutshell.

2. 41BL797

Time Period	Late Archaic
Ecological Region	Blackland Prairie
No. of Features	1
Class of Features/ Feature #s	Class III/Feature 1
Geophytes	Unidentified bulb
Radiocarbon Dates in B.P.	Beta 136823–1510±50

Site 41BL797 is a rockshelter located on the east facing wall of Bear Creek. The rockshelter has been extensively vandalized prior to its initial recording in 1985. A geophyte sample was recovered from Feature 1 (Mehalchick, et al. 2003).

Feature 1 is a tallus midden measuring 12 m by 4 m and is .50 m in thickness. The midden was observed within the rockshelter deposits. The undisturbed midden was encountered approximately .40 m below the shelter ground surface. Approximately 40 percent of the midden was disturbed by previous looting. The midden consisted of a denser layers of limestone rock primarily 5 cm in size. The rocks at the lower depths were "softer," due to possible water saturation. The midden was a result of multiple occupations that occurred continually from the Late Archaic to the Late Prehistoric periods.

The unidentifiable bulb fragment was recovered from the flotation samples. Oak, juniper, hackberry, and black locust wood charcoal was also identified from the samples. Faunal remains identified from the midden deposits consisted of medium sized mammal bones and mussel shell. The artifacts recovered included dart points and arrow points, bifaces, cores, modified flakes, a hammerstone, and debitage flakes.

3. 41BL1214

Time Period	Late Archaic Late Prehistoric
Ecological Region	Blackland Prairie
No. of Features	2
Class of Features/ Feature #s	Class I/Feature 4 Class I/Feature 5
Geophytes	Unidentified bulb
Radiocarbon Dates in B.P.	UGA-13456–1760±40 (Feature 5) UGA-13457–1730±40(Feature 5) Average–1745

Site 41BL1214 is situated on a flood terrace of the southern bank of the Little River. The multi-component site contained eight cultural features. Feature 4 and Feature 5 contained evidence of geophytes (Griffith and Kibler 2005).

Feature 4 was a small amorphous cluster of limestone rock measuring approximately .40 to .50 m in diameter. Charcoal staining and a few pieces of burned soil were observed in the matrix. The feature rested on a flat surface and was approximately .16 m in thickness. The flotation samples taken from the feature yielded 1 unidentifiable bulb fragment measuring 0.01 grams. Other botanical remains include elm, oak, and walnut wood charcoal. In addition, seven unidentified bone fragments and 84 debitage flakes were recovered. A discrete cultural component could not be determined for the feature.

Feature 5 was a small circular basin-shaped hearth measuring .88 m by .98 m and almost .17 m in depth. The feature was distinguished from the surrounding matrix by very dark sediment with burned clay and burned rock. Flluvial gravels were also observed within the matrix. The sixteen unidentifiable bulb fragments recovered from the flotation samples weighed 0.13 grams. Other plants identified include elm, oak, hackberry, ash, pecan, and yaupon wood charcoal. Faunal remains consisted of mussel shells and nine unidentified fragments. Only 220 pieces of debitage was recovered from the feature (Griffith and Kibler 2005).

4. 41BQ47-Horn Shelter

Time Period	Late Prehistoric
Ecological Region	Cross Timbers
No. of Features	1
Class of Features/ Feature #s	Class III/Midden
Geophytes	*Allium* sp.
Radiocarbon Dates in B.P.	Shell Devel.-5210A-B–590±60*

Site 41BQ47 is situated in a bluff overlooking the Brazos River. The rockshelter is approximately 50 ft long and 20 ft deep. Geophytes were observed atop of the midden within the rockshelter (Watt 1978).

Atop of the midden deposit, a mound of carbonized onion bulbs, initially thought to be seeds, were collected. The specimens were covered by 36” of sterile red river sand which suggests flood backwaters may have covered the midden. It appeared that the specimens were being processed when waters deposited sediments (Watt 1978).

No other additional data on the midden was encountered during research. Details about the midden deposits was not reported.

5. 41BR65-Camp Bowie Site

Time Period	Late Prehistoric
Ecological Region	Rolling Plains
No. of Features	1
Class of Features/ Feature #s	Class III/Midden
Geophytes	*Camassia scilloides*
Radiocarbon Dates in B.P.	Beta 158821–1160±40, Beta 158822–1140±40 Beta 158823–970±40 Average–1090

Site 41BR65 is situated on an upper terrace of the Devils River. The site contained a circular burned rock midden measuring approximately 14 m in diameter (Mauldin, et al. 2003b). The midden contained a central depression approximately 4 m in diameter. Three contiguous test units were excavated from the outer edge of the midden extending towards the center depression. The excavation of the central units did not reveal a central cooking feature, however a small feature designated Feature 6 was observed near the center of the midden. Feature 6 consisted of a concentration of sandstone slabs lying on a flat surface .20 m below surface. The authors speculate that the feature may have been a smaller thermal feature or a discard pile from the interior cooking feature (Mauldin, et al. 2003b).

Fifty-nine bulbs and bulb fragments were recovered from the test units. Most samples were identified as Eastern camas and most were recovered from the test unit adjacent to the center of the midden depression from charcoal and flotation samples (Dering 2003b). Other botanical remains consist of juniper, oak, and unidentifiable wood charcoal. Three species of mussel shell, bird bones, artiodactyls bones, and other unidentifiable mammal bones were recovered from the excavation units. Artifacts include 90 pieces of debitage, bifaces, and utilized flakes (Mauldin, et al. 2003b)

Shovel test and test excavations over the rest of the site around the midden revealed evidence of two features. The features were identified as a possible post hole and the other a basin-shaped layer of reddish-brown sandy silt. The investigations surrounding the midden produced debitage, bifaces, a core, unifaces, graver, utilized flakes, sandstone metate fragments, and untyped dart point fragment. Deposits around the site were of moderate density and the authors determined that the midden was focus of activities at the site (Mauldin, et al. 2003b).

6. 41BR87-Camp Bowie Site

Time Period	Late Prehistoric
Ecological Region	Rolling Plains
No. of Features	1
Class of Features/ Feature #s	Class III/Midden
Geophytes	Unidentified bulbs
Radiocarbon Dates in B.P.	Beta 158818–1290±40, Beta 158819–1160±40 Beta 158820–860±40 Average–1103

Site 41BR87 is situated on a rolling slope approximately 200 m from Devil's River contained a circular burned rock ring midden designated as Feature 1 and measured 15 m in diameter (Mauldin, et al. 2003b). The central depression was slightly lower than the rest of the midden surface. Three contiguous test units were excavated from the ring portion and extended towards the central depression. The unit excavation near the center of the midden did not reveal evidence of a central cooking feature.

The geophyte samples recovered from the midden as charcoal samples consisted of unidentified bulbs. Seven bulbs weighing 1.9 grams were recovered between 30 to 80 cmbd. Other botanical remains identified included oak and unidentifiable wood (Dering 2003b). Faunal remains consisted of three species of mussel shell and artifacts recovered included 167 pieces of debitage, biface fragments and a Late Prehistoric Scallorn point (Mauldin, et al. 2003b)

Artifacts recovered from around the midden include debitage, bifaces, groundstone, cores, utilized flakes, a piece of ochre, and projectile points. The projectile points consisted of an Ensor, Godly, and Fresno projectile points. The shovel test and unit excavations around the site determined that site was occupied from Late Archaic period into the Late Prehistoric. Based on the artifact distribution, the authors suggests a single occupation period (Mauldin, et al. 2003b).

7. 41BR228-Camp Bowie Site

Time Period	Late Archaic Late Prehistoric
Ecological Region	Rolling Plains
No. of Features	2
Class of Features/ Feature #s	Class III/Feature 1, 4
Geophytes	*Camassia scilloides*
Radiocarbon Dates in B.P.	Beta 160814–850±430(Feature 1) Beta 160815–1040±40(Feature 1) Average–945 Beta 160816–2980±40(Feature 4) Beta 160817–1210±50(Feature 4) Average–2095

Site 41BR228 is situated on a saddleback ridge approximately 500 m north of an unnamed tributary of Devils River. The site contained two burned rock middens designated as Feature 1 and Feature 4. The middens are approximately 150 m apart. Excavation units were placed on both middens.

Feature 1 is approximately 15 m in diameter and 1 m in height from the surface (Mauldin, et al. 2003b). Although a central depression was evident in the midden, no central cooking feature was encountered during the unit excavations. Three contiguous test units were placed within the midden with two located on the ring and one near the center of the midden.

From the excavations, 38 bulbs or bulb fragments weighing 2.7 grams were recovered from charcoal and flotation samples (Dering 2003b). The bulbs resembled Eastern camas and most were recovered from the test unit located on the talus of the ring. Oak wood charcoal was also identified from the midden excavations and faunal remains consisted of three species of mussel shell. Artifacts recovered from Feature 1 excavations include 400 pieces of debitage, bifaces, groundstone fragments, utilized flakes, and projectile points. The projectile points were Tortugas, Bulverde, and a small untyped arrow point fragment (Mauldin, et al. 2003b)

Feature 4 is an oval shaped burned rock midden measuring 20 m by 10 m in size (Mauldin, et al. 2003b). The midden has been severly disturbed by road vehicles and any evidence of central depression may have been destroyed. Three excavation units were randomly placed within the midden due to the nature of disturbance. Only one Eastern camas bulb weighing 0.2 grams was recovered from the excavations as well as two species of mussel. Artifacts recovered from the units consisted of 166 pieces of debitage, bifaces, utilized flakes, and a few groundstone fragments. The projectile points collected from Feature 4 consisted of a Late Archaic Pedernales and a Transitional Archaic Frio projectile points(Mauldin, et al. 2003b)

Shovel test and unit excavations within the site and around the perimeter of the middens suggest deposits are pretty shallow and concentrated around Feature 1 (Mauldin, et al. 2003b). The artifacts recovered from non-midden contexts include debitage, bifaces, groundstone, utilized flakes, a ceramic sherd and projectile points. The identifiable projectile points include a Langtry, Bulverde, an Andice, and Gower. In addition, a cluster of mortar holes were observed on the site near Feature 4. Based on the diagnostic projectile points and radiocarbon dates of both middens, the site was occupied from the Early Archaic period to the Late Prehistoric. Feature 1 developed during the Late Prehistoric and Feature 4 may have developed during the Late Archaic period and used into the Late Prehistoric (Mauldin, et al. 2003b). The artifact distribution and density surrounding the middens indicate that Feature 1 was the focal point during the multiple occupations of the site during the Late Prehistoric. However, this interpretation may be skewed considering the area surrounding Feature 4 was not thoroughly excavated (Mauldin, et al. 2003b).

8. 41BR246-Camp Bowie Site

Time Period	Late Prehistoric
Ecological Region	Rolling Plains
No. of Features	1
Class of Features/ Feature #s	Class III/Midden
Geophytes	*Pediomelum* sp.
Radiocarbon Dates in B.P.	Beta 161949–650±40, Beta 161950–860±40 Average–755

Site 41BR246 is situated on a north facing ridge 150 m from an intermittent drainage of Devils River. The site contained a circular burned rock crescent shaped midden approximately 13 m in diameter (Mauldin, et al. 2003b). The midden ranges in height from .10 m to .50 m above the ground surface. Four test units were excavated within the midden. Two were placed on the apex of the ring, one near the outer edge of the midden, and one within the center. The center unit revealed evidence of pit which indicated the presence of the central cooking feature of the midden (Mauldin, et al. 2003b).

The excavations recovered 48 unidentifiable bulbs and bulb fragments and four tuber fragments weighing 0.2 grams from charcoal and flotation samples. The tubers recovered from the midden resembled *Pediomelum* sp. which may be prairie turnip, prairie peanut, or scurfpea (Dering 2003b). Oak wood charcoal was also identified from the midden excavations and faunal remains included four species of mussel shell and a few pieces of white-tail deer bone fragments. The artifacts from the midden excavations consisted of 76 pieces of debitage, utilized flakes, bifaces and one piece of ochre (Mauldin, et al. 2003b)

Artifacts recovered from the excavations surrounding the midden consisted of bifaces, utilized flakes, a core, and three projectile points. The three projectile points consisted of a Middle Archaic Nolan point, a Late Prehistoric Scallorn, and an untypeable arrow point. The artifact distribution from the shovel tests and non-midden unit excavations suggest distinct periods of occupation. The occupations of the site ranged from the Middle Archaic period to the Late Prehistoric (Mauldin, et al. 2003b).

9. 41BR250-Camp Bowie Site

Time Period	Late Prehistoric
Ecological Region	Rolling Plains
No. of Features	1
Class of Features/ Feature #s	Class III/Midden
Geophytes	*Camassia scoilloides* *Allium* sp.
Radiocarbon Dates in B.P.	Beta 160818–790±40

Site 41BR250 is situated on a landform extending from a ridge adjacent to a small drainage apprxomately 1.1 km from Lewis Creek. The site contained a circular burned rock ring midden measuring 15 m by 10 m in size. The midden height ranges from 40 cm to 70 cm above ground surface. The central depression was evident and a disturbance or intrusion located near the center of the midden was 1 m in diameter and 20 cm in depth (Mauldin, et al. 2003b). Two excavation units were placed within the center of the midden and one was placed near the disturbance. An additional unit was excavated on the apex of the midden ring.

A total of 89 bulb and bulb fragments weighing 8.9 grams were recovered from the ring unit as charcoal samples. Most samples were unidentifiable, however a few were identified as Eastern camas and wild onion. The test unit excavated near the disturbance yielded a two unidentifiable bulb fragments weighing 0.2 grams. Other botanical remains identified from the midden excavations consisted of oak and mesquite wood (Dering 2003b). The midden contained a significant amount of faunal remains that were recovered primarily from the central units. The fauna represented include bison, deer, birds, and small mammalian species. In addition, two species of mussel shell were recovered. The midden yielded a minimal amount of artifacts and consisted of 12 pieces of debitage, a core, an untypeable projectile point, and a Scallorn point. A ceramic Leon Plain sherd was recovered from the floatation sample of the outer ring unit (Mauldin, et al. 2003b)

Artifacts recovered from the site surrounding the midden included debitage, cores, bifaces, and utilized flakes. In addition, a mano and a few projectile points were recovered from surface collections. The projectile points consisted of an Early to Middle Archaic Pandale point, a Pederanales point, and an Ensor point. Based on the diagnostic artifacts and radiocarbon dates, the site was occupied from the Middle and Late Archaic period to the Late Prehistoric. The midden dates to the Late Prehistoric period and the frequency of burned rock and calcium carbonate accumulation suggest the midden was used intensively in two major periods (Mauldin, et al. 2003b).

10. 41BR253-Camp Bowie Site

Time Period	Late Prehistoric
Ecological Region	Rolling Plains
No. of Features	2
Class of Features/ Feature #s	Class I/Feature 6 Class III/Feature 1,2
Geophytes	*Camassia scoilloides* *Allium* sp.
Radiocarbon Dates in B.P.	Beta 160819–730±40(Feature 1) Beta 160820–750±40(Feature 1) Average–740 Beta 160821–850±40(Feature 2) Beta 160822–1120±40(Feature 2) Average–985

Site 41BR253 is situated on two prominent landforms approximately 1 km from Lewis Creek and 300 m north of an intermittent tributary of Devils River. contained two burned rock middens that were approximately 60 m apart (Mauldin, et al. 2003b). A small ephemeral drainage bisected the two middens and the smaller of the two was designated as Feature 1. The larger midden designated as Feature 2 was west of Feature 1 (Mauldin, et al. 2003b).

Feature 1 was roughly a rectangular midden measuring 10 m by 8 m. The top of midden is flat and is approximately .50 m above the ground surface. Three contiguous units were excavated within the midden from the center extending towards the ring. The test units revealed evidence of two smaller pit features that were not given feature designations. In addition, two clusters of tabular rock were designated Features 4 and 4a. The authors suggest that Feature 1 may represent a different accumulation debris pattern than the rest of the other sites based on the smaller features encountered during the excavation (Mauldin, et al. 2003b).

A total of 63 bulbs and bulb fragments weighing 7.4 grams were recovered and a few of the samples were identified as wild onion and Eastern camas most were recovered 30-40 cm below surface within an ashy loam soil. Some oak charcoal was recovered from the floatation samples. (Dering 2003b). Seventy-one pieces of debitage, two deer bone fragments, and mussel shell, were recovered from excavations (Mauldin, et al. 2003b).

Feature 2 was a circular ring midden with a central depression. The midden measured 16 m in diameter and approximately 2 m above the surface. The midden rested on a slope and it was approximately 2 m above the surface at its highest point. Three contiguous units were placed within the midden starting from the center and extending towards the ring. Human remains were encountered during the excavations within the center most unit. The remains were located at approximately 40-50 cm below surface. Large sandstone rocks associated with burial were above and west of the remains and were not fire-cracked (Mauldin, et al. 2003b).

A rock-lined pit designated as Feature 3 was discovered above the burial at .20–.30 m below surface within Feature 2. It was disturbed by the burial and roots and likely represents a use or re-use episode of the midden. Most of the geophyte samples from Feature 2 were recovered from the outer most unit between .50–.70 m below surface. Few of the samples were identified as Eastern camas from the 46 bulbs and bulb fragments weighing 5.4 grams. Oak and willow wood charcoal were identified from the flotation samples of the outer most unit (Dering 2003b). The artifacts recovered from the midden were 15 pieces of debitage and a biface. Faunal remains included mussel shell, jackrabbit, and two unidentified mammal bones (Mauldin, et al. 2003b).

Feature 6 is located outside of Feature 2 consisted of scatter/cluster measuring approximately .80 m by .40 m. The feature was not fully excavated so the exact size was not determined nor was the thickness or depth reported. The scatter consisted of sandstone rock on a flat surface. One indeterminate bulb sample was recovered from the feature as a macrobotanical sample.

Aritfacts recovered from the site shovel tests and surface collections included debitage, bifaces, utilized flakes, metate fragments and projectile points. The identifiable projectile points consisted of a Cuney point, a Perdiz point and an Alba point. The artifact distribution revealed shallow deposits and moderate density. (Mauldin, et al. 2003b).

11. 41BR420-Camp Bowie Site

Time Period	Late Prehistoric
Ecological Region	Rolling Plains
No. of Features	1
Class of Features/ Feature #s	Class III/Midden
Geophytes	*Erythronium mesochoreum*
Radiocarbon Dates in B.P.	Beta 159517–930±70, Beta 159518–1500±40 Average–1215

Site 41BR420 is situated at the base of a toeslope. The site contained a circular burned rock ring midden, designated as Feature 1, that measured 10 m by 9 m and approximately .70 m above ground surface (Mauldin, et al. 2003b). A central depression was evident form the surface of the midden. Two test units were excavated near the center of the midden and one was placed on the midden ring. A central cooking feature was discovered during the excavations of the center units. It was designated as Feature 2 and consisted of a circular concentration of rocks with a pit measuring 10 to 25 cm below surface (Mauldin, et al. 2003b)

Eight bulb fragments weighing 1.1 grams were recovered from the midden excavations. More than half of the samples were recovered from the center units. Two specimens were identified as dog’s tooth violet and most were unidentifiable. Oak wood and unidentifiable charcoal was also identified from the excavations (Dering 2003b). The faunal remains recovered primarily from Feature 2 consisted of bison, unidentified large mammal species, and a few pieces of mussel shell. Artifacts recovered from the midden units consisted of 42 pieces of debitage, utilized flakes, and three projectile points. The projectile points were a Late Archaic Frio and two untypeable arrow points (Mauldin, et al. 2003b)

The artifacts from the site surrounding the midden included lithic debitage, bifaces, and utilized flakes. The artifact distribution in shovel test excavations revealed that the Late Prehistoric period occupation was more intensive. The radiocarbon assays indicate that the site was occupied from the Late Archaic period to the Late Prehistoric period. The earlier occupational zone around the site was very minimal. Only one bulb sample was recovered from deposits dating to the Late Archaic period (Mauldin, et al. 2003b).

12. 41BR441-Camp Bowie Site

Time Period	Late Prehistoric
Ecological Region	Rolling Plains
No. of Features	1
Class of Features/ Feature #s	Class III/Midden
Geophytes	Unidentifiable bulb
Radiocarbon Dates in B.P.	None

Site 41BR441 contained a severely disturbed burned rock midden. The midden was heavily impacted by machinery resulting in splitting the midden into three mounds (Mauldin, et al. 2003b). The mounds cover an area of 30 m by 15 m. A test unit and trench was excavated into the larger of the mounds. The test unit contained a tabular sandstone feature designated as Feature 2 at .49–.59 m below surface. The trench revealed the central cooking feature of the midden. The feature, not given a formal designation, measured 1.7 m wide and was .65–.75 m below surface (Mauldin, et al. 2003b).

The flotation sample recovered from the test unit contained evidence of an unidentifiable bulb weighing 0.1 grams. The sample was recovered from the above the features. Other botanical remains consist of mesquite and oak wood charcoal (Dering 2003b). A few pieces of debitage and mussel shell, and an unidentified mammal bone was recovered Because of the nature of the disturbance no radiocarbon sample was obtained for analysis. Therefore, the authors were unable to determine the cultural time period in which the midden was formed and used (Mauldin, et al. 2003b).

13. 41BR493-Camp Bowie Site

Time Period	Late Prehistoric
Ecological Region	Rolling Plains
No. of Features	1
Class of Features/ Feature #s	Class III/Midden
Geophytes	*Camassia scoilloides*
Radiocarbon Dates in B.P.	Beta 161946–210±40, Beta 161947–880±40, Beta 161948–970±40 Average–925 (excluded 210±40 outlier)

Site 41BR493 is situated on the edge of a large ridge approximately 175 m from an intermittent drainage. The site consisted of a cresent-shaped burned rock midden measuring 13 m by 16 m (Mauldin, et al. 2003b). A central depression was evident from the surface and two units were placed within the center. One test unit was placed on the apex of the midden ring. The upper layer of the central units were disturbed by military activities or excercises. Historic artifacts consisting of nails, whiteware, and glass were all recovered from the disturbed layers of the central unit excavations. The ring unit revealed a cluster of large rocks from in the profile. The intact deposits of the midden began approximately .20–.30 m below surface (Mauldin, et al. 2003b).

From the midden excavations, twenty-eight bulbs and bulb fragments weighing 7.0 grams were recovered from charcoal and flotation samples. A few samples were identified as Eastern camas and most were recovered from the lower layers of the midden beginning from 50-60 cm below surface. Oak and mesquite wood charcoal was also identified (Dering 2003b). Faunal remains included five species of mussel shell, jackrabbit, and deer. The undisturbed layer contained 36 pieces of debitage, bifaces, and utilized flakes. (Mauldin, et al. 2003b)

The site shovel test excavations revealed shallow cultural deposits and the artifact distribution suggests there were two periods of occupation. The midden was used throughout the Late Prehistoric period and formed around 970±40 B.P. Deeper deposits of the midden indicated the feature was the primary focus of earliest occupations (Mauldin, et al. 2003b).

14. 41BR392-Camp Bowie Site

Time Period	Late Prehistoric
Ecological Region	Rolling Plains
No. of Features	1
Class of Features/ Feature #s	Class III/Midden
Geophytes	Unidentifiable bulb
Radiocarbon Dates in B.P.	Beta 173024–1110±50, Beta 173025–1150±50 Beta 173026–1180±40 Average–1146

Site 41BR392 is part of a series of sites recorded at Camp Bowie (Mauldin, et al. 2003a; Weston and Mauldin 2003a). The site is situated next to a drainage that flows into the Devils River.

The oval burned rock ring midden measured 12 m by 15 m (Weston, et al. 2003). The midden was .60 m above the ground surface and reached a depth of .70 m below surface. The central depression of the midden was approximately 5 to 8 cm lower than the surrounding rock.

Based on the analysis on the distribution of rock sizes within the midden, the data reflects two periods of intensive use (Weston, et al. 2003).

Three test units were excavated within the midden with two units in the central portion of the midden and one excavated on the ring. A single geophyte specimen was recovered from 40-60 cmbd of the ring test unit. The unidentifiable bulb weighed 0.2 grams and a single slag specimen was also recovered. Slag is sap that has been boiled out of bulbs and carbonized during the processing of the food (Dering 2003a). Other plant remains identified from the midden include mesquite and unidentifiable wood. Mesquite wood remains may represent fuel or a food source. Artifacts recovered from the midden include 166 pieces of debitage and a biface. The only faunal remains consist of 636.1 grams of mussel shell (Weston, et al. 2003).

15. 41BR522-Camp Bowie Site

Time Period	Late Prehistoric
Ecological Region	Rolling Plains
No. of Features	1
Class of Features/ Feature #s	Class III/Midden
Geophytes	*Camassia scilloides*
Radiocarbon Dates in B.P.	Beta 173028–810±40, Beta 173029–750±40 Average–780

Site 41BR522 is situated near an unnamed drainage that flows into Devils River. The site contained an oval burned rock ring midden that measured 14 m by 15 m (Weston and Mauldin 2003b). The central depression is .10 m lower that the apex of the ring and approximately 10 m wide. The analysis of burned rock size and frequencies in the levels suggest the midden was intensively used during one period. Five contiguous test units were excavated within the midden, two near the center depression, and three extending into the ring apex of the midden (Weston and Mauldin 2003b). The central units revealed evidence of a central cooking feature designated as Feature 2. Feature 2 was a rock lined and basin-shaped measuring 2 m in diameter and .45 m in depth. A smaller pit observed within Feature 2, noted by a different soil color, may represent fill after the removal of the processed food items (Weston and Mauldin 2003b).

Several bulb fragments were recovered as charcoal samples from the ring test units of the midden. Eighteen samples weighing 0.6 grams were recovered from the center units and 31 samples weighing 3.2 grams were recovered from the ring units. A few of the samples were identified as Eastern camas. Other plant remains identified from the midden include oak mesquite, and other unidentifiable wood fragments. Faunal remains consisted of mussel shell, armadillo, and an unidentified mammal. Artifacts recovered from the feature include 49 pieces of lithic debitage, a core, modified flakes, and a Late Archaic Montell dart point which is likely out of context (Weston and Mauldin 2003b).

16. 41CW54-Armstrong Site

Time Period	Early Archaic
Ecological Region	Blackland Prairie
No. of Features	1
Class of Features/ Feature #s	Class I/Feature 2
Geophytes	*Camassia scilloides*
Radiocarbon Dates in B.P.	Beta 129137–8490±40**

The Armstrong site is a Late Paleoindian to Early Archaic site situated near the confluence of the Blanco and the San Marcos River (Schroeder and Oksanen 2002). One feature with evidence of a geophyte dates to the Early Archaic component of the site (Schroeder 2002).

Feature 2 is a small flat cooking feature approximately .50 m in diameter. It consists of burned rock caliche clasts and an associated small cluster of burned caliche located northwest of the main feature accumulation (Schroeder and Oksanen 2002). No pit or basin was evident during the excavation of the feature, and no oxidized or burned soil was distinguishable from the rest of the unit matrix. The small cluster located northwest of the main feature may represent discard piles of the feature itself indicating repetitive use (Schroeder 2002). The lack of burned or oxidized sediment observed in the feature may be due to the poor preservation (Schroeder and Oksanen 2002).

Two pieces of camas bulbs were recovered from the analysis of floated material. Other plant remains discovered in the feature include oak, elm, hickory/walnut, and hackberry nutlets (Schroeder and Oksanen 2002). Mussel shell fragments and deer bone surrounded the feature at the same elevation (Schroeder and Oksanen 2002). Lithic artifacts located around the perimeter of the feature at the same elevation include a core, debitage, and a modified flake (Schroeder 2002). The lipid analysis of the burned rock indicated that fish and large herbivore resources were processed. In addition, the burned rock had evidence of low-fat plant lipid signatures. This evidence and the presence of the camas bulbs indicate the feature was used to roast camas as well.

A radiocarbon assay removed near the feature was processed and yielded a date that was questionable due to issues of preservation (Schroeder and Oksanen 2002). A sample of organic material believed to be charcoal was removed from the bottom of the rock and dated to 6780±50

B.P. Another assay from a more reliable source within the same occupational zone had a date of 8490±40 BP. The date taken from the feature may have been contaminated due to the severe soil weathering and chemical leaching affecting preservation of the site in general.

17. 41CV1553-Paluxy Site

Time Period	Late Archaic Late Prehistoric/Protohistoric
Ecological Region	Cross Timbers
No. of Features	2
Class of Features/ Feature #s	Class I/ Feature 3 Class III/ Feature 6
Geophytes	Indeterminate bulb fragments
Radiocarbon Dates in B.P.	Beta 136840–240±60(Feature 3) Beta 136842–2090±50(Feature 6)

Site 41CV1553 is situated north of an unnamed tributary of Stampede Creek on an alluvial terrace, colluvial toeslope, and on redeposited sands of the Paluxy Formation (Mehalchick, et al. 2003). The site contained occupations that spanned a period from the Late Archaic to the Protohistoric. The site was divided into three Analytical Unit areas. The geophyte samples were recovered from Feature 3 in Analytical Unit 1 and Feature 6 in Analytical Unit 2 (Mehalchick, et al. 2003).

Feature 3 was a rock-lined, basin-shaped hearth .80 m by .70 m. The circular hearth consisted of fossiliferous limestone rocks. Large tabular slabs, measuring about 20 cm in length were concentrated on the western portion of the feature. Smaller more fragmented rocks were on the eastern portion of the feature. The unidentified bulb fragments were recovered from the feature flotation samples. The two pieces weighed 0.2 grams. Other botanical materials identified in the flotation samples include wood charcoal of oak, pecan, walnut, ash, sumac, and elm, as well as acorns and pecan shells. A large and heavily heat altered nutting stone was also observed (Mehalchick, et al. 2003).

Feature 6 is basin-shaped hearth that was not fully excavated. It was estimated to be approximately 2 m in length, and the excavated portions measured .63 m by .62 m. The feature consisted of 2 layers of fossiliferous limestone. The slabs and tabular rocks sloped toward the center of the feature. Most of the slabs and tabular rock measured 10 to 15 cm in length. The interior matrix was defined by the slabs and the dark sediment. Three indeterminate bulb fragments, recovered from the flotation samples, weighed 0.2 grams. Wood charcoal also observed consisted of oak and elm. Although the feature was identified as a hearth, it was likely utilized as a cooking oven (Mehalchick, et al. 2003).

18. 41CV595-Firebreak Site

Time Period	Late Archaic
Ecological Region	Cross Timbers
No. of Features	2
Class of Features/ Feature #s	Class III/ Feature 15 Class I/ Feature 7 (later dropped)
Geophytes	*Camassia scoilloides* *Allium canadense*
Radiocarbon Dates in B.P.	Beta 154812–1870±40*, Beta 149093–1910±70 (Feature 15) Average–1890

Site 41CV595 is situated west of Stampede Creek on an outcrop of Paluxy sands (Mehalchick, Ringstaff, et al. 2004). The site was occupied from the Late Archaic to the Late Prehistoric. Geophytes were recovered from Feature 15 and Feature 7.

Feature 7 was recorded as a large amorphous burned rock scatter. The feature designation was later dropped as excavators determined the scatter was possibly a result of clean-out events from near by features. The units that made up the feature contained numerous burned rocks. Flotation samples recovered from the units yielded 4 wild onion bulb fragments and 27 eastern camas bulb fragments and weighed a total of 4.3 grams. Other materials within the surrounding scatter included wood charcoal of oak, sumac, elm, ash, hackberry, and walnut.

Feature 15 is a rock-lined oven that consists of 2 to 3 layers of fossiliforous limestone. The feature was irregular in shape and measured 2.10cm by 2.06 m. It was approximately .29 m thick and consisted primarily of flat slabs that were slightly angled toward the center. A total of 43 eastern camas bulbs weighing 2.6 grams were recovered from floatation samples. Other botanical remains include dogwood, elm, mulberry, and oak wood charcoal. Although no faunal remains were recovered from the feature, fatty-residue analysis on the burned rock indicated a high-fat content food was also processed. Artifacts from the feature consist of one edge-modified flake and 57 debitage flakes.

19. 41CV988-Paluxy Site

Time Period	Late Archaic-Late Prehistoric
Ecological Region	Cross Timbers
No. of Features	1
Class of Features/ Feature #s	Class I/ Feature 2A
Geophytes	Indeterminate corm fragments
Radiocarbon Dates in B.P.	Beta 102094–1280±40

Site 41CV988 is situated east of an unnamed tributary of Cotton Creek on an upland slope (Kleinbach, et al. 1999). Most of the site had been impacted by military training activities. The geophyte identified at the site was recovered from Feature 2A.

Feature 2A is a basin-shaped hearth that is approximately 1.75 m in diameter and is .34 m in thickness. The feature capacity thickness was approximately .13 m. The feature consisted of 5 layers of primarily nonfossiliferous limestone. Most of the rocks were tabular. Burned rock ranged from 25 cm to 3 cm in size. The rocks were not lined along the basin, rather they were mixed in within the rich organic-stained sediment. The basin shape was evident due to the clear distinction of the feature matrix and the surrounding fill.

The indeterminate corm fragment was recovered from floatation samples of the feature. The corm fragments totaled 13 and they weighed 1.0 grams. In addition, wood charcoal identified as oak was also recovered from the unit. Faunal material recovered from the feature consisted four unidentified fragments. Artifacts consisted of one Darl point and 78 debitage flakes (Kleinbach, et al. 1999).

20. 41HY341-Holt Site

Time Period	Middle Archaic
Ecological Region	Edwards Plateau
No. of Features	1
Class of Features/ Feature #s	Class III/Feature 4
Geophytes	Unidentifiable bulb
Radiocarbon Dates in B.P.	Beta 191422–4740±40, Beta 191738–5160±40 Average–4950

Site 41HY341 is situated on the western terrace of the Blanco River (Brownlow 2004). The site contained four distinct occupational zones from the Late Paleoindian to the Early

Archaic periods. An unidentifiable geophyte sample was recovered from a large burned rock feature within one of the distinct occupational zones of the site.

Feature 4 is an irregularly shaped oven measuring 3.5 m by 3.6 m in size comprised of burned limestone rocks (Brownlow 2004). The basin of the oven was approximately .22 m in depth and the total excavated thickness was .42 m. Burned rocks located at a higher elevation northwest of the basin are presumably evidence of debris from an oven lid removal or clean out. The unidentifiable bulb sample was recovered from a flotation sample taken burned rock debris northwest of the basin. The bulb fragments could not be identified, however the archeobotanist speculates they are likely Eastern camas (*Camassia scoilloides)* or a wild onion bulb (*Allium* sp.) (Iruegas and Brownlow 2004). Other botanical remains recovered from the feature include seeds of hackberry, goosefoot, pigweed, juniper and an unidentifiable flower stalk. Most of the samples, other than the wood charcoal sample, were uncharred. The authors speculated that these may be modern specimens that contaminated the feature through faunalturbation (Iruegas and Brownlow 2004).

The artifacts recovered from within and surrounding Feature 4 include 196 pieces of lithic debitage, a hammerstone, a lanceolate biface and three Early Triangular points. No faunal remains were recovered from the feature possibly due to poor preservation (Brownlow 2004).

21. 41HY209-Mustang Branch

Time Period	Late Prehistoric
Ecological Region	Edwards Plateau Blackland Prairie
No. of Features	
Class of Features/ Feature #s	Class I/Feature 12
Geophytes	*Allium* sp.
Radiocarbon Dates in B.P.	Beta 37280–790±50, Beta 37281–640±80 Average–715

Site 41HY209 in lies on a terrace and bluff overlooking Mustang Branch, a tributary of Onion Creek. The site contained cultural occupations that spanned from the Late Archaic period to the Late Prehistoric period (Ricklis and Collins 1994). The site The terrace location contained evidence of geophytes during the Austin Interval of the Late Prehistoric cultural occupation of the site (Ricklis and Collins 1994).

A wild onion bulb was collected from a fire stained patch of soil located 0.5 m southwest of Feature 12. The burned soil patch was approximately .50 m in size and was located at the same elevation as Feature 12. Feature 12 was a flat amorphous hearth approximately .60 m by .50 m in size. Charcoal fragments were located throughout the rocks, however no burned sediments or ash was noted. Land snail concentrations were observed within and around the feature (Ricklis and Collins 1994: 196). Because of the concentrations, the authors speculate the feature was possibly used for land snail processing. However, the lack of intact burned sediments also suggest that the feature may have been a discard pile or dispersed scatter of rocks related to the fire stained soil patch. It is likely that the feature is related to the processing of the wild onion bulb due to its close proximity. Other floral remains identified from the feature include cactus seeds and various wood species

Throughout the excavated area of the terrace location of the site, bone fragements of deer, antelope, rodent, turtle and other small fauna were recovered (Ricklis and Collins 1994: 201). In addition, Scallorn points, dart points, lithic tools and debitage were recovered and analyzed. Burned rock was scattered throughout the excavation block due to various cooking activities that occurred (Ricklis and Collins 1994: 203). An additional wild onion bulb was collected from the excavation block west of the first specimen. It was located among pieces of mussel shell, bone fragments, and a few pieces of burned rock. The location of the bulb may be a result of a secondary displacement of a cooking feature. The evidence of various fauna and floral remains suggest that hunter-gatherers during the Austin interval of the Late Prehistoric were incorporating broad based subsistence strategies at site 41HY209 (Ricklis and Collins 1994: 203).

22. 41HI1-Kyle Shelter

Time Period	Late Prehistoric
Ecological Region	Cross Timbers
No. of Features	None
Class of Features/ Feature #s	Class IV/ Context not reported
Geophytes	*Allium* sp.
Radiocarbon Dates in B.P.	Sample No. C-5–389 (AD 1561±130) Sample No. C-8–684 (AD 1276±165) Sample No. C-1–659 (AD 1291±150) Average–577

Kyle Shelter is situated in a limestone wall of a short tributary of the Brazos River valley. The shelter is 500 feet wide and 130 feet deep, approximately 10 to 15 feet above the canyon bottom (Jelks 1962).

Approximately 65 *Allium* sp. bulbs were recovered from the Toyah focus strata of the shelter (Jelks 1962). Unfortunately, the exact context of the samples was not reported. The shelter contained several hearth features and burials. Other resources recovered from the shelter include deer, beaver, raccoon, prickly pear, pecans, and sunflower seeds. Artifacts recovered from the site include dart points, arrow points, painted pebbles, pottery, and wooden digging stick (Jelks 1962).

23. 41MS32-Honey Creek Site

Time Period	Late Prehistoric
Ecological Region	Edwards Plateau
No. of Features	4
Class of Features/ Feature #s	Class I/Feature 8 Class III/BRM, Features 3,7,
Geophytes	Indeterminate root fragments Liliaceae bulbs
Radiocarbon Dates in B.P.	CAMS-7453–260±50, CAMS-7454–290±50 Average–275(Feature 7) CAMS-7467–180±60, CAMS-7452–270±60 Average–225(Feature 3) CAMS-7461, 7465, 7462, 7457, 7463, 7459, 7464, 7456, 7460, 7455, 7458 & Beta 75234 Average–547 (BRM)

Site 41MS32 is situated on the eastern bank of Honey Creek approximately 500 m above the confluence with Turtle Creek. The site consists of a large burned rock midden surrounded by several hearth features. Geophyte specimens were recovered from the burned rock midden, Feature 3, Feature 7, and Feature 8 (Black 1997b).

The burned rock midden (BRM) was a low dome midden with a shallow central depression. It measured approximately 14 m by 13 m and .50 m in thickness. The central depression was determined to be the center focused facility that had evidence of numerous use episodes. The geophyte samples recovered from flotation consist of four Liliacae bulbs and three indeterminate root fragments. They weighed a total of .5 grams. Other botanical remains recovered from the midden include various wood charcoal and nuts. Faunal remains include mussel shell, bison and deer bone. Artifacts include bifaces, modified flakes, unifaces, groundstone, and debitage.

Feature 3 was a large basin-shaped oven with very dark ashy matrix measuring 2.2 m by 1.6 m and .25 m thick. The flat rocks were slanted towards the center of the feature and consisted of 2 to 3 layers. The largest rock measured approximately 22 cm in length. Three indeterminate root fragments weighing 0.2 grams were recovered from flotation. Wood charcoal identified from the feature included persimmon, pecan, and oak. In addition, sotol leaf fragments, prickly pear, and acorn were also identified. Medium-sized mammal bones were also recovered from the feature. Artifacts included bifaces, modified flakes, and debitage (Black 1997b).

Feature 7 and 8 appeared to be associated with one another. Feature 8 consisted of scatter of fragmented rocks adjacent to Feature 7 and at a slightly higher elevation. Feature 8 measuring 1.0 m by .80 m, may be the lid removal or clean-out episode related Feature 7. Feature 8 contained an eight indeterminate root fragments weighing 0.7 grams from flotation. Other botanical remains consisted of live oak wood charcoal, and sotol leaf fragments.

Feature 7 was a large circular basin-shaped oven measuring 1.75 m by 1.70 m and .25 m in thickness. Charcoal and ash was evident throughout the rocks. Five Lilicae bulb fragments weighing 0.6 grams were recovered from flotation. Wood charcoal identified included ash, hackberry, pecan, and live oak. Other botanical remains included acorn and sotol leaf fragments. Faunal remains from the feature consisted of medium to small sized mammal bones and snake bones. Artifacts consisted of two arrow points, bifaces, modified flakes, and debitage.

24. 41MK8-Corn Creek I

Time Period	Late Prehistoric
Ecological Region	Rolling Plains Edwards Plateau Cross Timers
No. of Features	1
Class of Features/ Feature #s	Class III/ Midden 1
Geophytes	Unidentified storage root
Radiocarbon Dates in B.P.	CAMS-13886–440±60* CAMS-8959–1220±60 Average–830

Site 41MK8 is situated on a broad rocky bench on the eastern side of Corn Creek Valley. The site lies within the marginal boundaries of the natural regions of the Rolling Plain, the Edward Plataeu, and the Cross Timbers region. An unidentified geophyte sample was recovered from Midden 1 (Black 1997a).

Midden 1 is circular, ring or annular midden measuring 11.5 m by 10.85 m and is approximately .75 m thick. The top of the midden is approximately .50 m above the ground surface. The base of the midden was basin shaped and charcoal staining and ash was observed throughout the rocks. A central depression, measuring 3 to 4 m in diameter was designated as Feature 1. Within the central portion of the midden, Feature 1, two rock lined features were observed and designated as Feature 1A and 1B (Black 1997a).

Feature 1A was limestone slab-lined basin in the eastern portion of the central depression. Feature 1B was a smaller rock lined basin within Feature 1A, approximately .75 m in diameter. These features functioned as the central cooking features of the midden where several cooking episodes occurred. Two pieces of unidentifiable storage root fragments, weighing 0.2 grams were recovered from flotation samples. In addition, juniper wood charcoal and prickly pear seeds were identified.

Mussel shell was observed within the midden in a concentrated area suggesting steaming was also a function. Artifacts recovered from the excavation include Bifaces, cores, groundstone, unifaces, modified flakes, and debitage flakes (Black 1997a).

25. 41MK9-Corn Creek II

Time Period	Late Prehistoric
Ecological Region	Rolling Plains Edwards Plateau Cross Timers
No. of Features	1
Class of Features/ Feature #s	Class III/ Midden A
Geophytes	Unidentified storage root
Radiocarbon Dates in B.P.	CAMS-9064–870±70, CAMS-8960–820±60, CAMS-8963–750±70, CAMS-8961–740±60, CAMS-9065–690±70, CAMS-8962–350±60 Average–774 (excluding 350±60 outlier)

Site 41MK9 is situated on a third terrace on the left bank of Corn Creek, approxiamately 3.5 km south of the Colorado River. Like 41MK8, the site lies within the margins of three ecological regions. The unidentified geophyte samples were recovered from Midden A (Black 1997a).

Midden A is large circular dome shaped midden measuring 8.7 m by 8.5 m. The midden was approximately .35 m thick and the central depression reached bedrock. The central depression was filled and two additional internal features, Feature 1 and Feature 5 were observed. Three mussel shell concentrations were also observed within the layers of the midden. Feature 1 had several layers of rock indicating more than one episode of use. Unfortunately, the midden was excavated by untrained staff and recording and documentation methods were inadequate.

The geophytes samples were recovered from flotation and charcoal samples. Four pieces of unidentifiable storage root fragments, weighing 0.5 grams, were recovered from floatation and one piece from macrobotanical samples. Other plant remains recovered from flotation and charcoal samples include juniper, mesquite, and oak wood charcoal, as well as walnut shells. Artifacts recovered from the excavated portions of the midden include numerous lithic tools and projectile points, shaping disks, and over 4,000 pieces of debitage.

26. 41ME29-Jonas Terrace

Time Period	Late Archaic
Ecological Region	Edwards Plateau
No. of Features	2
Class of Features/ Feature #s	Class III/BRM Class I/Unit 23
Geophytes	Liliaceae bulb
Radiocarbon Dates in B.P.	Beta 62349/CAMS-6508–2600±70 (BRM) Beta 62339/ETH-10478–1295±55 (BRM) Average–1947 (BRM) Beta-62342/CAMS-6502–2400±60** Beta 62346/CAMS-6505–2420±60** Average–2410 (Unit 23)

Site 41ME29 situated on an alluvial terrace over the South Fork, San Geronimo Creek. The site contains occupational zones that span a period from 6000 B.C. to A.D. 600 (Johnson 1995). Evidence of geophytes occurred in the burned rock midden (BRM) area as well as in the plaza like southern portion of the site.

The BRM area was roughly 10 to 12 m in diameter and oval in shape. The lens of burned rock was .50 m thick and consisted of limestone rocks and dark charcoal stained soil (Johnson 1995). Five geophytes were recovered from the flotation material excavated from the soil columns and test units of the burned rock area. The bulb remains were from an unknown species of the Liliaceae family (Dering 1995). Other plant remains observed during archaeobotanical analysis include sotol, wood charcoal, and seeds (Dering 1995). Few pieces of animal bone and lithic artifacts were obtained from the midden excavations. Although no actual baking pit was observed during investigations, the accumulation of small to medium burned rocks and the nature of organic remains suggest several baking episodes occurred (Johnson 1995: 290). It must be noted that only a portion of the midden area was excavated. Johnson (1995) suggests that burned rock debris may have been brought into the burned rock midden area from the numerous fireplaces or hearths occurring in the southern area of the site.

The southern portion of the site yielded one geophyte sample from the presumed plaza-like area within the same strata of the burned rock midden (Johnson 1995). Excavations of this southern portion revealed a flat layer of scattered burned rock debris that was possibly a result of numerous open fireplaces or hearths. The only observable feature, Feature 6, consisted of larger rocks at a higher elevation than the rest of the scatter. The bulb remain was recovered south of Feature 6. Deer, bison, and mussel shell were recovered from the same excavation block and same elevation as the bulb sample. In addition, lithic artifacts include several tools and dart points. The points consisted of Pedernales, Montell, Marshall, and Castroville. This area was interpreted to be a plaza-like area where various cooking, knapping, and processing activities occurred (Johnson 1995). The accumulation of burned rock debris was greatest in this strata than in the upper and lower strata. This area does not reflect one instance of various activities, but numerous activities through a period of time.

27. 41TV441-Toyah-Bluff Site

Time Period	Late Prehistoric
Ecological Region	Blackland Prairie
No. of Features	4
Class of Features/ Feature #s	Class III/Feature 2, Feature 11, Feature 9 & 12
Geophytes	*Allium* sp.
Radiocarbon Dates in B.P.	Beta 13111–520±60*(Feature 2) Beta 131109–710±50 (Feature 11) Beta 131108–800±60* (Feature 12)

Site 41TV441 is situated on a high terrace that overlooks Onion Creek. The site had been disturbed by modern development and natural erosion. Geophyte samples were recovered from Feature 2, 9, 11, and 12 and other non-feature contexts (Karbula, et al. 2001).

Feature 2 was a rock lined oblong oven pit measuring 2.2 m by 1 m and .27 m thick. The feature basin was shallow and consisted of dark charcoal stained sediment. A dense scatter of fragmented rocks was located west of the feature which may represent a clean-out or lid-removal event (Karbula, et al. 2001). Four wild onion bulb fragments were recovered from flotation and charcoal samples. Additional botanical remains included oak wood charcoal and acorn nutshell fragments. Faunal remains recovered from the feature consisted of a bison premolar specimen. Artifacts recovered consisted of a hammerstone and 3 metate fragments.

Feature 11 is large oven measuring 1 m by 4 m with a deep concave pit measuring .30 m. Large rocks near the base of the pit were angled toward the center. Charcoal was evident throughout the rocks. Six wild onion bulb fragments were recovered from flotation samples as well as oak and persimmon wood charcoal. Only three manos were recovered from the feature.

Feature 9 was a oblong basin-shaped oven measuring .75 m in diameter and approximately 25 or more in thickness. Large limestone cobbles lined the bottom of the feature and the dark black matrix contained charcoal. One wild onion bulb was recovered from the flotation samples as well as oak wood charcoal. Two fragmented manos were also recovered from the feature.

Feature 12 was located adjacent to Feature 9 and consisted of a circular basin-shaped oven measuring .85 m by .50 m and was approximately .20 m thick. The feature slightly overlapped with the edges of Feature 9. The tabular like rocks lined the the feature however, none were encountered at the bottom of the basin. A lens of charcoal was observed at the bottom of the pit. Two wild onion bulbs were identified from the charcoal samples. One sample was recovered from the overlap of Feature 9 and 12. Unidentifiable wood charcoal was also recovered. Several bone fragments were recovered from the surrounding Feature 9 and 12 matrices. The authors speculate that the central rocks were removed from Feature 12 and used to construct the adjacent Feature 9 at a later time (Karbula, et al. 2001).

In addition, to the feature samples, other wild onion bulb specimens were recovered from the units surrounding the features. A total of 5 bulbs were recovered near Features 9 and 12.

28. 41UV88-Woodrow Heard Site

Time Period	Late Archaic
Ecological Region	Edwards Plateau
No. of Features	1
Class of Features/ Feature #s	Class III/ Midden 3
Geophytes	*Allium* sp.
Radiocarbon Dates in B.P.	CAMS-9055–3320±60, CAMS-9056–3500±60 Average–3410

Site 41UV88 is situated on a terrace above the Dry Frio River. The site contains deposits that date from the Early Archaic to the Late Prehistoric. The bulb identified from the site was recovered from the Late Archaic context of the site from Midden 3 (Decker, et al. 2000).

Midden 3 was not entirely excavated because it was outside of the right-of-way. However, excavators determined it was approximately 16 in diameter and lens-shaped in profile. Its margins thinned out and mixed with other adjacent scatters. The dome midden was approximately .40 to .50 m in thickness and consisted of limestone rock. Various clusters and concentrations of burned rock were observed at the base of the midden. Most of the rock ranged from 5 to 10 cm. The burned rocks were angular and rounded, however their condition was not recorded. No central cooking feature could be distinguished.

The geophyte sample was recovered from a unit on the periphery of the midden and it was the only one at the site. The sample was a wild onion bulb weighing approximately 0.3 grams. The sample was recovered as a charcoal sample. Unfortunately, no flotation samples were recovered from the upper deposits of the midden.

Other materials recovered from the midden deposits include wood charcoal of Llive oak, juniper/pine, and mesquite. Faunal materials included mussel shell, and bison and deer bone fragments. Artifacts recovered from the midden consisted of 154 bifaces, 52 cores, 6 groundstone, 3 uifaces, 16 modified flakes, and approximately 22,190 pieces of debitage.

29. 41VV82-Coontail Spin

Time Period	Middle Archaic Late Archaic Late Prehistoric
Ecological Region	Trans Pecos
No. of Features	None
Class of Features/ Feature #s	Class IV/Stratigraphic layer
Geophytes	*Allium drummondi*
Radiocarbon Dates in B.P.	TX76–2300 (190-510 BC)** TX81–1270 (AD 790-570)** TX77-600 (AD 1540-1160)** Average–935

Site 41VV82 is situated on the north wall of the Rio Grande, upstream from the mouth of Painted Canyon (Story and Bryant 1966). Two areas were excavated within the rockshelter and both yielded evidence of geophytes.

Area A contained five stratigraphic zones, Zones A-1 through A-5, and the upper Zone A-3 contained one bulb or bulb fragment (Irving 1966). Three radiocarbon dates were taken from this stratum that date to the Late Archaic to Late Prehistoric period (Story and Bryant 1966). Another sample was recovered from the Transitional level, a mixed area of Zone A-3 and Zone A-4. This level is dated to the Late Archaic period. Two additional samples were identified from surface and random contexts of an unknown period.

Area B contained two general stratigraphic zones that lacked clear distinctive stratigraphic levels. The deepest zone, 3–6 feet, contained five bulbs or bulb fragments. This zone contains mixed contexts of the Middle Archaic and Late Archaic periods based on the projectile points (Story and Bryant 1966). Additional specimens recovered from this strata include yucca, oak, and walnut samples (Irving 1966).

30. 41VV162-Conejo Shelter

Time Period	Early Archaic to Late Prehistoric
Ecological Region	Trans Pecos
No. of Features	None
Class of Features/ Feature #s	Class IV/Stratigraphic levels
Geophytes	*Allium* sp.
Radiocarbon Dates in B.P.	TX1758–6650±110** TX1763–5020±80** TX1762a–4950±70**, TX1762b–4590±90** TX1761–3310±90** TX1759–2690±80** TX1757–1810±70**

Site 41VV162 is situated on the north wall of a small dry canyon ¼ mile north of the Rio Grande. It is located approximately 2 miles north of the confluence of Pecos River and the Rio Grande. Geophyte samples were identified from plan macrofossil remains and coprolite remains that were recovered from various stratigraphic lenses in the rock shelter (Alexander 1974; Bryant 1974).

Numerous plant macrofossils were sorted from lens samples collected during excavations (Alexander 1974). The lens samples spanned a cultural period from the Early Archaic to the Late Prehistoric. Small percentages are reperesented in the material recovered during excavations for all periods. However, not all samples were analyzed. Of those analyzed, *Allium* sp. bulbs represented 2 percent of the total samples of lenses dating to the Early Archaic, 0.78 percent in samples from the Middle Archaic, 1 percent in those from the Late Archaic, and 4 percent in samples dating from the Late Archaic to the Late Prehistoric. Other macrofossils identified from the various lenses include agave, sotol, prickly pear, and mesquite (Alexander 1974).

In addition to the macrofossil analysis of the lens samples, Byrant (1974) examined coprolite samples from the lenses. A total of 43 coprolite samples were analyzed from contexts dating to the Late Archaic period of the rockshelter. Percentages ranged from 0 to 75 in samples based on total volume. Twenty-four of the 43 specimens contained evidence of wild onion bulbs. Other botanical remains found in the samples include prickly pear, sotol, yucca, and agave. The samples were not carbonized suggesting the they were eaten raw and whole (Bryant 1974).

Analysts observed that bulbs were eaten with other plants (Bryant 1974). A consistent relationship between yucca flowers, cactus stems and onion bulbs were found in samples (Bryant 1974).

31. 41VV167-Eagle Cave

Time Period	Early Archaic
Ecological Region	Trans Pecos
No. of Features	None
Class of Features/ Feature #s	Class IV/Stratum V
Geophytes	*Allium drummondi*
Radiocarbon Dates in B.P.	TX107–8760±50**, TX108–8680±150**, TX109–6640±120**, TX140–8540±120**, TX141–8760±150**, TX197–8680±180** Average–8343**

Site 41VV167 is situated on the western side of Mile Canyon approximately ¼ mile from the Rio Grande. It is a large amphitheater like cave that has been frequently disturbed. Geophytes were encountered in thee deepest stratigraphic layer, Stratum V, of the rock shelter (Ross 1965; Story and Bryant 1966).

One bulb fragment was recovered from Stratum V and another bulb was encountered from a random miscellaneous location (Irving 1966). The bulbs were identified from the "macrofossils" collected from the various stratigraphic levels. Other specimens include agave and prickly pear. Artifacts recovered from the stratum include "Early Barbed" projectile points, tools, shell artifacts, matting fibers, and painted pebbles (Ross 1965).

32. 41VV213-Baker Cave

Time Period	Late Archaic Late Prehistoric
Ecological Region	Trans Pecos
No. of Features	1
Class of Features/ Feature #s	Coprolites from latrine feature
Geophytes	*Allium* sp.
Radiocarbon Dates in B.P.	Beta 15634–1100±100

Site 41VV213 is situated above Phillips Canyon, a tributary of Devils River. Geophyte samples were identified in coprolite specimens recovered from a latrine area within the cave (Sobolik 1991).

The latrine area was located near the entrance to the cave. It is associated with living surface of adjacent Feature 84-3, a grass-lined pit. The coprolite samples recovered from the latrine area totaled 38 specimens. Wild onion bulbs were observed in 28 percent of the samples. The bulbs were nearly complete suggesting they were eaten whole and raw (Sobolik 1991).

33. 41VV216-Zopilote Cave

Time Period	Middle Archaic Late Archaic
Ecological Region	Trans Pecos
No. of Features	None
Class of Features/ Feature #s	Class IV/Stratigraphic Layer
Geophytes	*Allium drummondi*
Radiocarbon Dates in B.P.	None-based on projectile points

Site 41VV216 is situated within a wall of an arroyo of Seminole Canyon approximately 2 miles north of Rio Grande. Most of the deposits excavated within the rockshelter were mixed (Story and Bryant 1966).

One bulb or bulb fragment was recovered from a random context. The rockshelter had three stratigraphic zones, however the mixed cultural deposits made it difficult to assign distinct cultural periods. The projectile points that were recovered from the contexts determined that the rockshelter dated to the Middle Archaic to Late Archaic period (Story and Bryant 1966).

34. 41VV456-Hinds Cave

Time Period	Early Archaic
Ecological Region	Trans Pecos
No. of Features	None
Class of Features/ Feature #s	Class IV/Stratigraphic Level
Geophytes	*Allium* sp.
Radiocarbon Dates in B.P.	TX2459–5710±80 TX2458–5590±80 Average–5650

Site 41VV456 is situated on the west wall of Still Canyon, a dry tributary to the Pecos River. It is located 20 m above the canyon, and approximately 1 km from the junction of the Still Canyon and Pecos River (Williams-Dean 1978)

Approximately 100 coprolite samples were recovered from Lens 13. Lens 13 consisted of ash and burned rock deposits. Forty percent of the coprolite samples contained wild onion bulbs. Although no direct counts or weights were recorded, there were complete bulbs observed in the specimens. Other plant remains observed in the coprolites include prickly pear, yucca, and sotol. In addition, microfauna from the coprolites included small mammals and reptiles (Williams-Dean 1978).

35. 41VV74-Fate Bell Shelter

Time Period	Middle Archaic
Ecological Region	Trans Pecos
No. of Features	None
Class of Features/ Feature #s	Class IV/ Undetermined
Geophytes	*Allium* sp.
Radiocarbon Dates in B.P.	TX191–3330±110**

Site 41VV74 is one of the largest shelter within the Amistad Resevoir area. It is west of Seminole Canyon and 500 ft in length, with over 140 ft of cultural deposits. The rockshelter has been continuously looted and disturbed (Story and Bryant 1966).

Bulb remains have been identified from Middle Archaic contexts per Dering's continuous analysis of collected specimens (Dering 2003d). Other remains identified from previous analysis from the same general cultural period include lechuguilla and oak (Irving 1966).

36. 41WM235-Wilson-Leonard

Time Period	Early Archaic Middle Archaic
Ecological Region	Edwards Plateau
No. of Features	3
Class of Features/ Feature #s	Class III/Feature 8, BRM2, Feature 181
Geophytes	*Camassia scilloides*
Radiocarbon Dates in B.P.	CAMS-18375–8250±80*(Feature 8) CAMS-13514, 13841, 13512, 13840, 13513, 10201, 13844, 13509, 8355 Average–7997±60* (Feature 181) ETH-14115–3780±70*(BRM2)

Site 41WM235 contains one the most complete archaeological sequences in Texas (Collins 1998). It has deposits spanning from the Early Paleoindian into the Late Prehistoric. Two features dating to the Early Archaic and one dating to the Middle to Late Archaic contained evidence of geophytes (Dering 1998).

Feature 8 is a burned rock accumulation or sheet midden dating to the Early Archaic period (Guy 1998). The feature consisted of several rock layers as a result of the construction and use of three cooking features. The surrounding features were distinguished by a darker rock filled matrix and basin shaped pits. The general area of the accumulation measures approximately 4 m by 2 m, possibly larger, and .40 m in thickness. Although, the camas bulb was recovered from above Feature 8, it is likely related to the feature accumulation or the surrounding basins within the feature. The only other botanical remains recovered from the feature include unidentifiable wood charcoal (Dering 1998). Artifacts recovered from the feature include bifaces, unifacial tools, Clear Fork unifaces, projectile point fragments, and 1095 pieces of debitage (Guy 1998). Faunal remains recovered include bone fragments from turtle, snake, rabbit, deer, and unidentifiable medium to large mammals (Guy 1998).

Feature 181 is a large circular oven measuring 2.6 m in diameter. The feature was approximately .50 m in depth and lined with large limestone slabs within the basin and along the outer margins (Guy 1998). Oxidized soil was observed under the large slabs of rock and charcoal was scattered throughout the matrix. The feature contained 10 intact camas bulbs throughout the matrix. Unidentifiable wood charcoal and faunal remains were also recovered from within feature. The fauna represented in the feature include rodents, rabbit, fish, turtle, toad, deer, snake, toad, mussel shell, and unidentified small mammal bones. Artifacts recovered include 2254 pieces of lithic debitage, bifaces, perforators, unifaces, burins, and projectile points. The identified projectile points include a Hoxie and Jetta. Feature 181 was the largest burned rock feature at the site and was used repeatedly for the processing of camas bulbs (Guy 1998).

Burned rock midden 2 is a large circular midden measuring 20 m by 18 m (Guy 1998). The midden was severely impacted by road construction activities and looting. The midden thickness was approximately 1 m and the upper .60 m did not contain any cultural materials. The sterile layers consisted of a dark soil with small rock fragments and high ash content. A camas bulb was collected from below the sterile layers. Unidentifialbe wood charcoal and faunal remains were also recovered. The faunal remains consisted of mussel shell and unidentifiable medium to large mammal bones. Artifacts collected from the midden excavations include lithic debitage, bifaces, perforators, unifaces tools and projectile points. The identified projectile points include Bulverde, Nolan, Lange, and Travis (Guy 1998).

37. 41WM815-Rice's Crossing

Time Period	Late Archaic
Ecological Region	Blackland Prairie
No. of Features	1
Class of Features/ Feature #s	Class III/Feature 9
Geophytes	*Camassia scilloides*
Radiocarbon Dates in B.P.	Beta 135974, 135975, 135976, 135977, 135978, 135980, 135981, 135982, 135983, 135985 Average–2340

Site 41WM815 is situated approximately 0.75 km from Brushy Creek on the floodplain (Brownlow 2003). Investigations at the site resulted in the discovery of a large cooking feature in the upper occupation area that yielded evidence of geophytes.

Feature 9 was a very large shallow basin shaped cooking feature measuring 2.03 m by 2.13 m and .17 m thick (Brownlow 2003). The feature had a rock lined basin with evidence of burned soil beneath the rocks. The feature matrix consisted of rich charcoal stained soil above the dense layer of fire cracked rock. Burned rock concentrations at a higher elevation from the basin were located on the southern and southeastern edges of the feature center. The profile of the basin and the layer of dark matrix above the rocks suggest that the concentrations are result of removing the upper layer of the feature. Based on the observations, the authors determined the feature was an oven with evidence of a lid removal event (Brownlow 2003). Limestone and chert made up the majority of the fire-cracked rock and the basin was lined with large flat rocks which sloped toward the center of the pit. (Brownlow 2003).

Six camas bulbs were identified from macrobotanical charcoal samples recovered during excavations (Brownlow 2003; Dering 2003c). The specimens were recovered from the perimeter of the feature. Only one sample was recovered from inside the feature and no specimens were recovered from the five flotation samples taken from the center of the feature. The other botanical remains recovered from the feature were primarily wood charcoal.
Within the feature matrix, large pieces of charcoal, deer bone, and two pieces of modified bone were recovered along with camas bulbs. lithic artifacts recovered from the feature included debitage, one distal dart point fragment, and one fragmented biface (Brownlow 2003: 34).

38. 41WM632-Blockhouse Creek

Time Period	Late Prehistoric
Ecological Region	Edwards Plateau
No. of Features	2
Class of Features/ Feature #s	Class III/Midden 3 Class III/Midden 4
Geophytes	*Allium* sp.
Radiocarbon Dates in B.P.	Lot 221–950±50(Midden 3) Lot 255–1730±60(Midden 3) Lot 242–996±60 (Midden 3) Average–970 (Midden 3 without Lot 255 outlier) Lot 254–590±60(Midden 4) Lot 193–670±60(Midden 4) Lot 194–710±60(Midden 4) Lot 286–1190±52(Midden 4) Average–656 (Midden 4 without Lot 286 outlier)

Site 41WM632 is located on the southern terrace of Block House Creek (Keetley, et al. 1999). The site contained eight burned rock middens and spans a period of occupation throughout the Late Prehistoric. Five middens were near a small drainage approximately 300 m south of Block House Creek and three middens were on the southern terraces of the creek. Two middens in the southern terrace contained evidence of geophytes (Keetley, et al. 1999).

Midden 3 was a circular mound that measured approximately 12 m by 11 m. The thickness of the midden below the ground surface averages. 40 m. An articulated rock lined basin, designated as Feature 7 was discovered during the trenching of the midden. The feature was circular measuring 1.5 m in diameter, and limestone slabs lined the basin and the outer edges of the feature (Keetley, et al. 1999). Larger rocks sloped down from the outer edges of the feature and smaller fragmented rocks surrounded the basin. The depth of the basin was .40 m and was measured from the top of the rocks on the outer rim to the base of rocks in the basin. Flotation samples removed from the center of the basin yielded five wild onion bulbs. The bulbs were recovered from the upper layers of the excavated feature and the base of the feature. Other botanical remains identified from the feature and midden included oak, hackberry, juniper, and maple. Faunal remains represented in the midden included deer, turtle, and unidentifiable medium to large mammals. Artifacts recovered from the feature included debitage, snail shell, charcoal, and an untyped arrow point. Additional artifacts recovered from the midden include bifaces, scrapers, knives, blades and projectile points. The projectile points identified consisted of a Travis, Frio, and Scallorn (Keetley, et al. 1999).

Midden 4 was approximately 70 m southwest of Midden 3. The circular mound measured 12 m in diameter and was .24 m above ground surface. The average thickness of the midden below ground surface was .20 m with the deepest point at .46 m. The total thickness of the midden from the top to its base was .72 m. Two central cooking features were observed in the midden during trenching excavations. Feature 2 consisted of a rock lined basin that measured 1.5 m in diameter (Keetley, et al. 1999). Feature 3 was not excavated. Two smaller pits with concentrations of carbon were observed within the feature during excavations and were interpreted to be subsequent reuse of the feature. Two wild onion bulbs were recovered from the flotation samples near the center of Feature 2. Other botanical remains identified from the midden included wood charcoal of oak, elm, willow, maple and seeds of grape. Artifacts recovered from Feature 2 include lithic debitage, a Martindale point, two untyped arrow points, and three Scallorn points. Other points recovered from the midden surface consisted of Ellis, Frio, and Ensor points (Keetley, et al. 1999).

39. 41WM1126-Siren Site

Time Period	Transitional Archaic
Ecological Region	Cross Timbers
No. of Features	3
Class of Features/ Feature #s	Class I/Feature 23 & 30 Class III/ Feature 35
Geophytes	Indeterminate bulbs
Radiocarbon Dates in B.P.	Beta-215922–2370±40 (Feature 35) Features 23 & 30 same context as Feature 35

Site 41WM1126 is situated on the southern bank of the South Fork of the San Gabriel River. The site is extensive along the bank and contains occupations that span a period from the Early Archaic to the Late Prehistoric. Three features contained evidence of geophytes. These specimens were identified as bulbs out in the field and no identification analysis has been performed (Houk, et al. 2006).

Feature 23 was an oval burned rock cluster measuring 1.46 m by 1.25 m. The feature consisted of large tabular limestone slabs. The slabs tilted toward the center of the feature in the northern portion while the southern portion contained fragmented rocks fractured in situ. The feature appeard to lie on a flat surface and was approximately 17 to 28 cm thick. Charcoal stained was observed throughout the feature and two carbonized bulb-like specimens were recovered from the northern portion of the feature during excavations. Other materials recovered include bone fragments, a biface, debitage, and mussel shell.

Feature 30 was a basin-shaped rock-lined hearth measuring 1.62 m by 1.50 m. The flat limestone slabs were fractured in situ and the basin contained an ashy matrix. A carbonized bulb specimen was recovered from within the matrix during excavation.

Feature 35 is a large concave basin-shaped hearth measuring 1.80 m by 1.80 m. The slab-lined feature contained large flat limestone rocks, measuring 20 to 30 cm. The rocks along the edges of the feature were oriented vertically toward the center and placed side by side. The rocks within the basin, which was approximately 40 cm deep, were burned but not fractured. The matrix consisted of a dark charcoal stained soil. A carbonized bulb fragment was collected from within the feature matrix during excavation.

40. 41WM1010-Brushy Creek

Time Period	Late Archaic
Ecological Region	Blackland Prairie
No. of Features	1
Class of Features/ Feature #s	Class III/Feature D56
Geophytes	Indeterminate bulb
Radiocarbon Dates in B.P.	1230-990

Site 41WM1010 is situated along Brushy Creek and contains evidence of occupation spanning a period from the Late Archaic to the Late Prehistoric (Dixon and Rogers 2006).

Feature D56 is an oblong or oval shaped rock-lined oven measuring 65 cm by 77 cm and 32 cm thick. A profile view of the feature was not recorded so the basal configuration could not be determined. A scatter of burned rock was observed around the edge of the midden interpreted to be discarded material from clean out events. The layer of rich carbon soils located at the based of the feature was interpreted to be a reflection of intensity of use, or multiple baking episodes. Nine indeterminate bulbs fragments, weighing 0.1 grams, were recovered from flotation samples, as well as oak wood charcoal (Dering, et al. 2006). In addition, debitage, faunal, and ochre fragments were also recovered.

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