INTERPRETING PREHISTORIC PATTERNS: SITE-CATCHMENT ANALYSIS IN THE UPPER TRINITY RIVER BASIN OF NORTH CENTRAL TEXAS

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Archaeologically site-catchment analysis produces valuable information regarding prehistoric subsistence strategies and social organization. Incorporating archaeological data into catchment analyses is an effective strategy to develop regional models of prehistoric site selection and settlement patterns. Digital access to data permits the incorporation of multiple layers of information into the process of synthesizing regional archaeology and interpreting corresponding spatial patterning. GIS software provides a means to integrate digital environmental and archaeological data into an effective tool. Resultant environmental archaeology maps facilitate interpretive analysis. To fulfill the objectives of this thesis, GIS software is employed to construct site-catchment areas for archaeological sites and to implement multivariate statistical analyses of physical and biological attributes of catchments in correlation with assemblage data from sites. Guided by ecological, anthropological and geographical theories hypotheses testing evaluates patterns of prehistoric socio-economic behavior. Analytical results are summarized in a model of prehistoric settlement patterns in North Central Texas.

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CHAPTER 1

INTRODUCTION

Archaeological sites are part of a human ecosystem built within a dynamic living physical landscape. It is within this interactive matrix that prehistoric communities interacted spatially, socially and economically. The nature of this matrix is typically extrapolated from subsistence activities and settlement patterns. Evidence of subsistence activities is primarily recovered from archaeological sites in the form of fauna (i.e. animal remains), features (e.g. fire-cracked rock, hearths, middens) and artifacts (e.g. projectile points, other stone tools, grinding stones, ceramics). In order to facilitate pattern recognition and assist in the modeling of prehistoric settlement patterns, archaeologists have examined the characteristics of the micro-environments that surround site locations. However, broad descriptive generalizations based on macro-environmental correlations are often found in the literature,

> The study of prehistoric sites is not usually complemented by some treatment of their setting, the situation in their immediate vicinity—the principal concern of the inhabitants—tends to be neglected or at any rate overshadowed by generalized statements regarding the physiographic, vegetational, climatic or kindred zones of which they form a part (Vita-Finzi and Higgs, 1970:1).

This is particularly the case for the state archaeological site files housed at the Texas Archaeological Resource Laboratory (TARL) in Austin. One of the most significant components missing from state archaeological site files is the specific environmental context within which these sites and artifacts were discovered. Records housed in state and university laboratories are increasing in number, yet often site report content is not substantial enough to facilitate comprehensive regional studies. Glimpses into prehistory that have been provided by archaeological discoveries must be viewed cumulatively in order to understand the larger patterns that emerge regarding prehistoric behavior. Although many contract, academic and published reports from the region make reference to soils, vegetation, geology and zonal physiographic characteristics of the landscape, there is a general disconnection between the sites, the data and the interpretive inter-relationships. This research seeks to bridge the gap by providing a series of maps with interpretive visual representations that provide a bird's eye view and facilitate pattern recognition toward developing a more comprehensive view of site distribution within the environment. Tabular data coupled with interpretive discussion based on spatial and statistical analysis is used to explain these patterns.

Research Orientation

A substantial amount of research has been conducted, in north-central Texas, with respect to prehistoric socio-economic systems (Dawson and Sullivan, 1969; Hays et al., 1972; Bousman and Verrett, 1973; Nunley, 1973; McCormick et al., 1975, Filson et al., 1975; McCormick, 1976; Lynott, 1977, 1981; Skinner and Baird, 1985; Lebo and Brown, 1990; Prikryl, 1990; Ferring and Yates, 1986, 1997, 1998). These archaeological reports involving cultural-ecology, subsistence and settlement pattern studies have provided a wealth of empirical data. Much of the contract and academic research in this region, conducted between 1968 and 1998, has resulted in the development of models that discuss site function, distribution and regional settlement patterns. It is important to note that the research conducted in north-central Texas (figure 1) has revolved around contract work associated with the construction of reservoirs. Along the Elm Fork of the

Trinity River extensive professional archaeological investigations have been conducted. Research along the East Fork is based on academic and professional efforts but to a much lesser extent than the Elm Fork. As a result, there is a strong bias in site distribution related to the intensity of investigations along the Elm Fork. West Fork sites were primarily reported by amateur archaeologists. The lack of professional investigations along the West Fork partially explains the paucity of sites. However, the sites that do exist offer valuable comparative environmental data for site catchment analysis (SCA).

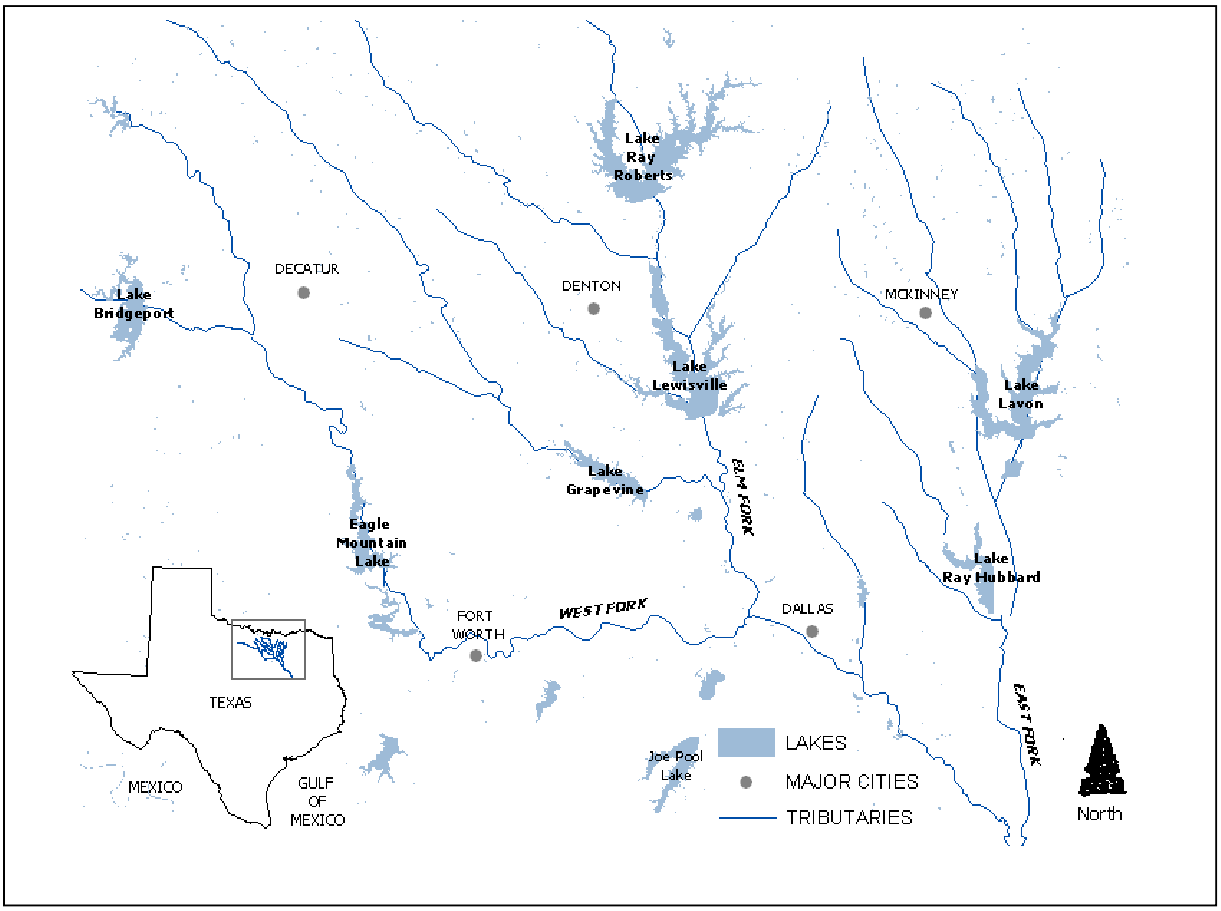

Figure 1. Lakes and major cities in north-central Texas.

Although a variety of regional models have been proposed for this "region", many of these models are built in relation to specific excavation sequences typically located in isolated microenvironments, which are considered to be representative of the region. General physiographic characteristics are frequently employed to fill in the gaps in order to extend the model beyond the immediate study area.

Previous studies conducted along the Elm Fork of the Trinity River have resulted in a variety of interpretations of prehistoric settlement patterns. This section will review the settlement pattern theories that have been formulated based on prior research in the region. Several investigators have referred to this region as "marginal" (Lynott, 1977; Skinner and Baird, 1985; Prikryl, 1990; Story, 1990). However, other investigators such as Dawson and Sullivan (1969: 5) consider the grassland, woodland, riverine and transitional ecotonal settings to be "highly opportune" for prehistoric occupation.

Dawson and Sullivan acknowledge the economic potential of the variety of resources within each environment. Within the grassland, a variety of vegetation and faunal resources are accessible. Riverine environments, nested within the woodlands, provide a substantial supply of protein associated with fishing and gathering activities. Throughout the entire region, small fauna, supplementary foods, medicine, lithics, wood and various sources for construction can be obtained (Dawson and Sullivan, 1969). Since multiple environments are present in north-central Texas these authors speculate that prehistoric groups utilized a generalized and vast array of resources. A highly mobile and semi-sedentary model of occupation is posited within all three settings. Based on the character of the environment they propose that food could be obtained during extremely dry or wet climates if groups remained small and spread out across the landscape. A scattered settlement pattern would sustain balance with climatic and seasonal fluctuations. Differences in site positioning between Archaic ridge sites and bottomland Late Prehistoric sites, on the East Fork of the Trinity, are considered to be a intentional selection of site location geared towards maintaining this balance (Dawson and Sullivan, 1969).

> A food surplus, stored during the spring and summer, would probably be required for group survival during the late winter and early spring. At that time, the probable high water, hibernation of many woodland animals and the scattering of grassland herds would vastly reduce food production. The usual size of the surplus would probably determine functional group size. This surplus could be achieved by hunting and gathering groups from herd slaughter, grass seeds and gathered woodland and lowland products (Dawson and Sullivan, 1969: 6).

Fundamental assumptions of their settlement pattern theory are that "site positioning reflects basic needs that vary according to cultural adjustment; and that sites are located near the major source of food" (Dawson and Sullivan, 1969: 2). Given that several food sources are available, location is thought to have been based on situating women and children near areas where gathered food sources are maximized (Dawson and Sullivan, 1969). Essentially, Dawson and Sullivan conclude that prehistoric population size was primarily dependent on the environment in correlation with the seasons and the climate. As a result, they propose that an environmentally based economic threshold was established that dictated prehistoric group size, site selection and organization.

Hays et al. (1972) identify three distinctive geomorphic locations related to archaeological sites in an environmental impact study conducted along the Elm Fork of the Trinity. Floodplains, terraces, and uplands are considered to be preferred locations for archaeological sites (Hays et al., 1972). Floodplain sites investigated by Hays and others primarily consist of concentrations of burned rock, mussel shells, flint tools and debitage. According to these investigators several floodplain sites seem to represent single events of preparing and eating mussels. "Projectile points are present and indicate this activity may have resulted from a small hunting party stopping for a meal or for overnight" (Hays et al., 1972: 18). Terrace sites are reported to predominantly contain lithic scatter and upland sites are typically found where natural quartzite and chert deposits occur on the surface (Hays et al., 1972). Prehistoric populations probably quarried raw material at upland locations given the association with local raw materials (Hays et al., 1972). Faunal remains of both large and small species indicate hunting in the floodplain and uplands. Remains from the sites, investigated during their survey, indicate utilization of a variety of microenvironments (Hays et al., 1972). Overall, Hayes categorizes sites as representing activities such as food preparation and/or camping, short term seasonal occupations or long term base camps sites that provided access to various environmental resources.

During an archaeological reconnaissance of the proposed Aubrey reservoir Bousmann and Verrett (1973) define six micro-environmental zones on the basis of correlated biology, geology and physiography. These zones include: "rivers and drainages; floodplains; floodplain rises; fluvatile terraces; upland slopes; and uplands" (Bousmann and Verrett, 1973: 7). Their purpose for developing these categories is to provide an explanatory mechanism for inter- and intra-site variation (Bousmann and

Verrett, 1973). Employing this model, Bousmann and Verrett (1973: 12) hypothesize that "the Eastern Cross Timbers district was utilized more often for base camps, and the prairies were utilized for specialized activities, i.e. hunting." Supporting evidence for this hypothesis includes the "presence of permanent water sources, concentration of wood, highly permeable sandy soils and a stable supply of native plants and animals in the Cross Timbers" (Bousmann and Verrett, 1973: 12). Another hypothesis, formulated by these investigators, is that fluvatile terraces specifically function most often as base camp sites while other zones are occupied only when seasons or climatic conditions permitted and provided sufficient returns (Bousmann and Verrett, 1973). The central location of terraces maximized access to all of the resource zones and proximity to permanent water sources in areas that would be protected from flooding (Bousmann and Verrett, 1973). In relation to this supporting environmental evidence it is posited that prehistoric groups moved to upland camps during wetter seasons and lowland sites during drier seasons. Deviations from this model are expected due to variations in social organization, religious factors, taboos and other socially defined parameters.

McCormick et al. (1975) proposes that this region served as an avenue of seasonal migration due to the increased availability of eco-tonal resources. Based on a survey project conducted along the southern reaches of the Elm Fork these investigators observe that Archaic seasonal camps are typically located in eco-tonal settings and secondary activity-specific sites are situated in relation to specific outcroppings, plants, and water (McCormick et al., 1975: 41). McCormick (1975) posits that Late Prehistoric groups followed similar patterns, producing seasonal camps and activity specific sites, until agriculture was introduced and large base camps or permanent villages emerged. According to McCormick's settlement model, groups seasonally migrate with the bison and return north in spring to spend the summer months in large agricultural villages.

> During the late fall, family sized groups would leave the base camps to follow the bison herds south into the central Texas area, by following the Cross Timbers from the Red River south to the vicinity of Waco, Texas. Temporary camps, showing signs of both male and female activities, should be located well into the Cross Timbers and out on the prairies in association with whatever resource was being exploited. These will be fewer in number than during the Archaic period because of the transitory nature of the usage (McCormick et al., 1975: 41).

The proposed settlement model divides sites into Archaic and Neo-American (Late Prehistoric) subdivisions. These subdivisions are classified into three groups: permanent village, temporary campsites and activity-specific sites. In the study area, located south of Lewisville, along the Elm Fork of the Trinity, this model is found to be useful. As predicted the large village type settlement is also present in the study area. Temporary campsites for both the Archaic and Neo-American periods are situated in similar ecological microenvironments. Permanent villages and activity-specific sites, such as manufacturing stations, are not recognized within their study area. However, these site types are found to the southwest further into the Cross Timbers. According to the model, temporary camps of Neo-American and Archaic groups should be located in similar areas with affinities in site structure with the exception of diagnostic tools such as large "dart" points associated with the Archaic and small "arrow" points with ceramics which identify the Neo-American groups (McCormick et al., 1975: 45). All of the Neo-American sites are ephemeral and situated along the upland edge, providing immediate access to a maximum of resource zones. Seasonal Archaic sites tend to display more “permanent characteristics” since these sites were apparently occupied for a longer duration (McCormick et al., 1975: 45). McCormick and others hypothesize that the zone of movement was along the prairie-cross timbers boundaries attributed to the presence of more “permanent” sites (Prikryl, 1990: 31). McCormick et al. (1975) find Lewisville sites located respectively north and south in almost identical environmental situations. What is considered to be unusual is the “apparent similarity of activity regardless of temporal considerations” (McCormick et al., 1975: 78).

> The amount of patterning in artifacts and activity areas within a site will increase in proportion to an increase in occupation time. Neo-American permanent villages will display the most evidence of "city planning", Archaic seasonal camps next, then Neo-American transitory camps, and lastly, both Neo-American and Archaic activity-specific stations. In the absence of diagnostic artifacts it is difficult to distinguish Archaic from Neo-American stations where similar activities took place (McCormick et al., 1975: 46).

Reoccupation of sites over a long period of time is also considered to be common in this region. The settlement pattern exhibited here is thought to have been established during the Paleoindian and continued until the “westward expansion of the Europeans altered the native cultures to such an extent that they could no longer continue their normal settlement and subsistence patterns” (McCormick et al., 1975: 78).

Lynott (1977) presents a regional model for future archaeological research in north-central Texas and provides an extensive listing of previous investigations in the prairie-cross timbers area of the region. Lynott (1977) emphasizes subsistence-settlement models and encourages use of general systems theory. His regionally oriented design hypothesizes changes in adaptive strategies through time. During the Early to Middle Archaic, Lynott (1977) observes a shift from open-land to big game hunting to bottomland riverine hunting and gathering. An "increase of population density and decrease in territoriality" defines the Late Archaic (Lynott, 1977: 158). As a result, Lynott (1977: 158) proposes a "restricted wandering" settlement pattern where sites are situated in terraces settings near water and bottomland resources. During the first phase of the Late Prehistoric, Lynott proposes that the initial stages of tribalization, sedentism and horticulture were related to an increase in population pressure that instigated territorial conflicts (Lynott, 1977: 159). The concept of tribalization is related to the presence of ceremonial structures that emerged on the East Fork of the Trinity. This situation is thought to have continued to a greater extent during the second phase of the Late Prehistoric as the "population grew and social boundaries became more defined" (Lynott, 1977: 160). Throughout time Lynott emphasizes the utilization of bottomland resources. Regionally, he proposes use of the Wichita model of settlement and subsistence patterns. This model is based upon a nomadic winter bison hunt in the prairies with semi-permanent villages occupied during the spring and summer (Lynott, 1977). An alternative model is proposed by associations with the Tonkawa that suggests seasonal hunting and gathering in north-central Texas (Lynott, 1977). In general, the settlement pattern that Lynott (1977) proposed for sites revolves around large bottomland base camps and smaller, seasonally occupied, special activity sites.

Skinner and Baird (1985: 5-11) propose a "marginal territory" model for the Ray Roberts Lake area, along the northern branch of the Elm Fork. This model is based on the paucity of sites, small site size, low density of cultural remains at individual sites and numerous natural environmental variables. It operates on the premise that the diverse resources in the region served as specialized ecosystems. In particular, the mast resources provided in the uplands of the Cross Timbers and the riparian species, documented by archaeological reports, reflect these specialized ecosystems. Field observations of maintenance and extraction sites reveal a concentration in the Cross Timbers and riparian environmental zones (Skinner and Baird, 1985). Conclusions based on research conducted at these sites are made according to a demographic version of a settlement model known as the central based wandering (CBW) community pattern. The "CBW model", developed by Beardsley and others in 1956, has been used as an "organizational tool in various parts of Texas and surrounding regions" (Skinner and Baird, 1985: 5-1). It is employed as a means of "categorizing sites which had a limited number of surface artifacts" and where diagnostic tools or pottery are not found (Skinner and Baird, 1985: 5-1). Due to the lack of datable artifacts, sites are categorized into functional types on the basis of the character of lithic debris present on the surface of sites and artifact assemblages. It was expected that by correlating these two classes of information, consistent site types could be defined and could be replicated by others (Skinner and Baird, 1985: 5-3).

Based on the results of the site survey, it is noted that 40 of the prehistoric sites appear to represent a single occupation period while 22 have artifacts from more than one occupation period. Twenty-one morphological site types are defined by cluster analysis of the survey data and then consolidated into 7 functional sites (Skinner and Baird, 1985). Results indicate that of the 117 sites surveyed 62 were datable, 23 were base camps, 32 seasonal camps, 16 hunting camps, 10 musselling camps, 9 hunting stations, 2 collecting stations and 21 lithic procurement sites (Skinner, 1985). According to Skinner (1985), undated sites typically include locations where stone was gathered, or quarried, and where initial tool making processes were carried out.

Skinner and Baird (1985) pay particular attention to site type, age, location, and other variables such as assemblage, deposition and preservation. Skinner and Baird (1985) also provide an alternative model of settlement that utilizes the work of others in the surrounding areas for assistance in the reconstruction of the effective natural environment. This alternative settlement model associates cultural change and shifts in settlement locations with changes in the natural environment. It is noted that emerging patterns indicate that certain locations were preferred over time. According to Skinner and Baird (1985), while repeated reoccupation may distort functional differences, this situation provides a means of observing the use of a particular site location during its lifetime. However, besides reference to the mast crops, there is no specific discussion as to why these locations were preferred and if there are patterns in particular environmental variables that made them desirable locations for occupation. There is also a lack of clarity as to the shifts in settlement locations that were reportedly responding to environmental change.

A series of observations from the Lewisville report (Ferring and Yates, 1998) and Ray Roberts report (Ferring and Yates, 1997) shed light on prehistoric settlement patterns and provide informative data regarding site selection along central portion of the Elm Fork of the Trinity. Site location patterns at Lake Lewisville indicate the utilization of ecotonal resources associated with the transition between the prairies and woodlands. Faunal data documented from archaeological excavations indicates that prehistoric populations may have been focusing on hunting on the wooded edges rather than harvesting the potential mast crops at central locations within the Cross Timbers (Ferring and Yates, 1998). Accordingly sites are primarily situated on the eastern edge of the Cross Timbers near the border of the Blackland Prairie.

Topographic settings are a fundamental component of site selection that is often incorporated but not explained interpretively. For example, one could ask why the upland and terraces settings would be preferred over floodplains. Of the 150 components in the Lewisville Lake area 49% are located in terrace settings, 49% in upland settings and 2% in the floodplains (Ferring and Yates, 1998). With respect to drainages 45% are located along Little Elm Creek, 27% along the Elm Fork of the Trinity, 20% along Hickory Creek and 8% are situated along minor tributaries (Ferring and Yates, 1998). Given that these sites are primarily located on terraces and upland settings rather than in the floodplain may indicate that the Lake Lewisville area was occupied during wetter climatic episodes. Artifact assemblages excavated in this area suggest seasonal occupations so it may be that these areas were occupied during the wetter seasons rather than wetter climates.

The overall pattern detected by Ferring and Yates (1998: 153) suggests that prehistoric populations "exploited whatever was available to them, and possibly did so within quite well-defined territories. Life was rigorous and large sedentary communities were probably never common if they existed at all." Ferring (1998: 153) concludes that while evidence supports an increase in resource availability, stimulated by climate change, in the Late Prehistoric, there is little evidence to support that "this stabilized culture groups as indicated by decreased mobility, increased specialization of patch exploitation, or decreased diversity of floral-faunal resource procurement practices."

Despite all of the investigations that have been conducted in north-central Texas it is the consensus of several archaeologists (Lynott, 1981; Skinner and Baird, 1985; McCormick et al., 1975; Prikryl, 1990; Ferring, 1998) that information about subsistence and settlement patterns of the prehistoric occupants of north-central Texas needs to be expanded upon and models refined on a regional scale. According to Ferring (1998), the absence of a local record of past environments and chronological controls has prevented previous settlement models from consideration of diachronic adaptive changes. As a result, regional settlement models have not actively considered changes in past environments as possible controls on site frequencies or site characteristics. Throughout the discussion, of the proposed regional models, there is no mention of sites along the West Fork of the Trinity and typically Elm Fork investigations do not incorporate East Fork research. Although these investigators are certainly familiar with the cultural history of the region it appears that their "regional" settlement pattern models are situated along and primarily in reference to either the Elm Fork or the East Fork of the Trinity. In addition, although the settlement models refer to environmental settings, the bulk of the analyses revolve around archaeological remains. While the results yielded from such analyses are informative, correlations with the micro-environments for these sites are not directly addressed or synthesized on a regional scale. Specialized ecosystems are referenced in several reports yet these areas lack definition in relation to the sites and associated prehistoric behavioral patterns. In some cases the economic utility of the environment is addressed but these data are not directly related back to site-specific interpretations. Most investigators refer to the general physiographic characteristics and then shift focus to describing the archaeology. While the archaeology is of primary importance and provides evidence of prehistoric behavior it must not be viewed in isolation. Details concerning the specific ecological setting where this evidence was found are equally important. The dynamic relationship that exists between the two must be preserved. As such, the inter-relationships between the artifacts and the immediate environmental setting should be evaluated and interpreted accordingly. The current research is designed to reveal patterns in these inter-relationships. In addition, relationships between site locations are evaluated with respect to the multi-facetted context in which these sites are found, in order to consider change through time, site density, occupation frequency and explain site location.

Objectives

All of the research efforts conducted in this region have provided important contributions and valuable insight regarding prehistoric populations that inhabited north-central Texas. However, when sites are viewed in isolation, regional settlement pattern behavior is difficult to discern. Given the dynamic relationship of the parts paired with the bulk of archaeological data, formulating a regional model is a formidable task. Fortunately, geographic information systems (GIS) technology provides organizational mechanisms to manage the wealth of data and create links between the various components of a complex ecosystem and archaeological sites. Rather than accepting the previous generalizations, concerning settlement pattern behavior in north-central Texas, based on a few excavated sites or surveys, the objectives of this research are to:

1. Develop research methods and integrative techniques that enhance evaluation, analysis and interpretation of regional settlement patterns.

2. Conduct analysis of a large collection of prehistoric surface sites using excavated sites, as a means of temporal control, in order to evaluate settlement models formulated for this region.

3. Transform environmental data layers into interpretive maps for spatial and statistical analysis.

4. Employ GIS to define site catchments, reconstruct the economic resource space around sites, extract descriptive information and attach meaning to these attributes for interpretive analysis.

5. Test a series of hypotheses with spatial and statistical techniques to address unanswered questions and evaluate settlement pattern theories proposed by previous investigations.

6. Provide more specificity for the interpretation of regional settlement patterns by utilizing GIS techniques to manage large data sets, identify the particular variables that may have attracted prehistoric populations to sites and investigate adaptive changes through time.

7. Develop a methodology for future investigations and a model to explain regional prehistoric settlement pattern behavior, in north-central Texas, that can be utilized beyond the study area, in other regions, to improve cultural resource management practices.

8. Create environmental archaeology maps to facilitate future cultural resource management, planning, mitigation, preservation, excavation, and analysis.

Primarily, this research is conducted to shed light on prehistoric socio-economic behavior by constructing a regional environmental archaeology database and performing SCA to evaluate previous investigations in an interpretable environmental setting. Focus is upon decision-making processes, related to site selection, as reflected by the variability and interpretive value of soils, vegetation, faunal remains and artifacts. To meet the objectives of this research, GIS software is utilized to place archaeological sites in their spatial context, establish economic territories, identify associated environmental variables, infuse the environment with interpretive meaning, correlate artifacts and statistically evaluate a series of hypotheses. These data are interpreted and results are synthesized in a regional model of prehistoric settlement patterns in north-central Texas.

CHAPTER 2

METHODOLOGICAL FOUNDATIONS

Essentially, settlement patterns are correlates of prehistory (the archaeological record) and geography (spatial information). Prehistory and geography are closely linked with respect to the fact that both examine the distribution of human phenomena, use of natural resources and inter-relations of humans with their environment (Renfrew, 1969: 74). Site catchment analysis (SCA) provides a means to evaluate these relationships and cultural ecology, a means to interpret the associated behaviors.

Cultural Ecology

Interpretation of prehistoric behaviors is interwoven with cultural ecology. As a science, ecology is concerned with investigating the reciprocal relationships between living populations and the natural and social environment in which they exist (Geier, 1974: 47). Cultural ecology is "adaptation to environment" (Steward, 1955: 30). The differentiating factor between ecology and cultural ecology is related to the added dimension of cultural behavior which forms a dynamic part of the ecosystem. According to Geier, this approach is more than studying relationships between man and nature,

> It is concerned with the patterned interrelationships of individuals within human populations, the manner in which a population interacts with each other and with different living species; and it is concerned with the effect that change in the physical environment has on influencing and restructuring the relations of individuals and the relations between human and non-human populations in an eco-community (Geier, 1974: 47).

Since the time of Darwin, the environment has been conceptualized as the "total web of life wherein all plant and animal species interact with one another and with physical features in a particular unit of territory" (Steward, 1955: 30). Understanding the mechanisms of cultural development begins with variation. This variation is what defines the unique character of individual cultures. More important then the variation itself is the source of the variation and that it can be correlated with psychological preferences or ecological adaptations. It is this variability that explains behavioral change and this is precisely what archaeologists seek to do.

> We will never learn what causes variability in the archaeological record by simply providing a behavioral "interpretation" of our sites or if we are fortunate to have chronological data, "by reconstructing culture histories." We must strive to learn what factors have conditioned cultural variability in the recent as well as in the distant past. This goal requires that we embrace research strategies that permit us for purposes of learning to use our prior knowledge analytically rather than simply apply it to the archaeological record in a accommodative piecemeal fashion (Binford, 2002: 472).

SCA provides a means to evaluate the ecological factors that have influenced cultural behavior. According to Jochim (1979: 84), "until we understand the mechanisms involved, we are limited to description and analogy." Geier aptly points out that the "description of a behavior pattern does not tell us why it exists only that it exists" (Geier, 1974: 46). Cultural history is not fully interpretable without the incorporation of the ecological framework into research strategies,

> For archaeological interpretation to proceed past mere description and notation of observed patterns and regularities in material debris, the frame of reference must be extended beyond the artifact to site context, or beyond the site to the social system, eco-community, and eco-system in which it occurred. To describe a behavioral event is only one step; to understand it is the real goal (Geier, 1974: 47).

An ecological "frame of reference" (Geier, 1974; Binford, 2002) can help understand a portion of the mechanisms involved that influence variable prehistoric behavioral choices in relation to site selection. Developing an ecological understanding involves "exploration of the resources used in relation to those available, the constraints on the organization of procurement, the spatio-temporal variability of the environment, and the environmental effects of exploitation" (Jochim, 1979: 89). By employing an "ecological frame of reference", human culture is seen as an integral part of the environment or ecosystem, influencing and being influenced by, the patterned interaction of its parts (Geier, 1974: 47).

Ecosystem complexity has prompted trends of ecological research in archaeology that require multi-scalar research. Jochim (1979) cites several examples of archaeological attempts to reconstruct prehistoric economies that correspond with this trend. According to Jochim (1979), it is beneficial to limit the number of interrelated variables in order to examine their interaction and reaction to change. These allegorical windows provide brief glimpses at isolated parts of the archaeological record. In some respects, it is necessary to break the system down into smaller components in order to understand the parts that create the whole. However, although, the information derived from specialized studies is of great value, it must be viewed as part of the larger system. Focus on an isolated part causes distortion of the larger picture whereas focusing solely on the larger picture obscures important descriptive and interpretive details. As such, a healthy balance between these two perceptual viewpoints is desirable. For settlement pattern studies to be potent, empirical details along with an understanding of their cumulative effects must be interpreted, translated into subsystems and evaluated in relation to other subsystems that form patterns within the larger system.

A common problem inherent in utilizing a theory of cultural ecology relates to the concept of "environmental determinism." According to Steward (1938), incorporating ecology is not environmental determinism or economic determinism. It is a "methodological approach" to gain a deeper understanding of behavior patterns required to survive in a given environment. Steward (1938: 261) views it as an "equation of culture process involving the interaction and mutual adaptation of both historically and environmentally determined behavior" rather than "a claim a priori that ecology predetermines cultural behavior." Even in the sciences the realization that "physical scientific laws are not deterministic but only statistical approximations of very high probability based on finite populations" has been accepted (Haggett, 1966: 26). This is a key point in support of the current research. Concern is with probability patterns that emerge from the landscape, in association with the archaeological record, as a basis for the interpretation of regional settlement patterns. The effect of the environmental setting on the range of possibilities available for the manifestation of human behavior is what is appealing about an ecological approach. Even though different economies, each composed of a system of activities that include the utilization of different resources, may be employed within a specific environment there are still parameters that set limitations. Any adaptation may vary only within the limits of the character of the natural environment or the populations cannot survive. Establishment of these limits is an important part of interpreting prehistoric behaviors and spatial patterning. Combining cultural ecology precepts and geographical theory is the basis for establishing these parameters and understanding the associated dynamic relationships.

Geographical Theory

In order to examine the spatial patterning of past human activities archaeology has borrowed a number of analytical techniques from geography and adapted them successfully. Locational theory, "a product of economics, ecology, systems theory, and regional analysis" (Haggett, 1966: 26), has been applied to prehistory with little change from its use in human geography. The text, *Locational Analysis in Human Geography* served as a "major contribution to prehistoric archaeological theory" (Renfrew, 1969: 74). Central place theory first proposed by Von Thunen, in the early 1800s, developed into a method of geographical analysis that became central to locational theory.

Von Thunen hypothesized that an isolated population center, in a uniform environment, with an ideal distribution of production would create distinct land-use patterns that form concentric circles radiating from the center outward. Essentially, the further from the base site resources are, the greater their economic cost. Eventually there is a point where cost surpasses the return. This threshold defines an economic boundary that forms the exploitation territory of a site. A similar view developed by Christaller (1966) incorporates site hierarchies and their related economic spheres. The range of goods and resources available to a particular settlement are the foundation of the hierarchies. These theories of settlement hierarchy, referred to as "central place theory", proposed ways in which a settlement system could be spatially organized to perform certain types of work most efficiently (Christaller, 1966).

The location-allocation model developed by Bell and Church (1980) was formulated to evaluate archaeological settlement patterns by assigning "relative weights to strategic criteria, resource constraints, principles of economic efficiency, political control, and transportation interconnection" (Butzer, 1982: 222). The assumption is that settlement patterns are the "result of political, economic, and ecological forces working themselves out on the landscape" (Butzer, 1982: 222). Jochim (1976) developed a gravity model to analyze the interactions between human population and several preferred resources. It operates on the premise that site locations are situated near high density resources associated with decreased mobility (Jochim, 1976). Butzer's (1982: 223) ecologically based resource concentration models offer effective explanatory mechanisms that incorporate "differential plant productivity and animal biomass of different biomes." Such models "imply higher group density in preferred biomes, creating stepped population gradients between marginal and optimal environments, with major discontinuities at or near the boundaries" (Butzer, 1982: 223). These resource concentration models are viable mechanisms for forming hypotheses and developing theories about the dynamics of hunter-gatherer behavior.

Numerous applications, of geographical theory, to archaeological problems have been investigated. These geographically based models provide multiple perspectives and means to observe behavior in a spatial context. Human organization across the landscape ultimately reflects a strategic approach to survival. Geography provides effective tools and perspectives for archaeologists to evaluate prehistoric settlement patterns. Vita-Finzi, a geographer, and Higgs, a prehistorian, realized the benefits of collaboration between the two disciplines when they employed a method of locational analysis, which resulted in the development of the concept of SCA.

Site Catchment Analysis

Geographical theory and cultural ecology collectively form the foundation for SCA. Central place theory forms the primary theoretical geographical foundation. Cultural ecology includes fundamental procedures that are integral to SCA. An analysis of the interrelationship of material culture and environment is necessary. Behavior patterns involved in the exploitation of a particular area by means of a particular technology must be analyzed. Environmental variables include: geology, topography, soils, hydrology, vegetation, climate and fauna. Some subsistence patterns "impose very narrow limits while others allow considerable latitude" (Jochim, 1979: 40). In addition, the extent to which behavior patterns involved in exploiting a particular environment, affects other aspects of culture, must be determined. This aspect is much more abstract and can only be inferred based on the other two inter-relationships. Human behavior in its various forms of interaction requires study areas of different sizes. Three categories formulated during previous investigations include: "those focusing on the site and its catchment, the larger sustaining region for a group and broader areas containing several groups or larger societal units" (Jochim, 1979: 88). The current research employs a multi-scalar approach. SCA is performed on 150 sites. These sites are spatially and temporally analyzed to formulate explanations for regional settlement patterns.

SCA is a method that has been utilized by archaeologists to correlate prehistoric cultural remains with reconstructed environments (Vita-Finzi and Higgs, 1970; Schiffer, 1976; Butzer, 1982). Tiffany and Abbott (1982: 314) define SCA as an "inventory of artifactual and non-artifactual remains in relation to their sources." Its utility derives from the "incorporation of techniques relating site location to resource availability within a seasonally variable territory immediately surrounding a site" (Roper, 1979: 135). It assumes that this territory is of primary importance in structuring settlement patterns. This type of analysis provides an exploratory and explanatory mechanism for the organization of settlements upon the landscape.

The concept of site catchment developed in response to an expressed need for integration between environmental and archaeological aspects of the record (Vita-Finzi and Higgs, 1970). The term "site catchment analysis" was first used in archaeological literature by Vita-Finzi and Higgs to describe "the study of relationships between technology and those natural resources lying within economic range of individual sites" (Vita-Finzi and Higgs, 1970: 5). In other words, it is a technique that has been employed to analyze the locations of archaeological sites with respect to the economic resources available to them. SCA was derived from the movement-minimization concept, first introduced by central place theory (von Thunen, 1966), that land use is determined by transportation costs. SCA is typically performed by "delineating an arbitrary economic territory surrounding a site and evaluating the resource potential within that area" (Tiffany and Abbott, 1982: 314). Simplistically, the exploitation territory or catchment of a site can be approximated as a circular area centered on the site in question. The content of the catchment is interpreted by "comparative knowledge of site territories, resource distribution, site contents and settlement system structure" (Higgs and Vita-Finzi, 1972: 27).

Depending on the location, climate and time period, the environment offers very different possibilities. Typically, people are willing to travel only so far to utilize these resources (Roper, 1979). Sites frequently occupy positions that are not typical of their general zonal setting.

> Man sought the optimum and hence the atypical situation to meet his needs. Even if sites should prove after study to occur in an environmentally typical situation, it cannot be safely assumed at the outset that their presence is due to the factors that determine the environmental type. One means of ensuring that the environmental attributes investigated relate primarily to the site, its occupation and its occupants is by the intensive study of the small area immediately adjacent to it (Vita-Finzi and Higgs, 1970: 62).

Although this view provides information about the immediate vicinity of the site it is important to note that exploitation territories of prehistoric sites extend beyond the immediate vicinity especially in relation to a mobile economy.

Limitations are inherent in zonal approaches in terms of generalization but also in catchments due to the increased mobility of hunter-gatherer populations. The originators of the concept recognized these limitations. A human group that exploits more than one site territory during a year may vary the intensity and focus of its activities at certain sites. As such, it is the annual territory, rather than an individual site territory, that accurately reflects the economic system (Jarman, 1972; Yellen, 1977). When micro-environmental settings are investigated it is important to keep in mind the actual sphere of influence, of the particular population represented at the site, which likely extends beyond the area (Vita-Finzi and Higgs, 1970). Therefore, a multi-scalar approach that involves within-site and between-site investigations is necessary.

It is first essential to identify the territory in the proximity of a site, where primarily subsistence needs would be met, and then expand outward. Variable techniques have been employed to define catchment areas. Distance is one of the core variables in that it is the most fundamental property of spatial data. Estimates of where the boundaries of these territories should be placed have been derived from ethnography and differ depending on the cultural economic base and landscape character. Studies of modern hunting and gathering economies have indicated that the territory exploited from a site tends to be within certain well-defined limits. "Range of possible behavior is both in theory and practice limited by the capacity of a human population to exploit an area effectively, and is further reduced once the concept of optimum is introduced" (Jarman et al., 1970: 62). Other things being equal the further the resources are from the site the less likely that they will be utilized. Depending on the technology available at the time, beyond a certain distance, the area becomes uneconomical and is unlikely to be exploited (Chisolm, 1968). Ethnographic studies indicate that the base site will be moved, once the economic threshold has been met, to increase efficient utilization of resources (Lee, 1968). It is important to keep in mind that these prehistoric populations traveled by foot. "For optimal accuracy, distance should be qualified in terms of local topography; the operative factor is the time and effort involved in traveling the distance, rather than the absolute distance itself" (Jarman, et al., 1970: 63). Recognition of the inter-relatedness of these factors paired with the minimization of work as a motivating factor in human behavior is the basis for constructing site catchment parameters.

Studies of contemporary communities verify the importance of time, effort and distance in defining site territories (Lee, 1968). Chisholm (1968) and Vita-Finzi and Higgs (1970) both create an area that can be reached within 2 hours walking time, that takes into consideration the effects of topography and accessibility, for hunting and gathering economies. This revision of Von Thunen's model uses measurements of travel time rather than linear distance. Energy expenditure is considered to be more crucial than distance in determining the limits of exploitation territories. Two-hour radii are established on the grounds that daylight hours remaining after traveling to the outer threshold and back would be sufficient for food preparation. Resulting territories were compared with ethnographic case studies and found to fit fairly well with the size of the territories exploited from home bases respectively by collecting communities.

A combination of studies by Chisholm and Lee produce similar conclusions concerning the relationship of production to distance. These conclusions are that "available resources become uneconomic beyond a distance of 10 km" (Chisholm, 1968: 7). Site exploitation territory, for the modern hunter-gatherer !Kung Bushmen culture, is within a radius of about 10 km. This 10 km radius is "consistent in many parts of the world despite technological and environmental differences" (Vita-Finzi, 1978: 26). In Hastorf's analysis, the calculation of site catchment is based on the maximum radius beyond which a particular strategy is not effectively pursued. This study uses a 4km radius for everything except nut gathering and large game hunting. "Large game hunting and nut gathering encompassed a 10 km radius" (Hastorf, 1980: 90). Most studies have used either circular territories of fixed radii or time contours. Particularly in the case of flat or relatively uniform environments territories tend to be circular. A variety of site catchment models have modified the parameters of the economic boundaries, in different ways, based on the character of their region.

Site Catchment Analysis Case Studies

SCA studies have been conducted by various archaeologists over the past thirty years to analyze the environmental context of sites, determine site function and explain site distribution (Vita-Finzi and Higgs, 1970; Webley, 1972; Schiffer, 1976; Zarkys, 1976; Ferring et al., 1978; Flannery, 1976; Roper, 1979; Tiffany and Abott, 1982; Butzer, 1982; Bernick, 1983). SCA has also been utilized as a means to determine the "feasibility of various forms of economy, modeling settlement patterns and the study of demographic processes" (Roper, 1979: 135). Inferences regarding site function have proven useful in comparing the locations of sites. Contemporary site territories may have resources or properties in common, or may be economically complementary (Vita-Finzi and Higgs, 1970). Essentially, SCA focuses on the ecological, economic and procreative aspects of human behavior that extend beyond the archaeological remains (Hunt, 1983).

Vita-Finzi and Higgs (1970) utilized SCA techniques to establish the economic boundaries of sites in Palestine and systematically study the resources in this area. They classified the land within these boundaries into categories of prehistoric land use in order to make predictions concerning resource use. Land use classifications that are established for the current research include edibility, medicinal value, supplemental and overall economic categories. According to these authors, some site locations are not chosen primarily because of their land potential. When site locations do not correlate with areas that have a high economic potential other factors are considered to look for explanations for site selection. A similar approach is utilized in the current research. Sites that lack explanation in isolation can acquire meaning when compared with other sites (Vita-Finzi and Higgs, 1970). In addition, the character of the landscape combined with the climatic conditions that were prevalent at the time provides clues. By conducting intra-site comparison it has been shown that two sites situated 30 miles apart were complementary to each other in that they provided suitable seasonal settings for a hunter gatherer economy (Vita-Finzi and Higgs, 1970). Based on the character of prehistoric site distribution in north-central Texas it is expected that patterns similar to these occur in this region. SCA has also revealed that two different cultures, as defined by their artifacts, may represent two different economies rather than two different groups (Vita-Finzi and Higgs, 1970). Sites that are a part of the current research are likely to contain similar artifacts. Therefore it is expected that the economies offered by particular locations on the landscape are the primary source of differentiation between site locations.

Environmental diversity indices for site catchments have been utilized in previous investigations to measure the potential of an area for the presence of archaeological sites and to determine the extent and intensity of human use (Tiffany and Abbott, 1982). The basic assumption is that site presence is correlated with increased environmental diversity. The idea of establishing an environmental diversity index is based on the premise that,

> the biological and cultural needs of a society are easier to fulfill in a natural environment that has the greatest environmental diversity per area of catchment for that society. The occurrence of an archaeological site on a given portion of the landscape should be a function of the diversity of the local natural environment and likewise the greater the potential diversity of a particular study area, the more extensive and complex will be its use by groups (Tiffany and Abbott, 1982: 315).

Tiffany and Abbott (1982) consider reoccupation of a site as a function of the stability of the local environmental diversity through time. The environmental diversity index employed by these authors involves counting the diversity of mineralogical, hydrological and vegetational resources within the site catchment territory. The current research utilizes a diversity index to test for this however it is derived by different means.

Hunt conducts a case study in Northeastern America by utilizing a SCA methodology that includes Geographic Information Systems (GIS) based analysis (Hunt, 1982). Hunt is concerned with the landscape that surrounds the archaeological site and the concept of site catchment as it applies to quantifying the physiographic space within and around a site (Hunt, 1982). Hunt demonstrates the ability to characterize soil matrix around Late Woodland village sites in a multitude of ways and to link soil data to other attributes (Hunt, 1982). Webley's (1972) analyses of Tell Gezer and several other sites in Palestine are based entirely on analysis of soils and their potential productivity (Roper, 1979: 126). While such studies are limited to description of how sites are located relative to soils or vegetation, soils analysis offers valuable information to cultural history, including comparisons among sites of their potential for certain economic activities. According to Roper (1979), focusing on soils or vegetation in isolation may not explain why a site is located where it is or how it functioned in a settlement system. More complete modeling of settlement location and the settlement system requires the use of a wider variety of resource types (Roper, 1979). While the current research is highly dependent on soils, to economically interpret site catchments, other factors are taken into account to provide explanatory mechanisms. Each component is a piece of the puzzle that fits together to form a more comprehensive view of prehistoric behavior.

In a study about subsistence strategies of prehistoric populations that inhabited the Mimbres River Valley in New Mexico, SCA is the principal technique used to collect and systemize information (Hastorf, 1980). In this study conducted by Hastorf (1980) six food gathering strategies are described, and by SCA, potential yields for each strategy, in each time period, are determined. The economic model provides the framework within which the strategies and their potential yields are organized and graphically depicted. According to the model, "in a subsistence economy, population size determines both caloric requirements and marginal costs needed to meet those requirements" (Hastorf, 1980:80). The assumption is that there is a definable area for each food-procuring strategy associated with each settlement (Hastorf, 1980). SCA translates environmental information into potentiality for particular strategies. SCA is used to determine a land-use area for each strategy for each time period. Once this area is defined and the caloric productivity per unit is calculated, the potential yield for each strategy is obtained (Hastorf, 1980). Given the character of the prehistoric sites in north-central Texas this type of approach is not directly applicable for the current research.

Presence of the unique floral and faunal material excavated at a site on Vancouver Island, in British Columbia, prompted a site catchment analysis (Bernick, 1982). Instead of starting with the site territory and reconstructing the economic patterns, an analysis conducted by Bernick (1982) begins with the set of excavated cultural remains that imply particular subsistence strategies. The exploitation territory is delineated based on these data. Her objective is to define the spatial dimensions of economic activities and to assess the applicability of the site catchment model to analogous sites on the Northwest Coast (Bernick, 1982). She factors in a defined travel time required to procure specific resources and the topographical location of sites. Confirmation of hypotheses is interpreted as an indication that the site catchment model is effective for evaluation of economic behavioral patterns of Northwest Coastal prehistoric communities (Bernick, 1982). This case study is an excellent solution for site specific investigations. However, on a regional scale, currently the data are lacking to successfully carry out a methodology such as this one.

Statistical techniques are an effective mechanism for objectively evaluating site catchments in relation to their immediate resource potentials. Previous SCA studies have utilized statistical techniques to accomplish this goal. Multivariate statistical techniques such as "factor analysis, multidimensional scaling and cluster analysis" are utilized by Roper for description and comparison of site territories with their resource potential (Roper, 1979: 127). Zarkys (1976) analysis of site catchments at Ocos in Guatemala used "percentage point differences, chi-squared tests, and binomial tests for evaluating which environmental zones were represented in higher proportions immediately surrounding a site than they were in the total study area" (Roper, 1979:128). Kvamme and others followed a similar methodology comparing site selection to overall regional characteristics incorporating a GIS to facilitate analysis,

> A raster GIS, together with quantitative analysis software by the SAS institute Inc. [1985], provides an ideal tool for spatial analysis because a variety of archaeological and biophysical data can be co-registered to vast numbers of locations cross broad regions, allowing rapid investigation of relationships between archaeological features and any number of locations across broad regions, allowing rapid investigation of relationships between archaeological features and any number of environmental parameters (Kvamme, 1989: 168).

A variety of statistical approaches have been employed to condense vast amounts of data into interpretable statistics. However, it is important to note sample size and archaeological recovery bias. Particularly, in the current research, a strong bias is already present in the amount of contract work that has been conducted along the Elm Fork of the Trinity due to reservoir construction. Considerably less work has been conducted in Collin County and even less in Wise County. As a result, the current statistical results are heavily influenced by recovery bias.

SCA has proven to be a very useful methodological technique that has provided answers to a plethora of questions to meet the objectives of a variety of research efforts. Ultimately, SCA provides a means to develop a framework for investigating the distribution of resources in relation to site location. The rationale for SCA operates on the assumption that,

> human beings are refuging animals, rhythmically dispersing from and returning to a central place (Hamilton and Watt, 1970: 263), differentially using a seasonally and spatially variable landscape in a manner that generally is conservative of energy, but conservative relative to a relative scale of values placed on needs and wants (Roper, 1979:122).

Given that such behavior takes place in particular locations it is logical to extract and evaluate environmental attributes from catchments of archaeological sites to shed light on prehistoric behavior. The theoretical foundation of the SCA model is a sound and viable basis for the current research. This method is a useful way to integrate the archaeological investigations conducted in the region and a means to systematically study sites in relation to the dynamic character of the ecosystem.

Although the current research employs SCA techniques that are similar to those that have been utilized in previous investigations it does not follow any of these research methodologies in particular. Given the data limitations and character of the region, the current research design incorporates a variety of techniques suggested by several studies, modifies them and adapts them to meet the needs of the current research. This methodology is designed to provide answers to the unanswered questions related to prior research conducted in the region and formulate a model of prehistoric settlement pattern behavior.

Geographically, factors such as topography, geology, soils, vegetation, water sources, fauna and land suitability influence past cultural behavior. Identifying the specific cultural and non-cultural characteristics that factored into site selection with respect to site catchment variability is pertinent to understanding the dynamic socio-economic prehistoric behavioral patterns in north-central Texas. In order to gain a deeper understanding of these patterns it is appropriate to begin with an evaluation of the natural setting (environment) followed by the synopsis of the defining characteristics of the various populations (cultures) that inhabited the region.

CHAPTER 3

RESEARCH SETTING

North-central Texas is located in an advantageous position within the "bioclimatic transition between the forested Gulf Coastal Plain and the rolling Southern Plains" (Ferring, 1997:19). Increased "biological diversity" is the result of numerous factors, including the region's geologic, soil and climatic variation combined with its eco-tonal location between the "deciduous forests of East Texas and the grasslands of the Southern Plains" (Diggs et al., 1999: 20). The combination of these factors provides a highly productive blending ground for plants and animals from the east and west. In addition, the increased diversity of this region offers a wide range of economic opportunities for prehistoric populations.

Geology of North-Central Texas

Geological structures in north-central Texas were shaped by uplift and formation of an extensive mountain system that includes the "Appalachians, Wichitas and Ouachitas" (Diggs et al., 1999: 21). Through time, shallow seas repeatedly advanced and retreated over most of Texas depositing a number of different layers of Cretaceous sediments (Diggs et al., 1999). As a result of these depositional processes and subsequent erosion, surface rocks in north-central Texas are predominantly Cretaceous in origin. Numerous layers of limestone, marl, shale, and sandstone were deposited over the area. Since climatic variation in north-central Texas is minor, differences in landforms, soils and vegetation are attributed to bedrock lithology (figure 2) (Ferring and Yates, 1998: 5). Lynott (1981) describes the geology as, "dominated by a series of eastward dipping sedimentary marine deposits." Pennsylvanian deposits are exposed in the western parts of the region, while Cretaceous clays and sands dominate the eastern prairies. These eastward dipping strata (figure 2) consist of Antlers Sandstone, Denton Clay, Woodbine Sandstone, Eagle Ford Shale, Austin Chalk and Ozan Marl interspersed by resistant outcrops known as the Goodland, Kiamichi, Pawpaw, Weno, and Grayson formations. The entire Upper Trinity drainage basin has developed over these Cretaceous and Pennsylvanian sedimentary rocks (Ferring, 2001; Diggs et al., 1999). North of the West Fork of the Trinity the "Antlers Formation is primarily composed of fine-grained sandstone and shale" (Ferring and Yates, 1997: 19). South of the West Fork the "Twin Mountains, Glen Rose and Paluxy Formations have a more diverse lithology" (Ferring and Yates, 1997: 19). The upper part of the West Fork drainage, northwest of Fort Worth, formed on top of Pennsylvanian limestone, shale and sandstone. All other portions of the Upper Trinity drainage basin developed over Cretaceous rocks (Ferring, 2001). Geology is culturally significant in that it provides resources for tool manufacture and settings for sites. In addition, the characteristics of the geology influence the character and range of potential soil types that can develop. Geology, combined with the climate, organisms, and topography ultimately determine the range of possible vegetation that can be produced in a given area. In north-central Texas limestone settings have predominantly produced prairie vegetation and sandstone settings have provided the foundation for forest vegetation. The variation within these geological formations is illustrated (figure 2) from a bird's eye view.

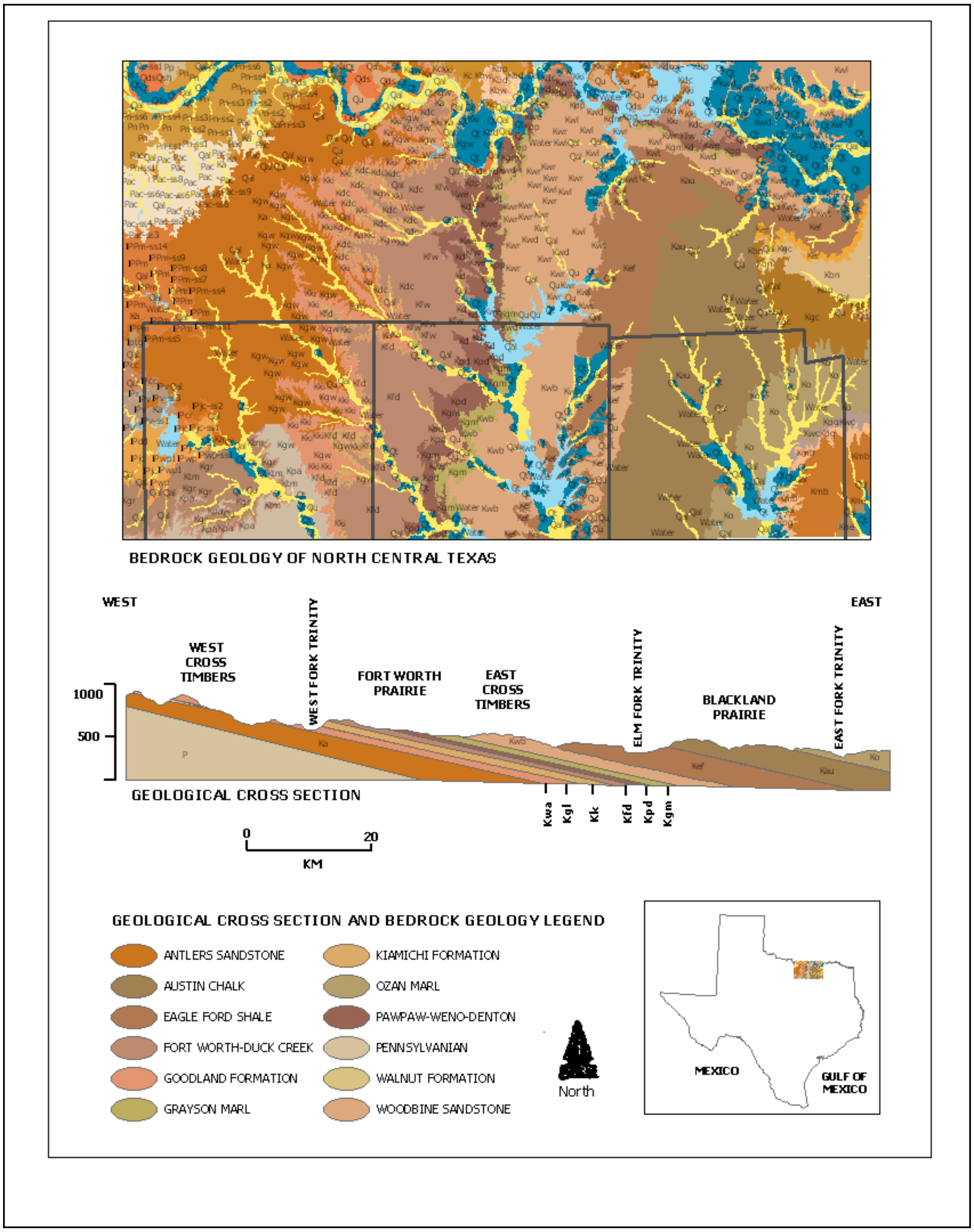

Figure 2. Geology of north-central Texas (based on USGS; Ferring and Yates, 1997).

Topography

The topographic expression of geological formations in north-central Texas originated from tectonic activity, erosion and variable depositional processes. Elevation in north-central Texas generally decreases from west to east. Topography is nearly level to very hilly. Wise County is transected by the Fort Worth Basin which combined with the uplifted resistant bedrock creates a highly variable landscape with steep slopes. The elevation reflects this variability ranging from 1,286 feet in the southwest to 649 feet in the eastern portion of the County. Denton County, although also transected by the Fort Worth Basin in the southern portion of the county, is less variable with very few resistant outcrops. This is reflected by elevations that range from 900 to 500 feet. Elevations, in Collin County, reflect the less resistant limestones, shales and marls, range from 900 to 400 feet, gradually decreasing eastward. Collin County is situated in an area where the Fort Worth Basin and East Texas Basin merge. This topographic setting reflects relatively lower elevations that explain the increased number of sites associated with bottomland settings along the East Fork of the Trinity. Topography in north-central Texas combined with the character of the geology ultimately influences and is influenced by the character of the drainage networks.

Drainage Systems

Drainage systems have actively sculpted the landscape forming as a result of the topography and resistivity of the geology. Northern Texas is drained by a network of rivers that includes the Brazos, Canadian, Colorado, Red River, Sabine, Sulphur and Trinity (figure 3). One of the most dominant features transecting the landscape of

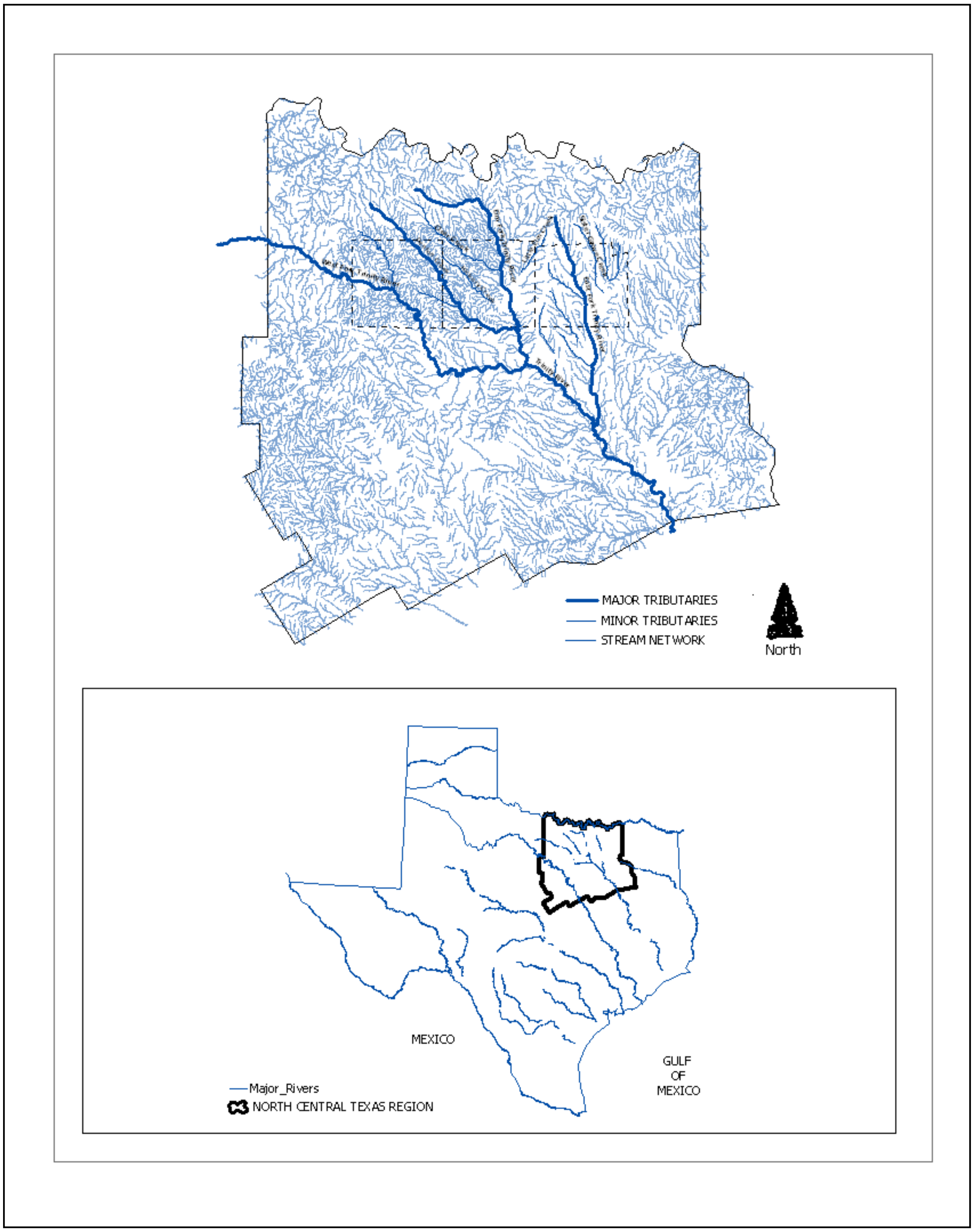

Figure 3. Hydrological networks of north-central Texas (based on TNRIS data).

north-central Texas is the Trinity River. From its beginning, northwest of Fort Worth in Archer County, the Trinity flows to the southeast approximately 692 River miles to the Gulf Coast with a change in elevation of 1,250 feet (Nixon and Willett, 1974). The Upper Trinity drainage basin is surrounded by three major drainage basins: the Red River to the north, the Brazos River to the southwest, and Sabine River to the east. The Trinity has been a focal point of cultural activity for thousands of years.

The West Fork of the Trinity flows in a southeasterly direction through Jack, Wise, Tarrant and Dallas Counties until it forms confluence with the Elm Fork of the Trinity. The West Fork is a consequent stream of the Upper Trinity drainage basin that has incised into the resistant Woodbine sandstone and Austin chalk (Ferring, 1998). Although archaeological sites are rarely reported, along the West Fork, within the confines of Wise County, there is considerable undocumented evidence to suggest that prehistoric populations aggregated along this major tributary. Denton Creek is a major tributary in the Upper Trinity Basin that forms a part of the Trinity "fork" system. It is referenced due to its archaeological significance and proximity to the West Fork. The headwaters of Denton Creek begin in Montague County and flow to the southeast through the northeast corner of Wise County and the southwest corner of Denton County where it veers east to form a confluence with the Elm Fork. For the current research sites near Denton Creek will be included in the West Fork study area

The headwaters of the Elm Fork of the Trinity are in the west central section of Montague County near the Cooke County line. From this point it flows in an easterly direction to central Cooke County where the principal drainage curves to the south and then southeast. This general course is maintained to the stream's confluence with the West Fork of the Trinity near Dallas. The vast majority of sites in this region are associated with the Elm Fork of the Trinity.

The headwaters of the East Fork of the Trinity originate in Grayson County flowing south through Collin, Rockwall, and Grayson Counties until Ellis County where it forms a confluence with the Trinity. This major tributary is situated in a unique environment centrally located in the Blackland Prairie where it serves as the only major intermediary water source between the main stem of the Trinity and the Sabine River.

All of these drainages follow the tilt of the regional bedrock forming elongated dendritic patterns. The West Fork, Denton Creek, Elm Fork and East Fork all merge into one by the time the River system reaches Ellis County where the Trinity guides the flow to the Gulf of Mexico. In prehistoric times drainage systems acted like highways linking separate geographical areas together. In addition to being culturally significant, these hydrological networks are responsible for the variable character of the landscape.

Physiographic Setting

Four major upland physiographic subdivisions (figure 4) have been recognized in north-central Texas: the Western Cross Timbers, Grand Prairie/Fort Worth Prairie, Eastern Cross Timbers and Blackland Prairie (Dyksterhuis, 1948; Ferring and Yates 1997). The character of the four major upland geomorphic subdivisions is influenced mostly by the bedrock lithology and the correlative soils. These alternating strips of prairies and oak woodlands form a landscape that is mosaic in character and has significantly contributed to the increased diversity of north-central Texas.

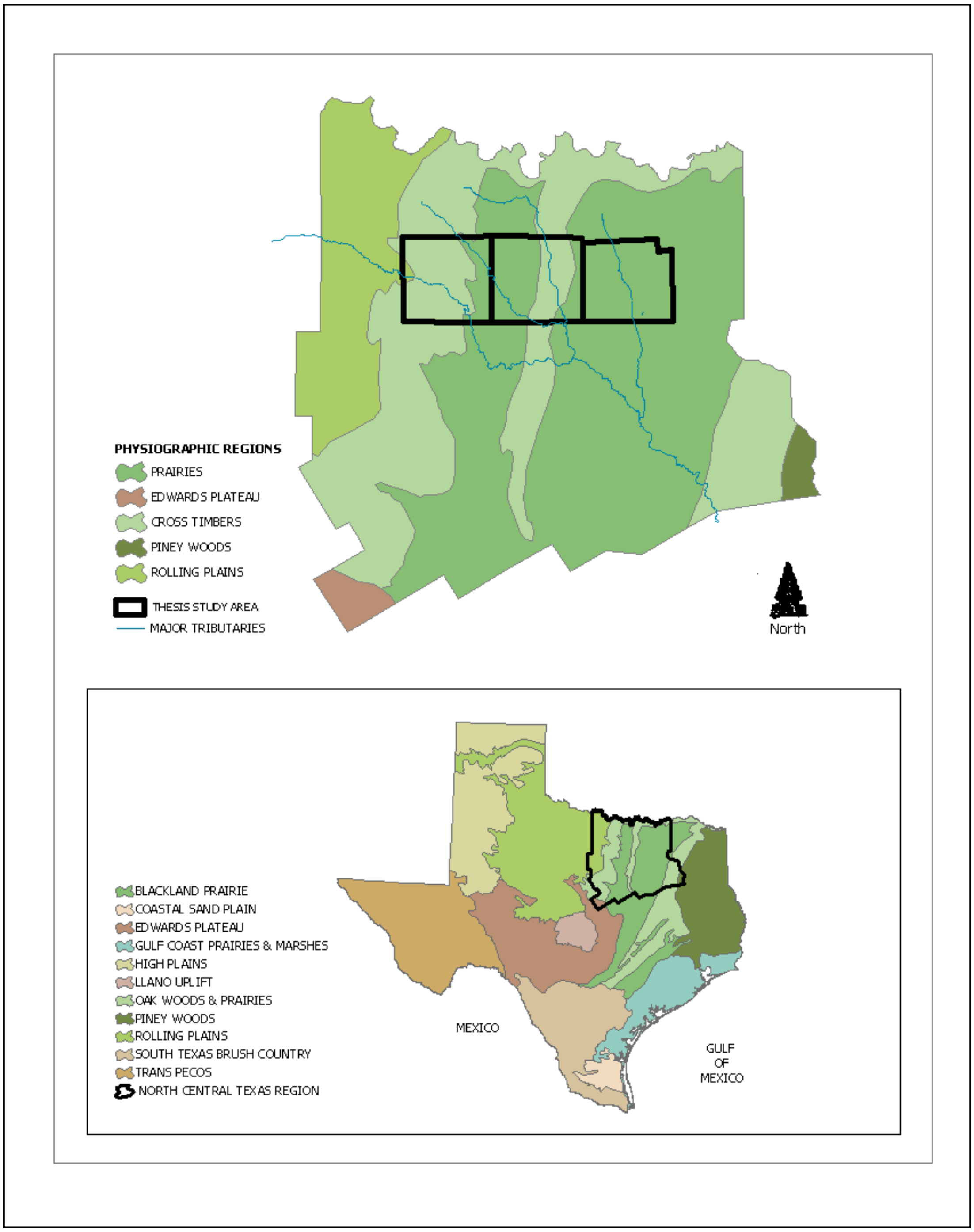

Figure 4. Physiographic regions of Texas and north-central Texas (TNRIS).

The Western Cross Timbers is a physiographic subdivision that occurs in the western part of the Upper Trinity Basin. This region, situated mainly in the Wise County portion of the study area, is a rolling to deeply dissected area with sandy soils that corresponds with the Antlers Formation (Ferring and Yates 1997; Ferring 2001). It is characterized by a rolling to hilly topography with a very sandy soil cover. The Western Cross Timbers are similar to the Eastern Cross Timbers, yet less rugged in character due to the corresponding geology.

The Grand Prairie physiographic subdivision occupies the central part of Denton County and the eastern portion of Wise County. Alternating beds of shales and limestones stratigraphically situated between sandstone formations provide the geological foundation. Typically, it is a "rolling upland prairie with small escarpments and benches" formed by geological layers such as the Goodland formation, Duck Creek limestone, Fort Worth limestone and Main Street limestone (Skinner, 1973: I-II). The Fort Worth Prairie is a level to gently rolling surface, nested in the central portion of the Grand Prairie, north of the West Fork of the Trinity. The foundation of this area is a resistant Cretaceous limestone, composed of the Goodland Formation in the west and Grayson Formation in the east. "Differences in lithology have primarily controlled development of the upland prairie topography and tributary alluvial valleys" (Ferring, 2001: 27).

The Eastern Cross Timbers are situated along the central and eastern boundary of the Upper Trinity Basin. This physiographic region follows the Woodbine sandstone forming a narrow north-south belt of low hills that rise above the prairies on either side

(Ferring and Yates, 1998). Due to the fact that the Woodbine formation is not as thick as the Antlers Sandstone, the Eastern Cross Timbers are narrower than the Western Cross Timbers (Ferring and Yates, 1998). The woodbine formation consists of sandstones, shales, sandy shales, and fine to coarse sands providing the foundation for the Eastern Cross Timbers. Since the sandstones are more resistant to erosion than the clays and shales "the topography is more hilly and rugged in character" than the Western Cross Timbers (Prikryl, 1990: 6).

The Blackland Prairie physiographic subdivision is immediately east of the Eastern Cross Timbers. At the eastern margin of the area the "Blackland Prairie developed on relatively young Cretaceous layers" (Diggs et al., 1999: 21). Most of the Blackland Prairie corresponds with Upper Cretaceous rocks, including the Eagle Ford Formation (shale, clay, and marl), the Austin Chalk and the Ozan Marl (Ferring and Yates 1997; Ferring 2001). This physiographic region is characterized by a fairly flat to rolling surface developed on the Eagle Ford Shale and Austin Chalk formations (Dyksterius, 1948). These patterns reflect the dominant influence that the bedrock has over the region.

The Western and Eastern Cross Timbers, interspersed by prairie settings, form a diverse physiographic region that is related to the geology, topography, soils and vegetation. These physiographic settings are described in more detail in the vegetation section following a brief review of the soils formed in north-central Texas. The character of the soil is highly dependent on the geology and forms the basis for the range of vegetation available for prehistoric utilization.

North-Central Texas Soils

Soils in north-central Texas vary dramatically, ranging from the erosive sandy soils that form the foundation for the Western Cross Timbers to the highly plastic clay soil of the Blackland Prairie. The character of the soil is interdependent upon the geological parent material, topography, the organic and biotic community and the climate. Comparisons of the soil taxonomy within the prairie and forest environments provide a greater understanding of the range of variation and differences in vegetation that can potentially form in each setting. West Fork soils are composed of Western Cross Timbers, Grand Prairie and Fort Worth Prairie soils from west to east (figure 5A). Elm Fork soils consist of Grand Prairie, Eastern Cross Timbers and Blackland Prairie soils from west to east (figure 5B). East Fork soils are entirely composed of Blackland Prairie soils (figure 5C). An overview of the great groups present in the study area illustrates the soil distribution referred to in the following discussion (figure 5).

Western Cross Timbers Soils

Soils of the Western Cross Timbers are mainly Paleustalfs. These "Alfisols are associated with the sandstone bedrock and sandy alluvium, whereas the Mollisols and Vertisols are associated with the calcareous bedrock and alluvium" (Ferring, 2001: 27). With the exception of the soils in the western portion of the Western Cross Timbers that developed on gravelly and rocky Pennsylvania strata the soils of the East and Western Cross Timbers mainly developed on sandy Cretaceous Woodbine strata. Mollisols and Vertisols are both typically associated with the grassy areas of the Cross Timbers whereas the Alfisols are associated with increased production of hardwoods.

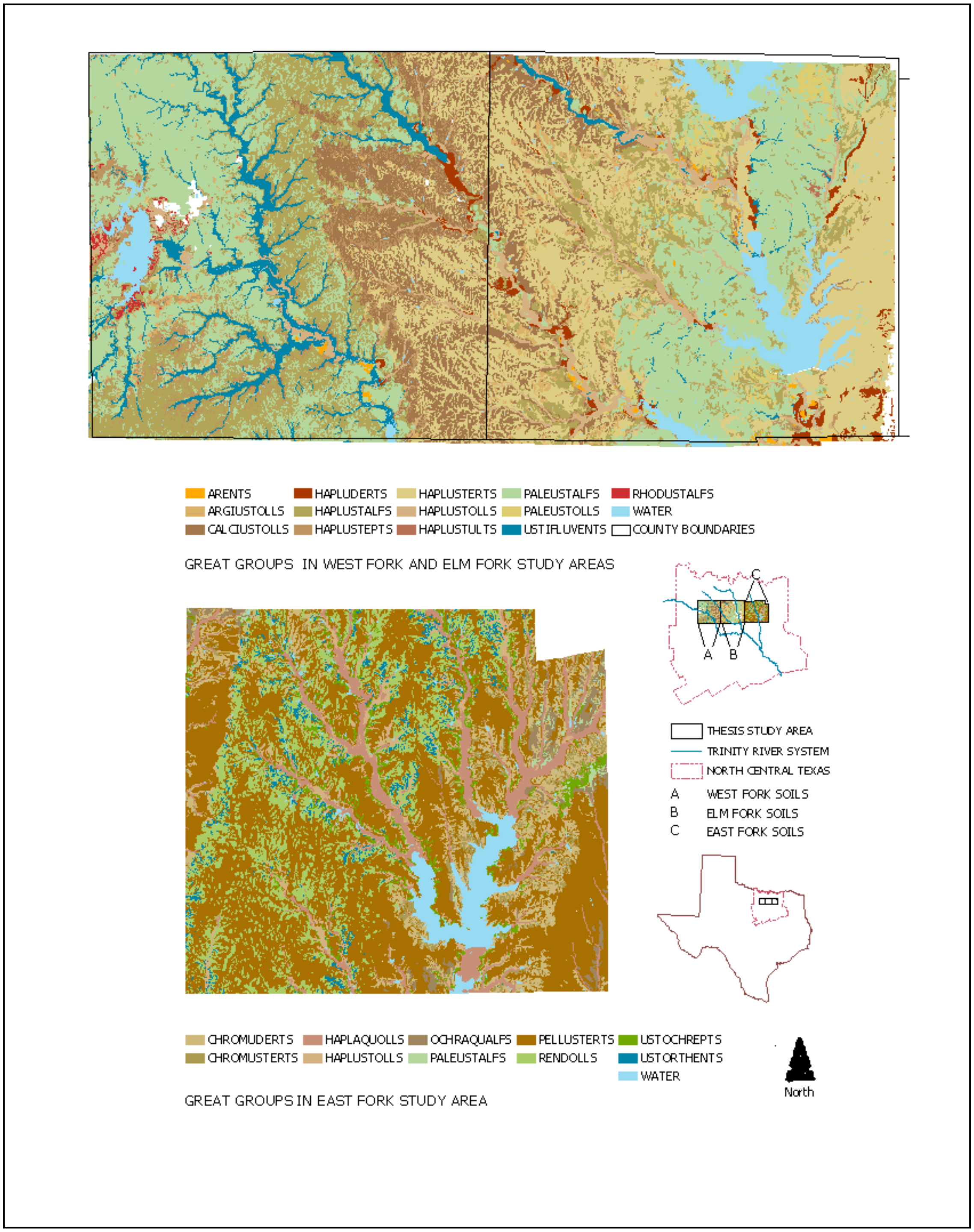

Figure 5. Soil distribution in north-central Texas study area.

Duffau-Keeter-Weatherford, Windhorst-Chaney-Selden, Truce-Cona and Bastsil-Silawa are general soil map units associated with the Western Cross Timbers (Ressel, 1989). These loamy and sandy, well drained soils composed of material weathered from sandstones and shales, formed upon a dominantly gently sloping surface on upland and terrace savannahs (Ressel, 1989). Great groups associated with these units are Paleustalfs and Haplustalfs (Ressel, 1989). A mixture of these older more developed and younger minimally developed Alfisols maintain a fair amount of moisture with dry intervals. Climax vegetation includes oaks, with an under story of grasses, peanuts, grapes, tree fruits and nuts (Ressel, 1989). Woody and herbaceous vegetation provide food and cover for deer, turkey, squirrel, dove, and quail (Ressel, 1989).

Grand Prairie and Fort Worth Prairie Soils

Soils of the Grand Prairie and Fort Worth Prairie have similar characteristics to the Blackland Prairie but the shrink-swell properties of the clay are less intense. Differences between the prairie environments can be attributed to the bedrock lithology. Mollisols are primarily found on the Grand Prairie and Fort Worth Prairie on various limestone layers (Diggs et al., 1999). "Mollisols are less problematic than Vertisols in terms of shrink-swell (Diggs et al., 1999: 25) and are considered among the world's most productive soil due to their high native fertility. Soils on the Fort Worth Prairie vary according to bedrock parent material. Most upland soils are clayey and calcareous Chromusterts, Calciustolls or Haplustolls.

General soil units associated with the Grand Prairie include the Sanger-Purves-Somervell and Venus-Aledo-Somervell units (Ressel, 1989). These units are clayey and loamy, well-drained soils that formed in material weathered from limestones and marls on upland prairies (Ressel, 1989). Related great groups include Chromusterts, Calciustolls, and Haplustolls that indicate a mix of Mollisols and Vertisols in moist and dry climates (Ressel, 1989). The presence of Mollisols and Vertisols indicate a prairie-dominated environment. Yet cobble and limestone fragments contribute to a lithic component that creates a habitat that is unsuitable for most wildlife (Ressel, 1989).

Aledo-Somervell soils are well-drained loamy soils formed in material weathered from limestone in the Uplands (Ressel, 1989). These soils are not very common and are focused in two particular locations near Denton Creek and Clear Creek. The Aledo component is made of Lithic Haplustolls while the Somervell is Typic Calciustolls (Ressel, 1989). Both are composed of Mollisols in fairly moist to periodic dry regimes but the former has a stony character with minimum horizon development whereas the latter is more calcareous indicating increased development. According to the soils survey, 90% of the vegetation consists of varieties of grasses and the remaining portion consists of various trees and shrubs (Ressel, 1989).

Sanger-Somervell, Navo-Wilson, Slidell-Sanger and Ponder-Lindale are fairly well-drained clayey and loamy soils that formed in material weathered from calcareous clay and marl in the upland prairies (Ressel, 1989). Chromusterts, Calciustolls, Paleustalfs, Ochraqualfs, Pellusterts and Halustalfs indicate a diverse mixture of Vertisols, Mollisols and Alfisols revealing the gradual shift from the Grand Prairie to the Eastern Cross Timbers (Ressel, 1989). Vegetation associated with these soil units is dominated by grasses and forbs (Ressel, 1989).

Eastern Cross Timbers Soils

Soils of the Eastern Cross Timbers are primarily Alfisols that developed from the sandy woodbine formation. Alfisols are generally productive soils that promote the growth of hardwood forest vegetation and crop yields. Principal surface soil associations are summarized by the Birome-Gasil-Callisburg unit that contains well-drained loamy soils formed in sandstone and clay parent material (Ford and Pauls, 1980). Great groups associated with this soil unit are Paleustalfs indicating a fairly moist climatic regime (Ford and Pauls, 1980). Paleustalfs are the most dominant great group in the Eastern Cross Timbers with minor variations related to the clay parent material. On the sandy Alfisols, the woody plants--namely post oak, blackjack oak, and hickory are dominant; while the grasses prevail on the tighter, more drought-resistant Mollisols (Ford and Pauls, 1980). Oak is the most common tree reported in the Eastern Cross Timbers (Ford and Pauls, 1980). River valleys crossing the region support a forest of hackberries and pecans mixed with oaks on the alluvial soils (Ford and Pauls, 1980).

Blackland Prairie Soils

Soils in the Blackland Prairie are composed of the Houston Black-Austin group, Houston Black-Houston, Ferris-Houston and Wilson-Burleson that consist of clayey soils formed in marl and chalk parent material (Wheeler and Hanson, 1969). Primary differences between these general soil units are found in the structural density of the clay, susceptibility to erosion and slope orientation.

Three dominant soil orders identified in the Blackland Prairies include Alfisols, Vertisols and Mollisols. Alfisols are less fertile than Mollisols or Vertisols and are found mainly on the Eastern and Northern margins of the Blackland Prairie. Vertisols develop mainly on the Eagle Ford Shale or rocks of the Taylor Group and are characterized by a high clay content that exhibits increased shrink-swell properties. "Swelling and shrinking causes deep and wide cracks" (Diggs et al., 1999: 23). The "black waxy" soils of the Blackland Prairie are derived from rocks of limestone origin (Diggs et al., 1999: 23). This "incredibly sticky soil has historically been particularly problematic and virtually impassable during wet weather" (Diggs et al., 1999: 25). Drought however is considered to have been more of a problem, with a lack of water considered a limiting factor for humans (Diggs et al., 1999). Impermeable black clay soils, the lack of dependable water bearing layers, and the ephemeral nature of surface streams made the "early Blackland Prairie a particularly inhospitable environment for humans" (Diggs et al., 1999: 29). Vegetation provides sustenance consisting of grasslands with a scattered mixture of hardwoods and particularly pecans. These areas are associated with bottomland hardwoods that provide a suitable habitat for wildlife.

Riverine and Floodplain Soils

Riparian corridors provide unique micro-environments that are significantly different from the generalized landscapes of the physiographic regions. Similarities can be attributed to bedrock lithology and differences to the influence of concentrated water resources combined with the variation in the alluvial parent material. Riverine settings provide increased productivity and tend to produce hardwoods that flourish in riverine settings. Characteristic vegetation and faunal resources found along streams and riverbanks reflects the variability of these settings.

The Pulexas-Balsora-Deleon unit is situated on the floodplains of the West Fork of the Trinity in the Western Cross Timbers (Ressel, 1989). It consists of loamy and clayey, moderate to well-drained soils that formed in alluvium. Associated great groups suggest that these soils are primarily recent Ustifluvents and Mollisols that exhibit minimum horizons (Ressel, 1989). Vegetation includes an overstory of oak, elm, hackberry, pecan and willow varieties. Small grains, peanuts, melons and sorghum are common (Ressel, 1989). These soils have a strong potential to support a wide variety of wildlife.

Frio-Ovan soils are well-drained, clayey soils that formed in material weathered from alluvium in the bottomlands that correspond with stream channels transecting the Grand Prairie and Eastern Cross Timbers (Ford and Pauls, 1980; Ressel, 1989). Related Haplustolls and Chromusterts indicate a mix of Mollisols with minimally developed horizons and Vertisols with a high organic content (Ford and Pauls, 1980; Ressel, 1989). These soils are concentrated in the floodplains of Denton Creek, Hickory Creek, Clear Creek and the Elm Fork of the Trinity. Vegetation related to these soils is composed of approximately 85% grasses with 15% representation of various trees such as pecan and elm (Ford and Pauls, 1980; Ressel, 1989).

The Frio-Trinity soils are loamy and clayey, moderate to well-drained soils that formed in alluvium on the floodplains in the Grand and Blackland Prairies (Ressel, 1989; Wheeler and Hanson, 1969). The Frio-Trinity component contributes Haplustolls and Pelluderts soils situated around portions of Denton, Catlett and Sweetwater Creeks. Mollisols and Vertisols associated with these great groups indicate increased productivity paired with a shrink-swell component (Ressel, 1989; Wheeler and Hanson, 1969). Soil units associated with riparian environments within the Blackland Prairie include the clayey and loamy soils of the Trinity-Frio found on the floodplains and the clayey soils of the Houston-Black Burleson found on stream terraces (Wheeler and Hanson, 1969). Many native pecan trees are located along the stream channels and interspersed on the floodplains (Ressel, 1989; Wheeler and Hanson, 1969). Yields from Pecan harvests would have provided a very desirable resource with a high-caloric value for prehistoric populations. The presence of this soil unit is so concentrated and economically valuable that prehistoric presence in association with these soils would strongly suggest a direct correlation with vegetation.

Floral Resources in North-Central Texas

North-central Texas is an interesting and diverse region in terms of vegetation, which responds to a combination of soils and climate. Following the physiographic character of the landscape, vegetation in Texas is divided into several zones known as the Pineywoods, Gulf Prairies and Marshes, Post Oak Savannah, Cross Timbers and the Blackland, Fort Worth and Grand Prairies. Oak-Hickory forest and tall-grass prairies transect this region. North Texas flora includes "2223 species (46% of the species known for Texas) and a total of 2376 taxa (species, subspecies and varieties)" (Diggs et al., 1999: 20). Due to increased biodiversity related to the Cross Timbers and Prairies different microhabitats within the same county contain different plant communities.

The regional study area is composed of a combination of four distinct geographic provinces including the Blackland Prairie, Eastern Cross Timbers, Grand Prairie, and

Western Cross Timbers. These zones extend, southward about 150 miles and northward to the Arkansas River, as continuous bodies of forest or savannah bounded by open prairie (Dyksterhuis, 1948). The Eastern and Western Cross Timbers reside east and west of the Grand and Fort Worth Prairies. Resources associated with prairies and forests offer a vast range of opportunities. This geographic expanse provides a unique opportunity to investigate prehistoric behavioral choices, in relation to an environment situated within an eco-tonal region that provided a diversity of resources.

Prairies

The predominantly clay-rich soils of the prairies support tall to mid-size grasses with clusters of oak trees in the uplands and riparian communities that follow the waterways. Vegetation along the waterways in the Prairies consists of similar understory species to those found in the temperate woodlands of the Cross Timbers (Dyksterhuis, 1946; Ferring and Yates, 1997). Climax vegetation in the Blackland Prairie is composed of mixed grass prairies, with scattered stands of cedar and oak trees situated on the "White Rock Escarpment" near the western edge of the Austin Chalk (Ferring, 1997: 22). Kindall, an explorer, in 1845, described the Blackland Prairie as "varied by small prairies and clumps of woodland", and the Fort Worth Prairie as "a perfect ocean" of grasses (Ferring and Yates, 1998: 12; Diggs et al., 1999). Dark clay soils of the Blackland and Grand Prairies sustain short grass prairies (Skinner and Baird, 1985: 2-2). Dominant species are bluestem, speargrass and wheatgrass. Prairie vegetation includes tall and midgrasses such as bluestems and gramas. Buffalo grass and species of three-awn, among others, tend to increase under grazing. Over "250 species of plants have been identified for these prairies" (McCormick et al., 1975: 39-40). Trees such as bois d'arc, oak, elm, ash, pecan and post oak trees dot the landscape along stream channels (McCormick et al., 1975). Brush species have invaded the prairie, and weedy annual and perennial grasses have increased in number (Ressel, 1989). The Blackland Prairie offers numerous seed bearing trees, plants and grasses. "Large herbivores traditionally migrated through this area in the fall" (McCormick et al., 1975: 39-40). Streams, transecting the prairies, provided "water and riverine resources including both nutritional and medicinal trees and plants" (McCormick et al., 1975: 39-40).

Cross Timbers

North-central Texas contains an oak dominated vegetation region that is part of a much larger area referred to as the Cross Timbers. Pollen data reveals that the "forests of the Cross Timbers were not established until the middle to late Holocene" (Ferring, 2001: 28). In Texas, this region is composed of two strips, the Eastern and Western Cross Timbers, separated by tall grasses and the Grand Prairie. Contrasts in vegetation between Prairies and Cross Timbers create natural barriers and facilitate north-south trails,

> The conspicuous change in vegetation from the Blackland Prairie to the Eastern Cross Timbers served as a landmark on early maps (e.g. Holley, 1836; Ikin, 1941; Gregg, 1844; Kendall, 1845) and was discussed in many immigrant guides and early explorer accounts (e.g. Marryat, 1843; Roemer, 1849; Parker, 1856). Kennedy (1841) wrote, "This belt of timber varies in width from five to fifty miles. Between the Trinity and the Red Rivers it is generally from five to nine miles wide……When viewed from east or west, it appears in the distance as an immense wall of woods stretching from north to south (Diggs et al., 1999: 43).

The Cross Timbers have also been described as a "singular strip of wooded country with an almost impenetrable undergrowth of brier" that was "broken" and "full of deep, almost impassable gullies" (Ferring and Yates, 1998: 12). This thick vegetation, coupled with the heavily dissected topography, led early travelers to comment on the difficulty of traversing the Cross Timbers (Prikryl, 1990; Diggs et al., 1999). Early accounts of the Cross Timbers also report of oak varieties with a dense under-story of saplings, vines and greenbrier (Diggs et al., 1999). Of the dominant trees, post oak is the most widespread. Hickory, which requires the most moisture, is the least common. "In the 1940s, wooded overstory covered 35% of the land surface in the Western Cross Timbers" (Dyksterhuis, 1948: 337). This consisted of "63% post oak and 29% blackjack oak with a remaining 8% composed of species such as hackberry and cedar elm" (Dyksterhuis, 1948: 337). The primary difference between the Cross Timber areas is found in the rate of precipitation that increases from west to east. Therefore, it is anticipated that the Eastern Cross Timbers would exhibit a relatively increased productivity. However, while there is a good variety in the subsistence resources of this vegetation region, it is an area that is prone to droughts (Story, 1985). Western and Eastern Cross Timbers are major areas of oak-hickory, with open savannah, dense brush, post and blackjack oaks. Eastern Cross Timbers are essentially a mix of the Western Cross Timbers and Oak Woodlands.

Vegetation of the Eastern Cross Timbers can be regarded as a western fringe area of the eastern woodlands. Over three hundred species of plants are native to this area (Tharpe, 1926). Forest vegetation is dominated by post oak, blackjack oak, pecan and elm. Hickory is virtually replaced in the Eastern Cross Timbers by the Pecan tree. Main components of the understory are little bluestem ragweed and elderberry. Small patches of prairie within the Cross Timbers are dominated by grasses such as wheatgrass, bluestem and speargrass. "Species diversity of dominant terrestrial plants for the upland post oak forest and the streamside forest is low" (Skinner and Baird, 1985: 2-3). Cross Timbers areas contain sandy upland soils that support dense groves of post oaks and greenbrier with an understory of big and little bluestem, switchgrass, lovegrass, sumac, plum, many varieties of forbs, legumes and other shrubby vegetation (Ferring, 1990; Story, 1985). In addition, these sandy areas often produced peanuts. Post oak, blackjack oak and hackberry are also particularly abundant in wooded uplands (Story, 1985; Prikryl, 1990). On the floodplains in the Cross Timbers, "tree cover consists of elms, pecans, oaks, cottonwoods, and willows with an understory vegetation that includes grasses, a variety of forbs and various fruit-bearing plants such as plums and berries as supplements to a rich variety of nut-producing trees" (Ferring and Yates, 1998: 12). Species associated with the well watered stream valleys of the Cross Timbers, include pecan, walnut, willow, elm, sycamore, and cottonwood (Story, 1985). Along the Elm Fork of the Trinity in the Eastern Cross Timbers a mixture of ash, blackjack oak, black willow, burr oak, elm varieties, hackberry, honey locust, mulberry, pecan, post oak and wild plum are available (Story, 1985; Prikryl, 1990). Trees from a variety of settings, including floodplains, uplands and stream valleys, within the Cross Timbers provided a valuable food source, as well as, fuel for fire.

The Western Cross Timbers share many of the same characteristics as the Eastern Cross Timbers separated only by the vegetation of the Grand Prairie. Stream floodplains are dominated by various hardwood species and Juniper clings to the steep slopes along Rivers. The natural vegetation is a savannah of oaks that follow the stream channel or cluster across the landscape accompanied by an under-story of mid and tall grasses. A variety of plant species create diversity with a patchy, mosaic distribution across the landscape. Even with the wide variation in soils, the climax understory vegetation is fairly uniform with the predominant grasses being little bluestem, big bluestem, Indian grass, switchgrass, Canada wild-rye, side-oats grama, hairy grama, tall dropseed and Texas wintergrass (Ressel, 1989; Prikryl, 1990).

In addition to the two main vegetation zones, Prairies and Cross Timbers, two other additional vegetation habitats are significant in the region and are important to understanding prehistoric settlement patterns in relation to plant resources. First, the transitional zones between physiographic settings referred to as the ecotones. These ecotonal settings contain plant species that are common to both physiographic settings and there are some species that are exclusively found in these zonal interfaces. This transitional zone effectively serves as an area where a number of species common to woodlands and prairies would have greater accessibility. Another small, but important habitat would be the riparian and floodplain zones. A large number of trees, shrubs, berries and other vegetation types are located in this zone and are not found elsewhere. This is due to the more mesic microenvironment of the riverbank and floodplain in contrast to the more xeric terrace habitats. Here a number of species uncommon or absent elsewhere would be available in a spatially limited area.

Investigations of McCormick et al. (1975) suggest that floral resources are equally distributed over the uplands, slopes, and bottomlands. Many individual species occur in more than one environmental setting (Prikryl, 1990: 12). For example, roots, such as prairie turnips, were probably an important food source available in both the post oak savannas and prairies (Martin and Bruseth, 1987: 128). Bottomlands are considered to be the most significant part of the entire region in terms of availability of native wild foods in these areas (Lynott, 1977; Ferring, 1990:17). Mast crops and many plant resources available in the bottomlands of the Eastern Cross Timbers are also present in the bottomlands of the Blackland Prairie. A potential for a large mast crop also exists in the upland oak woodlands of the Eastern Cross Timbers (Prikryl, 1990: 12). In contrast to the uplands of the Eastern Cross Timbers, the Blackland Prairie uplands are grasslands. Upland areas typically provide grains yet "seeds of the dominant grasses of the prairie uplands are small and were probably not valuable food sources for aboriginal people" (Prikryl, 1990: 12). However, "it is suggested that some plants in the prairie uplands, such as forbs, are usable foods" (Prikryl, 1990: 13). Some investigators suggest, "while human consumption of upland acorns in the Eastern Cross Timbers was important, these mast resources were also clearly important in sustaining fauna hunted by prehistoric people" (Prikryl, 1990: 12).

Many of these resources are available in more than one season with summer and fall having the highest number of species for potential use. The "floral resources that are most abundant between July and September are mustang grapes, wild plums, acorns and pecans" (Prikryl, 1990: 12). Pecans are available in the fall and throughout winter. Acorns become available in September and are plentiful through February (Prikryl, 1990). The most abundant plant resource are these mast (nut) crops, that would have made this region very attractive to prehistoric people, deer, squirrels and other animals. As such, it is expected that north-central Texas offered an abundance of resources in the fall and winter. This suggests that the region was seasonally occupied and probably accommodated tribal aggregation.

In prehistoric times five main groups of plants were collected and eaten by various Native American tribes: fruits, roots, seeds, greens and nuts (Steward, 1938; Ferring et al., 1978; McCormick et al., 1975). Examples of edible fruits include plums, blackberries, yucca, prickly pear, mesquite, clove current, mulberries, persimmons, hackberries and grapes. Roots utilized include sunflower, milkweed, cattail, bulrush, thistle, wild onion, potato varieties and wild buckwheat. Pecan, black walnut with burr, blackjack, post, and black oak nuts were also eaten. Seeds are often found in association with the grasslands, Cultures in the region were aware of the edibility and nutritional value of these species and probably enjoyed access to these resources.

Vegetation has a timeless relationship with geology, soils, and climate that helps form a picture of the past natural landscape. Available vegetation resources at certain intervals effected humans, animals, and the interaction therein. In order to learn more about human behavior in relation to the landscape inferences are made based on geology, soils, vegetation, faunal remains and artifacts found within site-catchment areas. Vegetation is nourished by the geology, soil and climatic conditions in each physiographic region. This same vegetation transforms this energy that it has derived from various combinations of the ecosystem into the characteristic biomass that sustained human and faunal prehistoric populations for thousands of years.

Faunal Resources in North-Central Texas

Faunal presence is directly associated with the botanical resources described in the last section. Fauna is culturally significant in that it served as a prehistoric food source and is an indicator of climate, seasonality and landscape. Fauna, adapted to the Eastern and Western Cross Timbers, Grand Prairie and Blackland Prairie, provided a variety of food resources for prehistoric populations. Previous archaeological investigations are the main source of information for gathering data about animal resources that would have been available during these various time periods. Faunal data is limited to certain locations where excavations were conducted. As such inferences are also extended to the fauna that would be drawn to a given habitat.

Verrett and Bousman (1973) view the Eastern Cross Timbers as an economically valuable location for base camps. A variety of hunting and gathering opportunities are provided in this area,

> Small groups of deer, buffalo, and other game animals could be hunted in the small grassland openings within the Cross Timbers. This forested section would have been ideal for trapping fur bearing animals such as fox, beaver and for hunting deer. Fish, mussels and riverine fauna could be exploited along the small Rivers and creeks typical of the area (McCormick, 1975: 16).

Major potential faunal resources include bison, white-tailed deer, antelope, turkey, raccoon, squirrel and rabbit. Other mammals associated with the Eastern Cross Timbers are cottontail, jackrabbit, armadillo, opossum, beaver, skunk and black bear.

Seasonally available resources include migratory birds, especially waterfowl which feed along the aquatic margins, spawning fishes, amphibians and reptiles, which are more active in warmer seasons (Ferring and Yates, 1998). According to sources cited by Prikryl (1990:11) "320 species of birds and 43 species of migratory waterfowl have been identified in the Cross Timbers and Prairies." Most large game species tend to aggregate in greater numbers within the bottomland forest zone. This would have been especially true "during fall and winter when acorns ripen and fall and when some late fruits like persimmons ripen" (Ferring and Yates, 1998: 12).

Lynott (1977:30) believes that it was not feasible for prehistoric people to exploit the acorn crops of the Eastern Cross Timbers uplands because, combined with their acidic content, the acorns are smaller in size than those of the bottomlands. However, he notes that the acorn upland mast crops were important in sustaining many species of animals that were hunted by prehistoric people (Prikryl, 1990: 12). Flora of the uplands would have been important in sustaining the herds of herbivores, principally bison and antelope, hunted by prehistoric people (Prikryl, 1990: 13). Information provided by Goodrum et al. (1971: 527-529) indicates that the acorn yields are heavily used as food by deer, raccoon, squirrel, wild turkey and quail. Squirrels and wild turkeys feed on acorns, and these nuts may constitute about 75% of the diet of squirrels (Prikryl, 1990: 12). Goodrum et al. (1971) propose that acorns make up as much as 50% of the diet of white tailed deer, a species that was frequently hunted by prehistoric people (Prikryl, 1990: 12). Evidence suggests that white-tailed deer provided the largest percentage of meat consumed by prehistoric people in the region. Deer would have been common in the bottomland forests of both the Blackland Prairie and the Eastern Cross Timbers, and in the uplands of the Eastern Cross Timbers. Other species that were drawn to the mast crop also would have occurred in these three settings (Prikryl, 1990: 13). Although fewer useful species would have been available in the prairie uplands, bison and antelope were present.

Presumably the most important large animals of the undisturbed prairies were bison, antelope, bear, and perhaps mostly along the wooded fringes, white-tailed deer. Bison are reported to have been present in north-central Texas during Late Prehistoric times (Prikryl, 1990: 13). Historic accounts indicate that bison were also present in great numbers on the Blackland Prairie in the Brazos River area during the eighteenth century (Newcombe, 1986). On the basis of faunal data from archaeological sites, Dillehay (1974: 180) suggested that there were "two periods in the past--6000/5000 BC to 2500 BC and AD 500- AD 1200/1300--when bison were essentially absent from the southern plains and the vicinity." In relation to this he has proposed that bison were present on the Southern Plains before 6000 BC and between 2500 BC and AD 500. Lynott (1979), on the other hand, believes that there is a lack of evidence to indicate bison presence in north-central Texas during these. His review of the Holocene faunal evidence pertaining to the sites in north-central Texas and has concluded that bison were never very common in the tall grass prairies, but after AD 1200 their numbers did increase to a certain extent. The faunal record is mainly one of terrestrial animals. While isolated finds are common, assemblages from well-defined depositional contexts with established taphonomies are uncommon. Faunal remains that are most commonly reported from aboriginal sites in north-central Texas consist of deer, cottontail, turtle, and mussels. Yet it should be noted that many sites investigated in the region have acidic sandy loams that do not preserve bone well. Furthermore, limited attention has dedicated to collection and identification of animal remains until recently. As such, "animals may have made up a more significant part of the aboriginal diet than evidence indicates" (Prikryl, 1990: 13).

Excavations conducted along the Elm Fork have provided a wealth of faunal data where change through time can be observed (Ferring and Yates, 1997). In order to evaluate fauna that was typically utilized during prehistoric times excavated sites from the northern and southern portion of the Elm Fork are evaluated (figure 6). Fauna recovered includes a variety of aquatic species such as fish, frog, turtle and beaver. Turtle is by far the most common from this group. Species classified in previous studies as occupying grasslands/woodlands, grasses/wooded edges, woodlands/wooded edges and wooded edges are grouped into ecotonal settings. These fauna include some varieties of turtle, turkey, cottontail, birds, skunk, white-tailed deer and fox. White tailed deer and cottontail are the most numerous represented in the archaeological record. Grassland species include lizards, squirrel, rodent, gopher, rabbit, pronghorn and bison. Pronghorn are the most numerous from this group. Bottomland and woodland species such as opossum, gray squirrel, snake, swamp rabbit, spiny lizard, armadillo, red fox, and raccoon are grouped into the same habitat category. Wolf, coyote, dog, snake, and unidentifiable small, medium and large mammals are grouped into the "various" category. Deer, turtle, mussels, rabbit and turkey are the most common fauna reported. Mussels, often found at archaeological sites in the region, drew populations to local stream beds. However, they have "low caloric yield and have been viewed mainly as a dietary supplement" (Prikryl, 1990: 13). Aquatic and ecotonal settings appear to be the most heavily utilized locales in relation to food procurement situated primarily along the Elm Fork of the Trinity. However, one site in particular in the northernmost portion of the study area indicates a notable utilization of bottomland fauna and grasslands rather than ecotonal aquatic zones. Unfortunately, no equivalent data sets are available for the East or the West Forks. Only one site contains definitive bison remains in the form of "bison scapulas" (Lynott, 1975:126). According to Lynott, data support that subsistence strategies along the East Fork of the Trinity were based primarily on plants and animals from bottomland-riverine zones. The variety of resources supported by the bottomland environment, primarily include "deer, raccoon, opossum, rabbit, squirrel, and wild turkey" (Ferring and Yates, 1998: 12). Although currently the data are lacking there was a wide variety of faunal resources available to prehistoric populations.

Faunal evidence recovered from archaeological sites ranges from the Middle Archaic to the second phase of the Late Prehistoric. A map depicts the distribution of these sites where fauna was excavated (figure 6). A graph (figure 6a) provides a summary of collective data from sample sites regardless of time period. The purpose of viewing the data in this manner is to evaluate the range of potential wildlife in each area all other things being equal. When change through time is considered the fluctuations can be observed to determine what types of fauna were available during specific time periods. A series of graphs (figure 6b-figure 6c) illustrate excavation sequences. This information is evaluated to look for correlations with hypothesized climatic conditions and to explain settlement patterns in relation to the habitats that provided resources through time.

Data available for the Middle Archaic is limited to 41DN102 situated along the northern portion of the Elm Fork. General trends fluctuate through time and suggest the utilization of resources from a variety of environments. In comparison with other time periods bottomland resources are the most dominant during the Middle Archaic. In the earlier and later levels grassland and aquatic resources are abundant. Ecotonal resources also follow the same trend. The middle levels at this site contain bottomland and grassland resources in order of abundance. This pattern supports the drier climate that has been hypothesized during this time period. Comparatively Middle Archaic populations utilized a wider variety of resources than any other time period.

Sites that contain evidence of Late Archaic occupation include 41DN26, 41DN346, 41DN381, 41CO144, 41CO141 and 41CO150. The geographical distribution of these sites provides a fairly balanced coverage of the Elm Fork. In all but one of these locations aquatic resources are fairly abundant yet ecotonal resources, although fluctuating, are continuously dominant. Site 41DN381 is the exception where a wider range of resources are being utilized as indicated by the abundance of the "various" category. This evidence supports that the climate was relatively wetter than the Middle

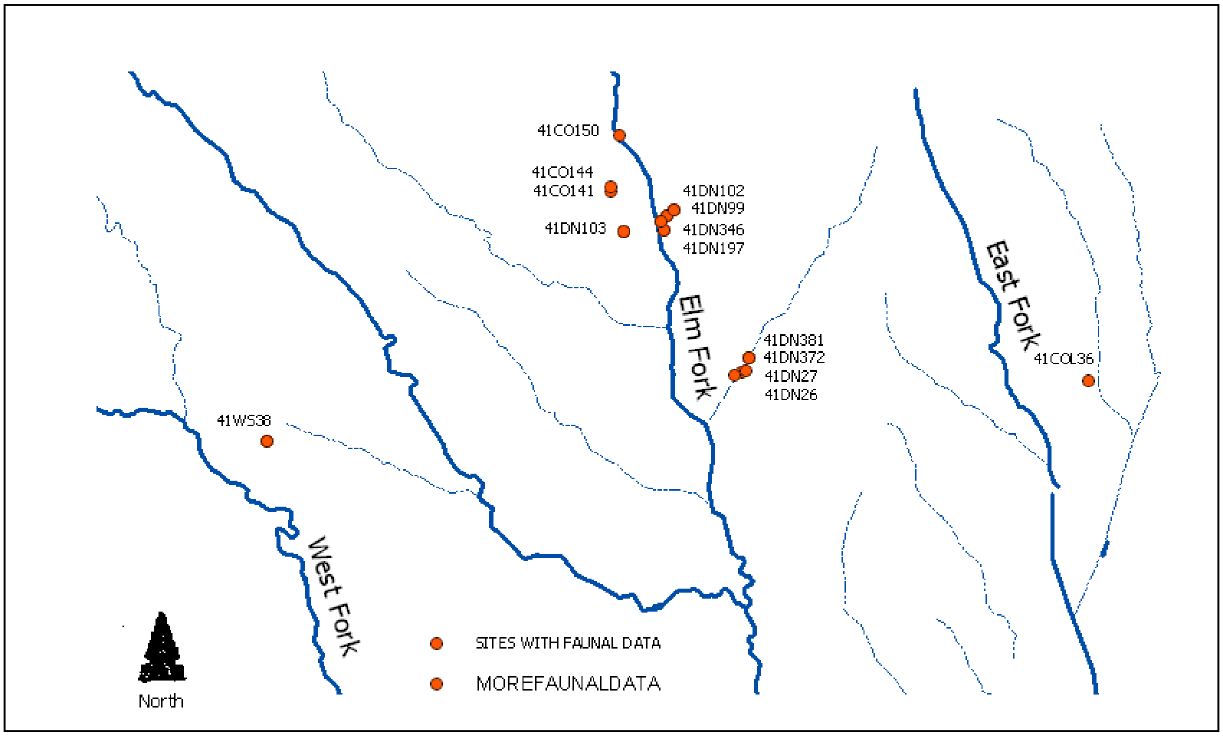

Figure 6. Archaeological faunal distribution from excavated sites in study area.

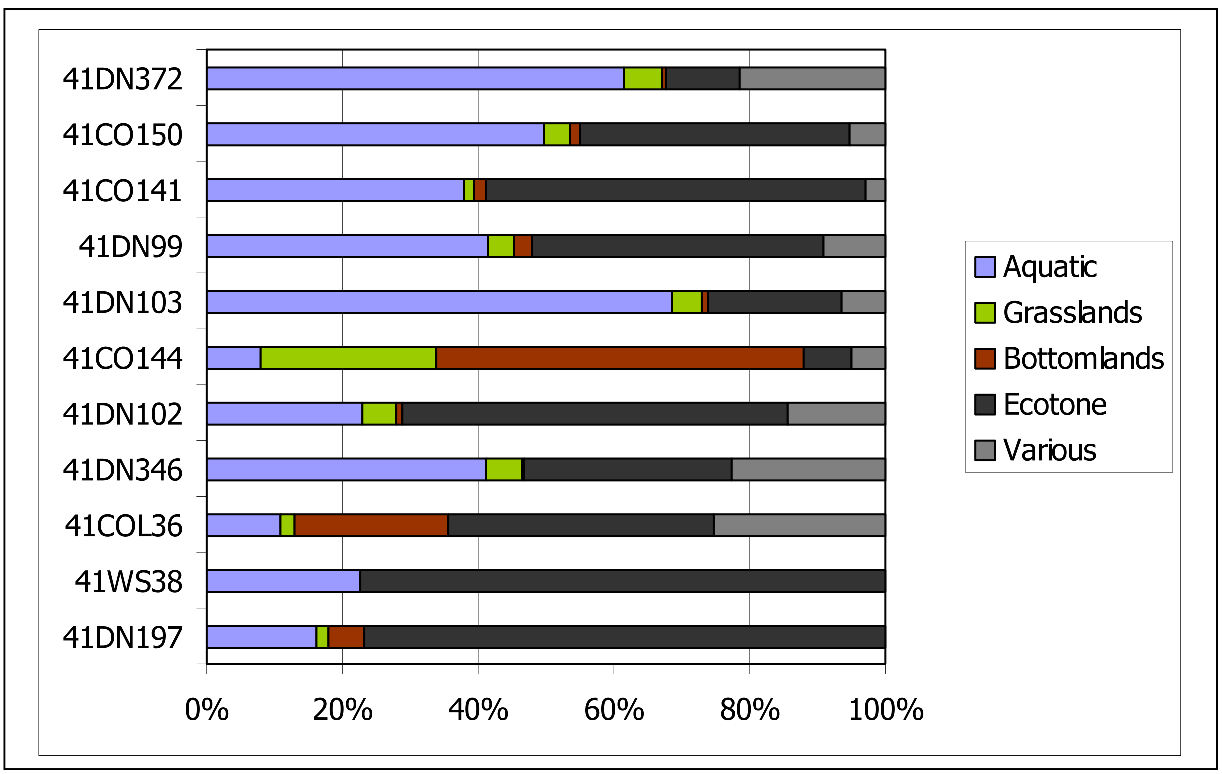

Figure 6a. Fauna recovered from archaeological sites in study area (data summarized from Lynott, 1975; Ferring, 1997, 1998; UNT 1990-2001).

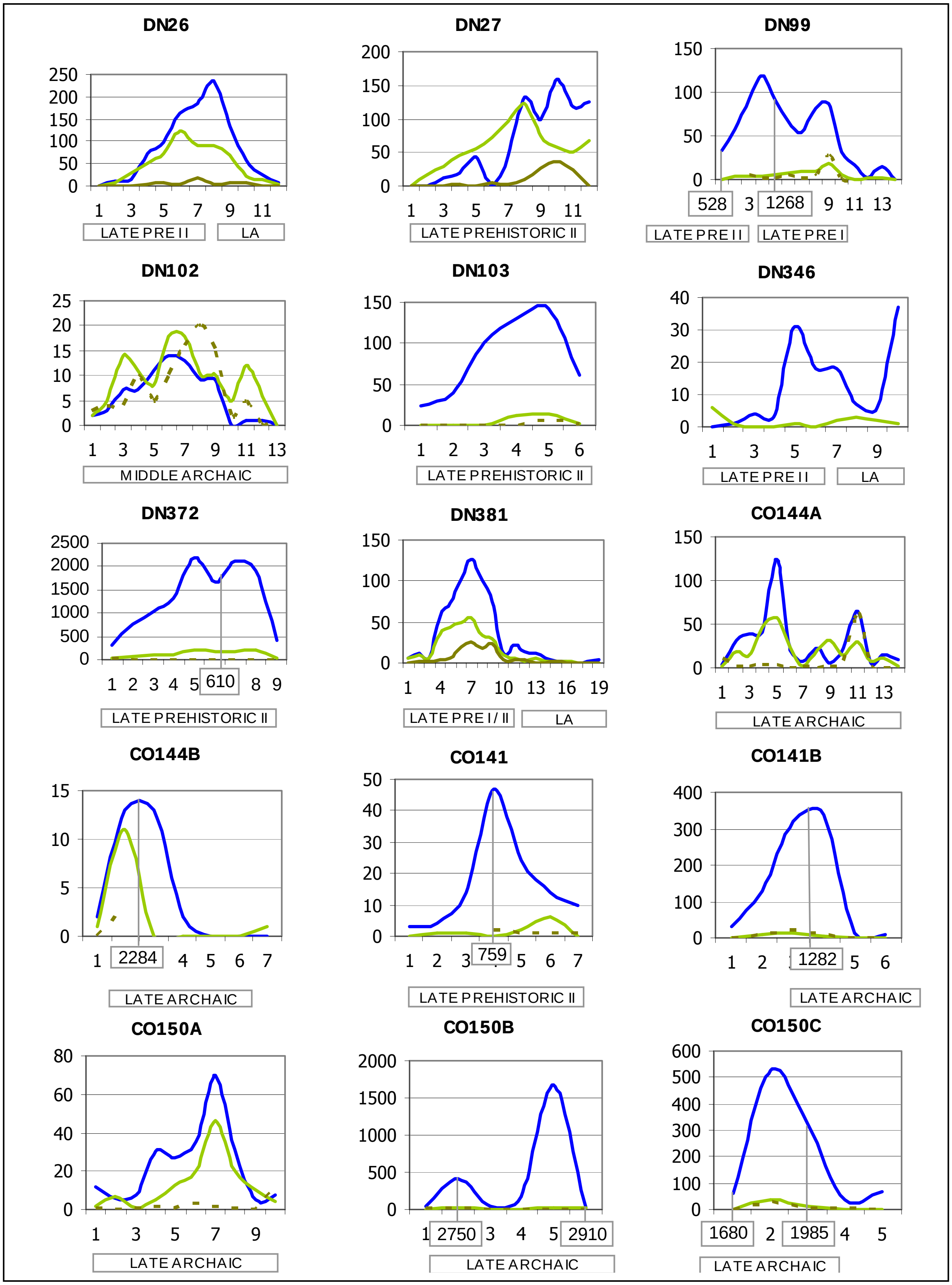

Figure 6b. Archaeological fauna and change through time (Aquatic=Blue; Grassland=Green; Woodland=Brown; Bottomland=Dashed Brown).

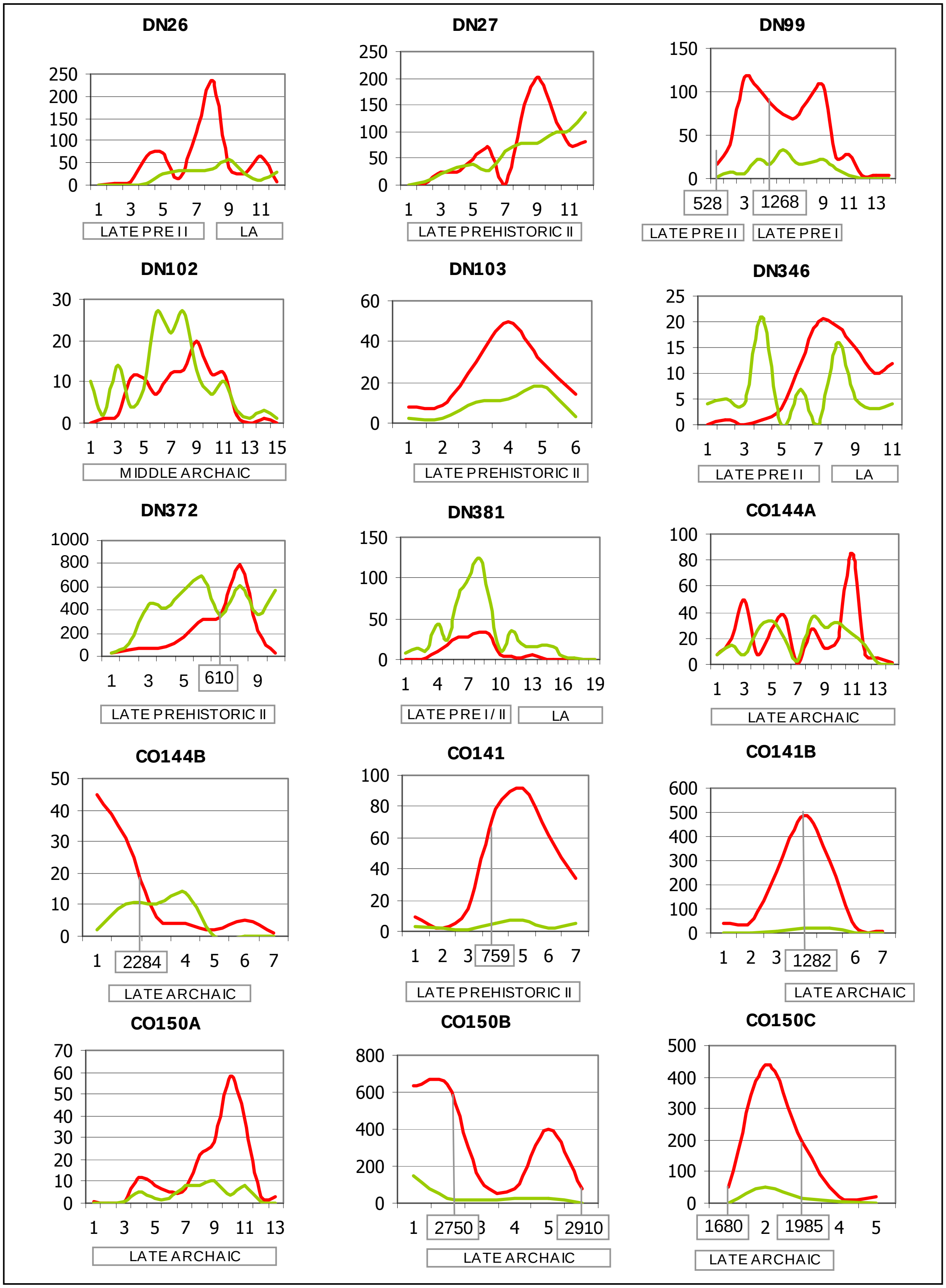

Figure 6c. Archaeological fauna and change through time (Ecotone=Red; Various=Green).

Archaic in the sense that more water resources would have been available and it would have been possible for terrestrial wildlife that was associated with wetlands to be more mobile. Overall, there appears to be a trend that reflects fluctuating climatic conditions due to a dramatic increase of aquatic resources followed by a decrease that is equal in intensity. The fact that ecotonal resources are the most abundant indicates a propensity to utilize the resources from both the grassland and woodland environments. Only two sites contain fauna that is associated with the first phase of the Late Prehistoric (41DN99 and 41DN381). Due to the "fuzzy" boundaries this discussion will combine the two phases of the Late Prehistoric with more emphasis on the second phase. Late Prehistoric II sites include 41DN26, 41DN27, 41DN99, 41DN103, 41DN346, 41DN372, 41DN381 and 41CO141. During the second phase of the Late Prehistoric there is an interesting trend that provides a contrast to the other time periods. There are two situations taking place. One is an inversion from the previous patterns indicated by a dramatic shift from resources located in the ecotone to resources from various environments. The "various" category indicates a wider range of food resources and higher degree of mobility. In the northernmost part of the area at 41CO141 ecotonal resources are dominant throughout followed closely by aquatic resources. Both faunal groups follow the same bell curve trend and there is a slight presence of grassland fauna as well. To the south 41DN99, 41DN103 and 41DN346 enjoy a healthy presence of aquatic fauna that increases and decreases through time. Sites 41DN99 and 41DN103 both maintain a fairly substantial abundance of ecotonal fauna. Site 41DN346, a little further south, follows an opposite trend and shifts to utilization of fauna from the "various" category. Approximately 20 km southwest, a cluster of sites (41DN26, 41DN27, 41DN372 and 41DN381) contain evidence similar to the other sites assigned to this time period but with a notable abundance in woodland fauna. A decrease in ecotonal resources and increase of various habitat echoes the pattern at site 41DN346. During the Late Prehistoric, population, territorialism, seasonal rhythms and fairly stable climatic conditions factor into a wide range of subsistence strategies.

Climate of North-Central Texas

North-central Texas is located in a dramatic transition between regional climates. The striking change in vegetation from "the East Texas deciduous forests on the eastern margin of north-central Texas to the grasslands of the plains to the west is a vivid reflection of this climatic transition" (Diggs et al., 1999: 28). The climate of this region has a "seasonal, subhumid precipitation regime and a strongly seasonal, thermic temperature regime" (Ferring and Yates, 2001: 16). For the most part, "summers are hot and winters are mild except for brief periods of cold temperatures associated with Arctic fronts" (Ferring and Yates, 2001: 16). These fronts frequently are "accompanied by rain, and less frequently by snow and/or ice storms" (Ferring, 2001: 16). These general trends are thought to be fairly consistent through time.

In terms of precipitation, there is a steep East-West gradient across north-central Texas (figure 7). Mean annual precipitation ranges from about 46 inches in the northeastern corner of the area to about 24 inches in the Western-most portion of the Western Cross Timbers. In general mean annual precipitation decreases about 1 inch for each 15 miles across Texas from East to West. This region is "prone to drought

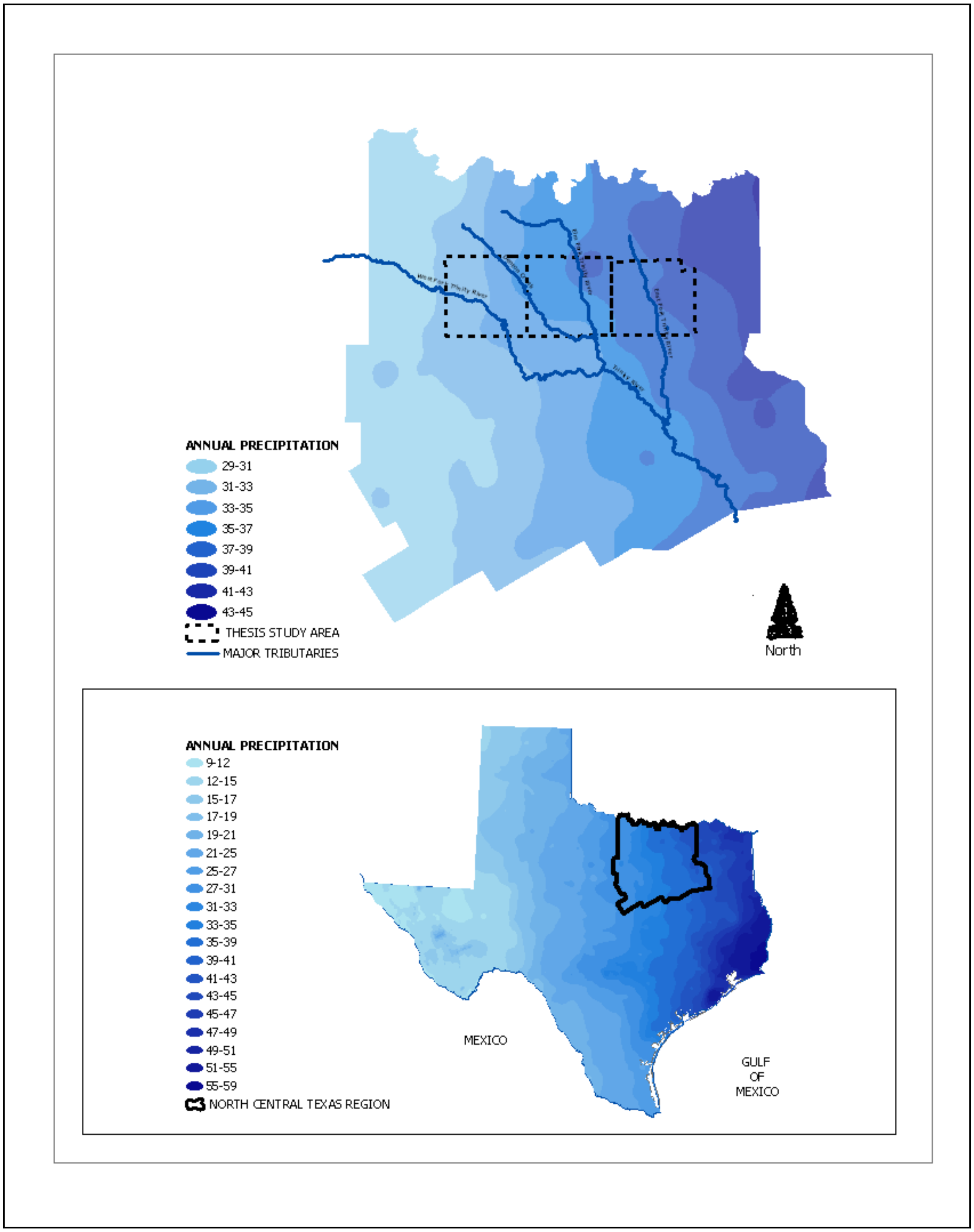

Figure 7. Precipitation patterns in Texas and north-central Texas.

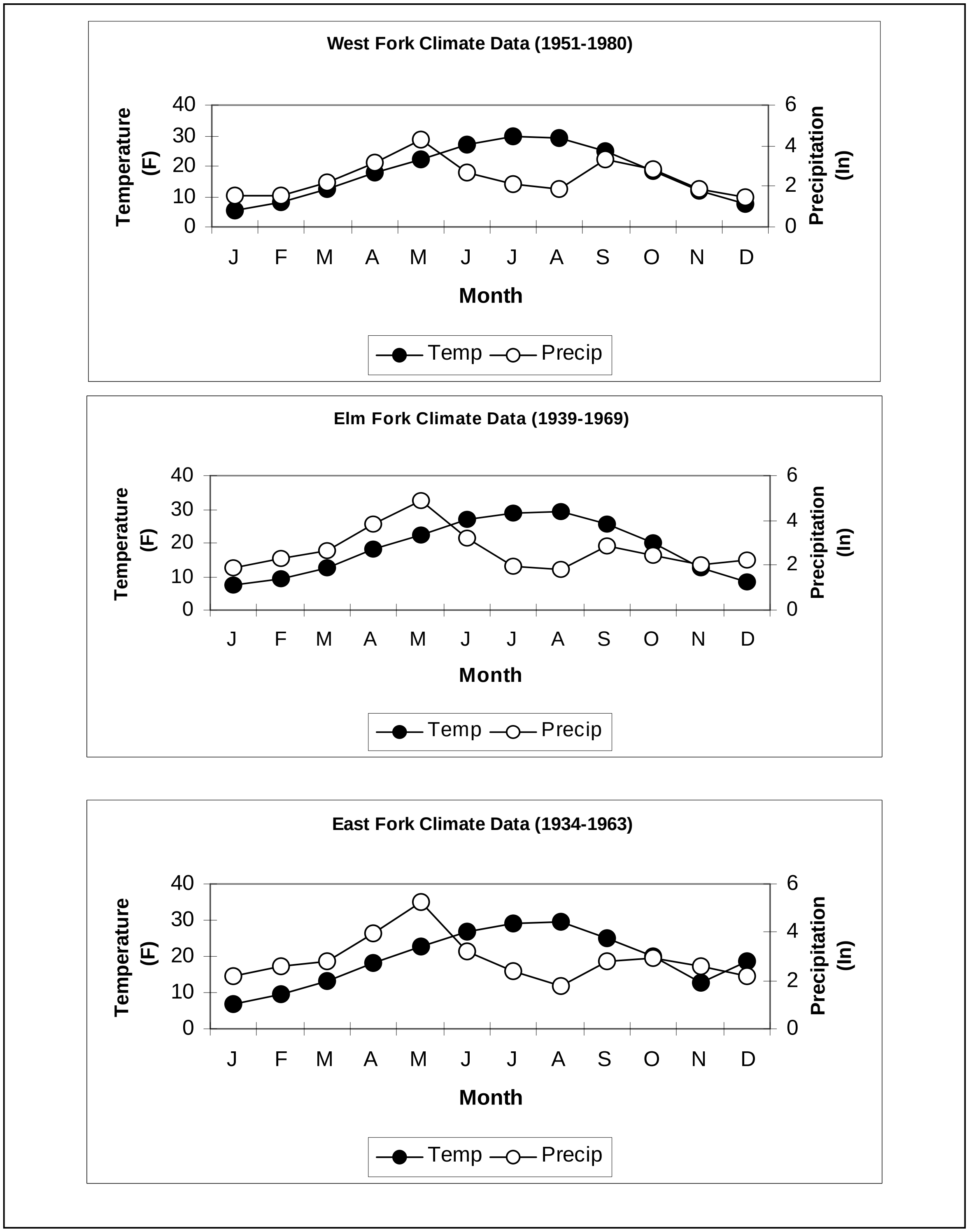

Figure 8. Average monthly temperature and precipitation trends in north-central Texas (compiled for West Fork (Ressell, 1983); Elm Fork (Ford and Pauls, 1978); and East Fork (Hanson and Wheeler, 1969) from Wise, Denton, and Collin County Soil Surveys respectively).

while at other times it receives too much rain in a short time" (Diggs et al., 1999: 29). When the climate patterns occurring in the area around the West Fork, Elm Fork and East Fork are compared (figure 8) the differences are minimal. The most notable difference is the increased temperature and decreased precipitation, in the East Fork in December. The opposite situation is true for the Elm Fork whereas both temperature and precipitation are relatively low in the West Fork portion of the study area.

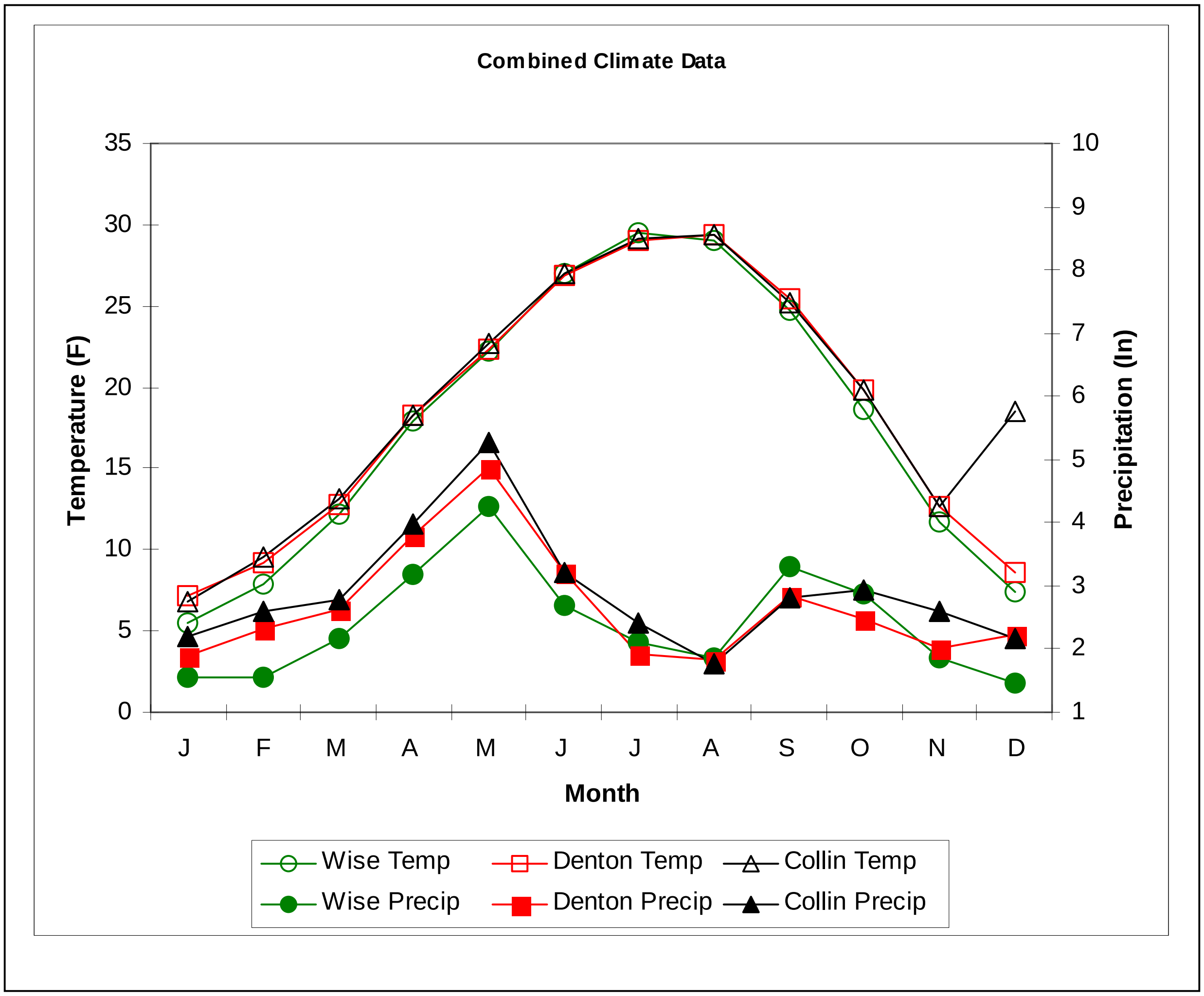

Figure 9. Comparisons of Average Monthly Temperature and Precipitation Trends in north-central Texas (compiled for West Fork (Ressell, 1983); Elm Fork (Ford and Pauls, 1978); and East Fork (Hanson and Wheeler, 1969) from Wise, Denton, and Collin County Soil Surveys respectively).

In general, precipitation and temperature data (1931-1989) indicate that late spring and early fall are the wettest months while summer temperatures are high accompanied by a decrease in rainfall (figure 9). These historical records indicate the average rainfall as 32 inches per year and the average temperature is 65.2 F. The similarities in climatic data for the three counties in the study area indicate that the climate in general was fairly uniform with minor variations on the theme.

Past Environments

The entire eco-system is interdependent and certainly the climate was a major factor for decision making in the past. Past environments have been extrapolated from pollen and other organic data preserved by stratified profiles. The Ferndale Bog pollen record is the sole source of early Holocene vegetational history for the region. Given the proximity to the study area combined with the presence of these vegetation families it is inferred that similar patterns likely occurred in north-central Texas during these time periods. For the current research, this has been taken into consideration and these data are mapped to provide a view of change through time in relation to the relative abundance of these taxonomic families.

From a long-term perspective, pollen, plant macro fossils, and other types of evidence demonstrate that the climate of Texas has changed substantially over the past 15,000 years (Diggs et al., 1999: 30). Paleoenvironmental change is not well documented, but it is summarized by Prikryl (1993: 192-193) and updated by Ferring and Yates (1997: 39-45). Prior to 14,000 BP the climate of north-central Texas was cooler and moister than at present. Between 14,000 and 11,000 BP, the climate became drier. It is suggested that the presence of high grass pollen and low arboreal pollen between 7550-3050 BP shows a drying return of arboreal pollen after 3050 BP. The latter change is similar to today's environment. High grass pollen also occurs at approximately 1550 BP and from 3550 to 3650 BP, and this also indicates drier periods. The presence of paleosols between 2000 BP and 1000 BP suggests a decrease in moisture with a return to wetter conditions after 1000 BP (Skinner and Ferring, 1999). Prehistoric climatic data is in great need of improvement. Palynological data supplemented by data from insects has the potential to add a tremendous amount of breadth to the current research methodology and resulting settlement model.

This chapter has reviewed the geology, topography, hydrologic networks, soils, physiography, vegetation, faunal communities, and general climatic trends that have given the environment in north-central Texas its character over the past 10,000 years. The environmental foundation is half of the entire ecological system. The other half of this story is completed by the human populations that inhabited the landscape. A chronological overview of these cultures provides a means to observe change through time and establish a set of expectations regarding the range of behavior that has been supported by previous archaeological evidence.

CHAPTER 4

CULTURAL CHRONOLOGY OF NORTH CENTRAL TEXAS

This chapter defines the characteristics of prehistoric populations, in north-central Texas, as they change through time. Previous research has established specific characteristics that define cultural subdivisions. Artifacts are a primary source of differentiation between cultural groups and are utilized as an indication of time period for surface sites that lack radiocarbon dates. Therefore, determining the range of "diagnostic" projectile point types and character of the tool kit, for each time period, is pertinent to the current research. Artifacts are a significant source of information related to prehistoric activities. Subsistence evidence facilitates comparisons between time periods and serves as an explanatory mechanism for site location or variable density of occupation. Settlement pattern behavior, as discussed by previous investigators, provides a means for comparison. These data collectively establish a cultural framework to relate to the results of the SCA conducted on archaeological sites dating from the Early Archaic to the Late Prehistoric.

North Texas prehistory spans across approximately 12,000 years. Geographic distributions of prehistoric cultures reveal that ancient populations inhabited virtually all of Texas with the exception of a few counties where evidence has yet to be reported. Based on data provided by a variety of sources (THC, 1985; Skinner, 1985; Ferring, 1997, 1998; TARL 2002), a series of maps have been built to illustrate the change in prehistoric Texas population distribution through time, with respect to physiographic boundaries, the north-central Texas region and the research study area. The first of these maps illustrates all prehistoric populations of record (figure 10).

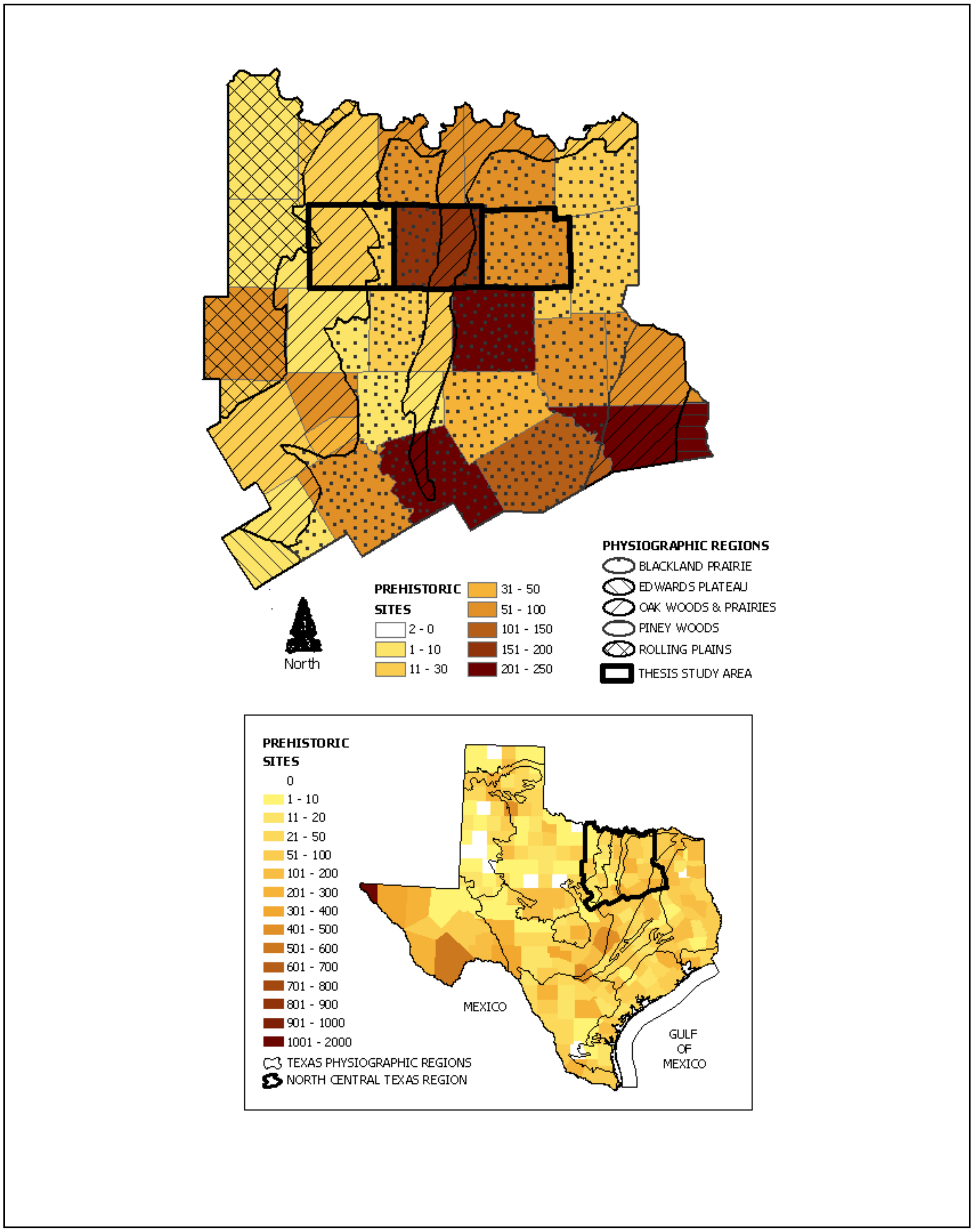

Figure 10. Distribution of prehistoric sites in Texas and north-central Texas (data compiled from Nunley, 1973; Lynott, 1977; Biesaart et al., 1985; Prikryl, 1990; Ferring et al., 1997, 1998, 2001; TARL, 2002).

Chronologies that have been developed for north-central Texas vary according to the investigator and reflect the lack of clarity or consensus in relation to cultural subdivisions. These chronologies (table 1) have been developed and correlated with projectile point typologies (figure 11). There is disagreement as to the correlation between the precise time period, point typology and cultural subdivisions. However, in general, there seems to be a certain level of agreement as to the general parameters of the various time periods. This is a geographically related issue that depends on the amount of work done in a certain region and is relative to few sites that have been radiocarbon dated. The overlap between time period designations and the various labels given to each time period by different investigators are important to note when comparing archaeological reports and corresponding regional models.

Based on stratified excavations "point types" have been established as "index fossils" to define each time period. Notable chronological sequences of point types that have been developed in Texas (Prewitt, 1981; Prikryl, 1990; Story, 1990) have served as the main reference for archaeological investigations. An overview of the currently accepted point type chronology for this research is illustrated pictorially (figure 11). These point types were recovered from archaeological sites, included in the current research, and are associated with time periods based on radiocarbon-dated investigations (figure 12). Archaeological data available for sites in north-central Texas is contained in a variety of contract reports, academic publications, journal articles and site reports filed with Texas Archaeological Research Laboratory (TARL).

Chronology	*Archaic*			*Neo-American*	
McCormick et al. 1975	9000 BP-1500 BP			1500 BP- 450BP	
Chronology	**Archaic** 8000 BP-1200 BP			**Neo-American** 1200 BP- 350BP	
Skinner et al. 1985	**Carrollton Focus** 8000 BP-4500 BP	**Elam Focus** 4500 BP-1200 BP		**Wylie Focus** 1100 BP-400 BP	**Henrietta Focus** 700 BP-250 BP
Chronology	**Early Archaic**	**Middle Archaic**	**Late Archaic**		
Johnson and Holliday, 1986:7	8000 BP-6000 BP	600BP-4000 BP	4000BP-2000 BP		
Chronology	**Early Archaic**	**Middle Archaic**	**Late Archaic**	**Late Prehistoric I**	**Late Prehistoric II**
Ferring et al. 1990	8500 BP-6000 BP	6000 BP-3500 BP	3500 BP-1300BP	1300 BP-800 BP	800 BP-350 BP
Chronology	**Early Archaic**	**Middle Archaic**	**Late Archaic**	**Late Prehistoric I**	**Late Prehistoric II**
Lebo and Brown 1990; Prikryl, 1990	8500 BP-6000 BP	6000 BP-3500 BP	3500 BP-1250BP	1250 BP- 750 BP	750 BP- 250 BP
Chronology	**Early Archaic**	**Middle Archaic**	*Late Archaic*	**Late Prehistoric**	
Ferring et al. 1997	8500 BP-6000 BP	6000 BP-3500 BP	3500 BP-1250BP	1250 BP-350BP	

Table 1. Various chronologies developed for cultural subdivisions.

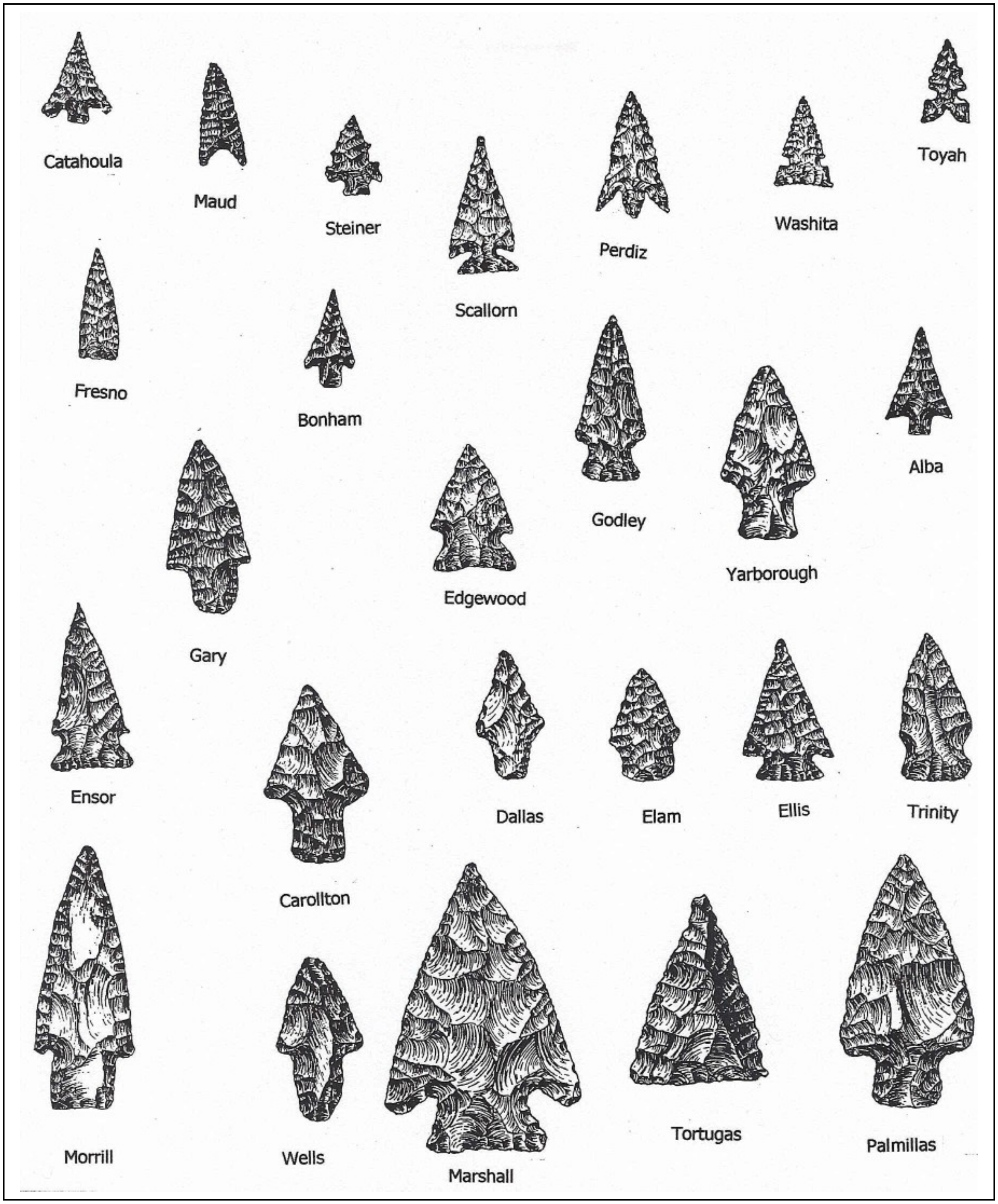

Figure 11. Overview of Early Archaic through Late Prehistoric I generalized projectile point chronology in north-central Texas that is utilized for current research (compiled from Turner and Hester, 1993; illustrations used with permission).

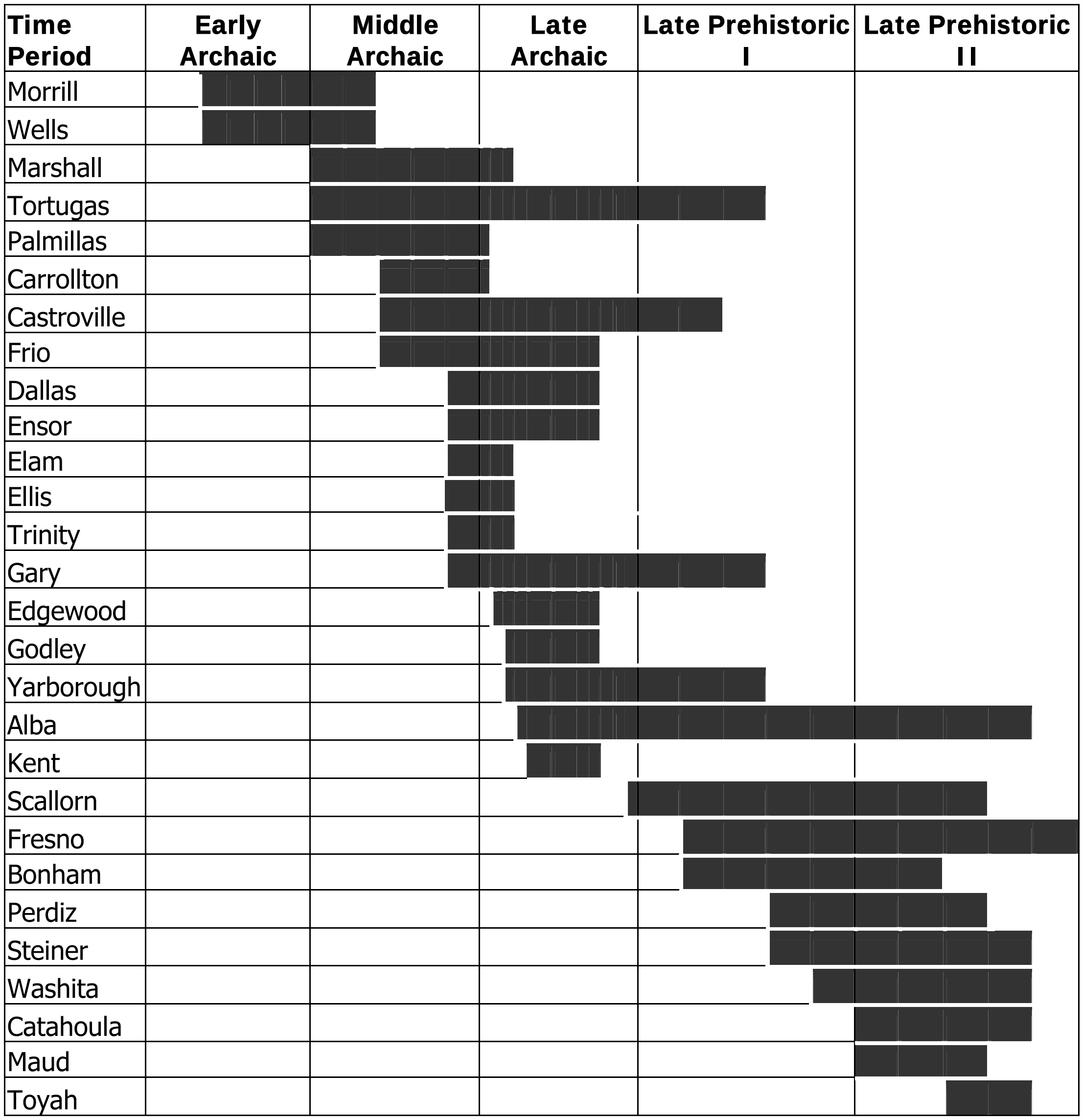

Figure 12 Chronological overview of projectile point types from north-central Texas (data compiled from Suhm and Jelks, 1962; Turner and Hester, 1993).

Paleoindian (11,500-8,500 BP)

Archaeologists generally agree that the first people that migrated into Texas arrived around 12,000 years ago around the end of the Pleistocene. These early inhabitants left behind distinctive artifacts that reveal sophisticated tool manufacturing techniques. Although Paleoindian artifacts have a widespread geographical distribution in Texas most evidence is found on the surface (figure 13). In north-central Texas the only well documented "in situ" excavation and subsequent publication, regarding a Paleoindian culture in north-central Texas, is the Aubrey Clovis site (Ferring, 2001). Otherwise, Paleoindian sites in the north-central Texas region are predominantly surface exposures in mixed association with later occupations. The current research does not include analysis of Paleoindians but it is necessary to review the characteristic artifacts, lifeways and settlement patterns associated with these populations because they essentially set the stage for the Archaic cultures.

Paleoindian cultures are defined by specific distinguishable characteristics that differentiate them from all of the other time periods. The single most distinctive trait of the Paleoindian cultures is the presence of unique and finely crafted projectile points. Clovis, Folsom, Midland, Plainview, Firstview, Eden, Angostura, Scottsbluff, Dalton, San Patrice and Golondria are projectile points (figure 14) associated with the Paleoindian period. Of the forty-two projectile points, documented by Prikryl (1990): Clovis, Dalton, Golondria, Midland, Plainview and Scottsbluff provide evidence of a Paleoindian occupation in north-central Texas. The Paleoindian period has been defined by three horizons based on projectile point typology: Clovis, Folsom, and Plano respectively.

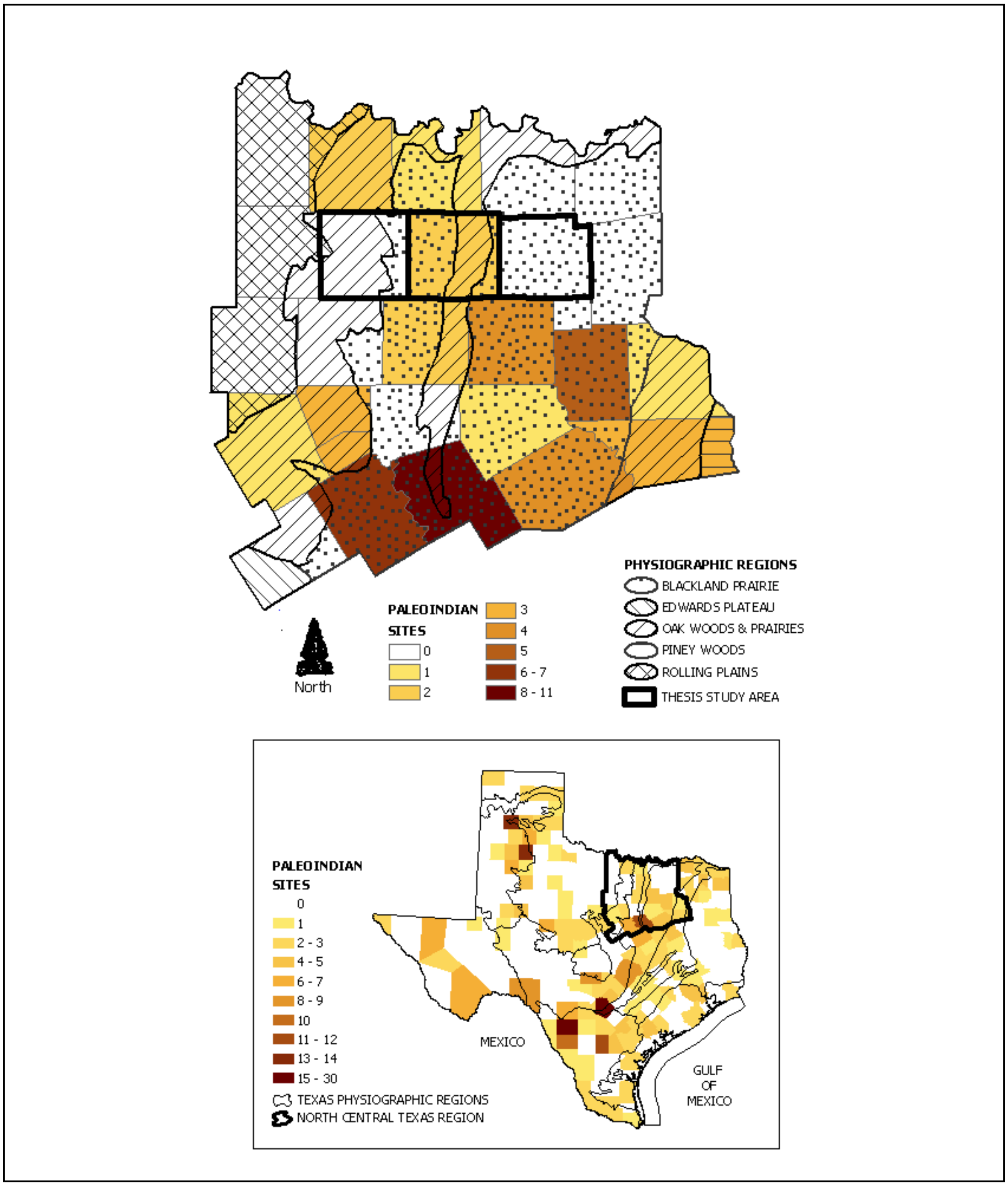

Figure 13. Distribution of Paleoindian sites in Texas and north-central Texas (data compiled from Nunley, 1973; Lynott, 1977; Biesaart et al., 1985; Prikryl, 1990; Ferring et al., 1997, 1998, 2001; TARL, 2002).

The Clovis horizon is primarily represented by finely crafted points with basal flutes and laurel-leaf shaped bifaces. Tool kits include a limited variety of tools consisting of blades, scrapers, and bone or ivory cylindrical shafts (Lynott, 1981). It is common for this time period that imported raw materials, rather than locally available quartzites and cherts, were utilized in the manufacture of projectiles and tools (Ferring, 2001). Utilization of non-local raw materials indicates increased mobility for long-distance procurement by direct acquisition or evidence of cultural interaction.

Tool assemblages associated with the Folsom horizon include fluted and non-fluted projectile point forms and various stages of lithic reduction that reveal a predominant bifacial technology. Scrapers, choppers, perforators, hammerstones, abraders and bone needles are also characteristic tools (Story, 1990: 189). Shifts in technology are indicated by an increased frequency of unfluted points, such as, the Plainview, Midland, and Eden. As with Clovis horizon artifacts, high-quality lithic raw materials were used for Folsom projectile points, implying long-distance travel or trade.

Plainview, Eden, Meserve, Angostura, Scottsbluff, Dalton and San Patrice point types are commonly associated with the Plano horizon. In correlation with other regions these points indicate a date around 10,000 BP. Dalton and San Patrice points are associated with the Paleoindian period. However, lifeways suggest affinities with the Early Archaic period. Therefore these particular projectile points are considered to be part of a transition between Paleoindian and Early Archaic technologies (Lynott, 1981:104; Prikryl,1987:157). Given that many of these point types were discovered in the study area, the Plano horizon is particularly important to the current research.

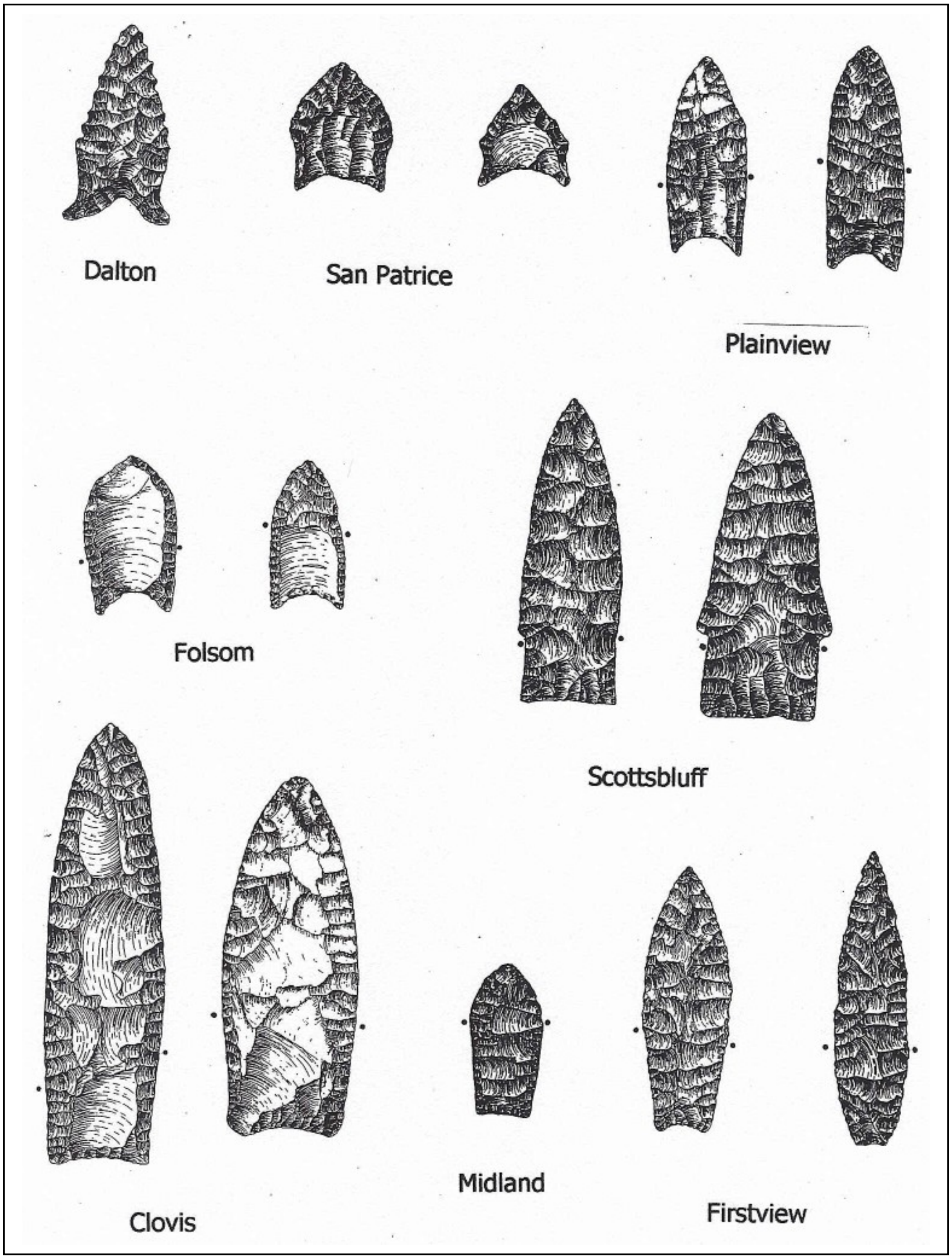

Figure 14. Paleoindian Projectile Point Chronology for north-central Texas (compiled from Turner and Hester, 1993; illustrations used with permission).

Surveys conducted along the Elm Fork of the Trinity by Prikryl (1990) mainly recovered Plainview and Dalton varieties. Dalton tool kits contain a variety of scrapers, retouched pieces, unifacial tools, blades, blade-like flakes, bipolar cores, wedges and specialized tools such as the uniquely fashioned bifacially chipped stone adze that was probably employed for woodworking (Story, 1990:190-202). Unlike the Clovis and Folsom the Plano horizon encompasses a more diverse set of cultural components as characterized by a proliferation of projectile point types and tools.

Paleoindian cultures hunted extensively in a fairly generalized manner from very small species to megafauna. Many Paleoindian sites contain remains of large mammals such as: mammoth, mastodon, bison, caribou, deer, camel, and horse. Faunal analyses at the Aubrey Clovis site indicate broad exploitation of large, medium, and small game, including bison, deer, rabbits, squirrels, fish, and turtle (Ferring and Yates, 1997). The range of variation presented by the faunal data indicates very flexible adaptive strategies (Ferring and Yates, 1997). Many of the large mammals found in association with Clovis sites became extinct requiring new adaptations. Folsom populations adapted adjusting their lifeways to respond to the challenges presented by these changes that are often attributed to the natural environment. This adjustment included a shift to hunting herds of Bison, refined tools and new techniques. The Plano horizon is believed to be the "final big game hunting occupation of the southern plains" (Lynott, 1981: 101). In north-central Texas, evidence is lacking for a subsistence strategy based heavily on big game hunting. A generalized hunting and gathering lifeway is considered more likely for Paleoindian populations that inhabited this region.

Vegetation during the Clovis horizon in this region was transforming due to decreased rainfall and warmer temperatures toward the end of the Pleistocene. Clovis point distribution suggests that all major environmental zones were exploited at one time or another (Story, 1990: 178). Around 9,200 BP the Folsom horizon developed in association to climatic changes and a complete shift to the hunting of bison. Shortgrass prairie ecosystems developed during this time period and were preferred by bison (Lynott, 1981: 101). During the Plano horizon evidence suggests that populations associated with Dalton points utilized woodland edge and prairie environments whereas San Patrice populations are associated with a more restricted range of environments. In general, the Paleoindian period is characterized by a series of flexible adaptations that correspond to the changing environmental conditions of the Late Pleistocene.

Paleoindian Settlement Patterns (11,500-8,500BP)

The settlement pattern for Clovis horizon populations is focused on upland settings and along small tributary streams (Story, 1990:182). In general, Clovis populations in north-central Texas were highly mobile and traveled considerable distances in small bands (Lynott, 1981: 101; Johnson 1989), indicating an overall low population density. Folsom presence in the region appears to have been very limited (Story, 1990: 189). Towards the end of the Paleoindian era, it has been speculated that a slight reduction of group mobility occurred in north-central Texas, possibly due to an increase in the tallgrass prairies coupled with an increase in population density (Lynott, 1981:101-103). However, repeated occupation of late Paleoindian sites by Early Archaic cultures obscures whether or not the increased population densities can be attributed to Plano horizon cultures. Nevertheless, the Plano horizon is mainly associated with Dalton points which are fairly numerous in north-central Texas suggesting more intensive use of the area in the Plano horizon than during the Clovis, Folsom or Early Archaic. Lithic raw materials indicate that the settlement patterns of these groups focused on primary and sometimes far-removed sources such as Alibates, Edwards Plateau, and the Ouachita Mountains supporting a significant level of mobility (Prikryl, 1990; Banks, 1990). Data from these sites combined with the lack of permanent structures indicate the existence of small, highly mobile groups utilizing scattered campsites. Overall, higher population densities, a reduction of mobility, and an emergence of territories are indicated towards the close of the Paleoindian era (Story, 1990: 196). Although notably different in character, hunting and gathering lifestyles endured throughout the Archaic.

Archaic (8,500-1,250 BP)

The Archaic time period represents a series of adaptations that were very similar to the Paleoindians (McGregor, 1987). The geographical distribution of Archaic cultures provides insight into the overall population density in Texas as it relates to the north-central Texas region (figure 15). Patterns indicate a fairly widespread distribution and increased population as suggested by the increase of sites reported across the state. The Archaic period has been defined as a time period designation for hunter and gatherer populations who practiced significantly different life-ways than their predecessors in relation to mobility and subsistence (Story, 1990:211). As previously mentioned, the varying chronologies produced by investigators for North Texas reflect the lack of clarity as to cultural subdivisions of the Archaic. However, the number of

Archaic period subdivisions primarily reflects differences in the intensity and geographical concentration of research conducted in each region (McGregor, 1987).

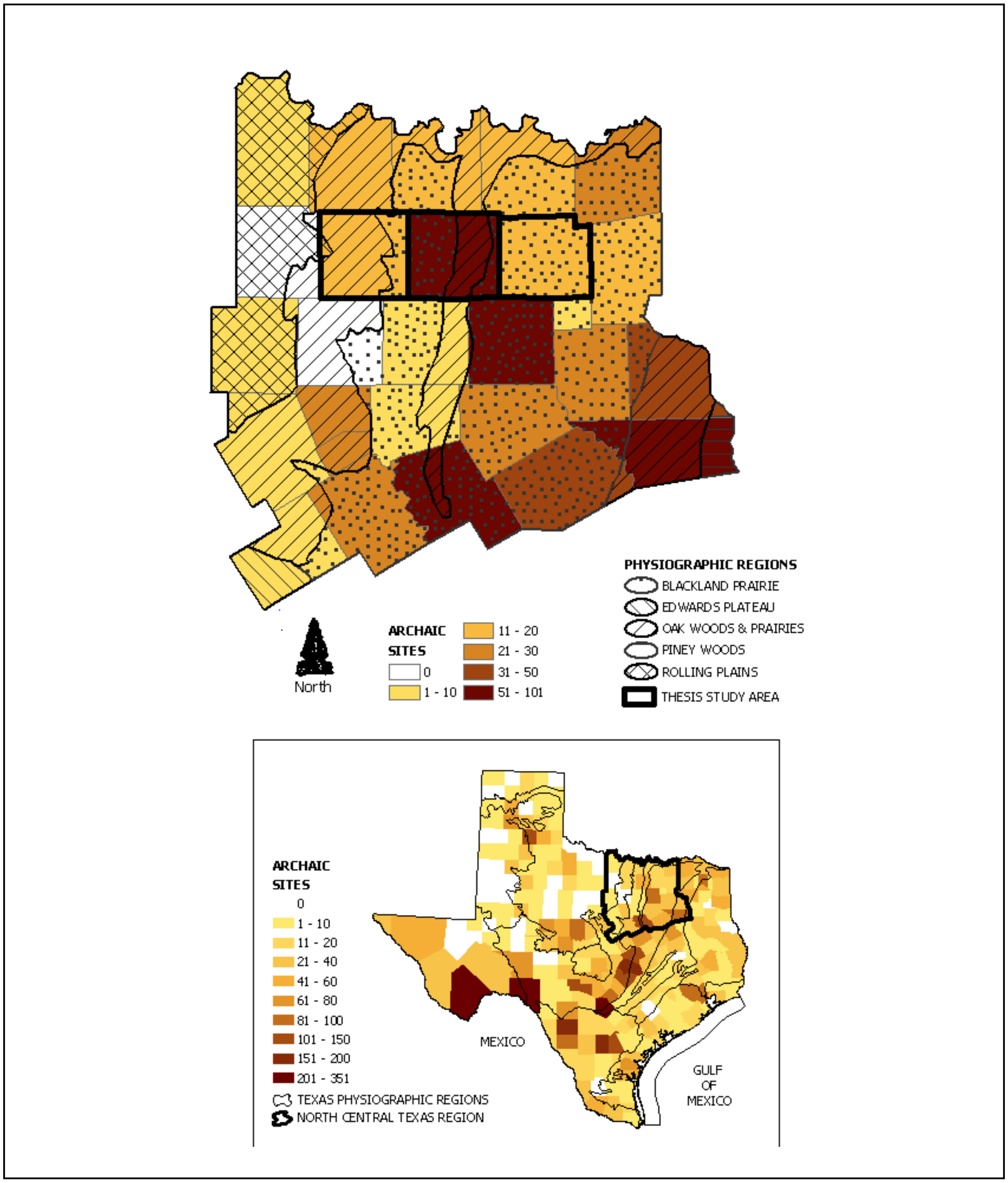

Figure 15. Distribution of Archaic sites in Texas and north-central Texas (data compiled from Nunley, 1973; Lynott, 1977; Biesaart et al., 1985; Prikryl, 1990; Ferring et al., 1997, 1998, 2001; TARL, 2002).

The more generalized chronologies reflect a lack of well-stratified sites and dated components. One of the main difficulties with Archaic age sites is the tendency for the mixing of cultural layers and frequency of surface finds that may be related to site formation processes or re-use of lithic materials in areas of low sedimentation. However, a handful of stratified sites have contributed to the development of chronologies based on projectile point types found in radiocarbon-dated strata. The current research depends on a chronology that has been most commonly accepted and, in part, based on radiocarbon dating in north-central Texas. This provides a date for the Archaic between 8,500 BP and 1,250 BP (Ferring and Yates, 1998).

Varieties of point styles (figure 16) that emerge during the Archaic provide a view of the tremendous diversity that bloomed and brought the Paleoindian period to an end. Rather than a small assortment of finely crafted artifacts, Archaic cultures adapted by developing an extensive assortment of stone tools. In addition to a variety of projectiles, scrapers, knives, gravers, burins, drills, gouges and axes were added to the toolkit (Lynott, 1986; Story, 1990; Ferring and Yates, 1998). During the Archaic a variety of small, stemmed dart points are first evident and polished stone tools appear for the first time along with grinding implements, mortars, manos, pestles, and a variety of bone tools (Ferring and Yates, 1998; Story, 1990). Hearths, middens and wells are significant features that are heavily utilized during the Archaic (Johnson and Holliday, 1986; Story, 1990). Archaeological remains from this time period reflect clear changes in cultural adaptations and increasing diversity in artifact assemblages suggest an increased dependence on plants. The arrival of this diversity is probably related to adaptations in response to population growth indicated by a substantial increase in sites, increased knowledge regarding effective plant utilization and fluctuating climates.

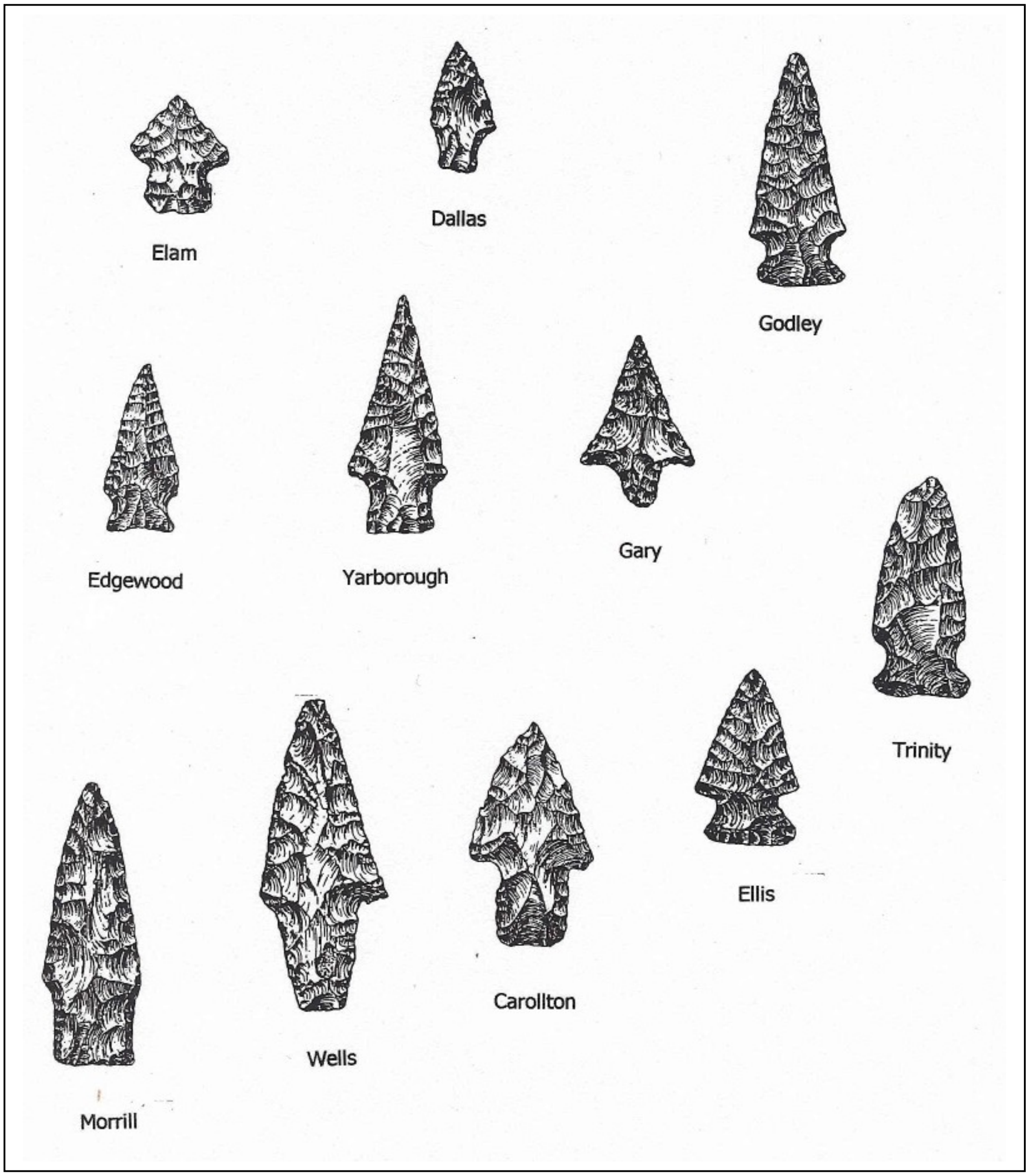

Figure 16. Overview of Archaic projectile points in north-central Texas (compiled from Turner and Hester, 1993; illustrations used with permission).

Early Archaic (8,500-6,000 BP)

The geographical distribution of Early Archaic cultures (figure 17) indicates a population increase as compared to the Paleoindian. In north-central Texas, the Early Archaic period is very difficult to define due to the lack of well-documented, temporally unmixed cultural deposits and use of inconsistent artifact typologies (Story, 1990:217). To date, few sites with discrete Early Archaic components have been investigated in this region, with the exception of Prikryl's (1990) identification of 57 diagnostic Early Archaic artifacts in assemblages from 22 surface sites in the Upper Trinity basin.

Compared to Paleoindian period artifact assemblages, Early Archaic (8,500 BP-6,000 BP) flaked stone tools tend to be less carefully fashioned and less often made of extralocal raw materials (Story, 1990:213). Point types that define this time period vary according to geographic location. Evidence of Early Archaic occupations in the Ray Roberts Lake area consists of surface finds of the Angostura, Wells and early split stemmed projectile point types (Prikryl, 1987: 158-161). The general evolutionary trend in projectile point manufacture (figure 18) throughout the period is toward shorter triangular points. Compared to the Paleoindian period, the tool kit of the Early Archaic is more diverse. Projectile points are primarily produced from local cherts and quartzites. Appearance of polished and ground stone items suggests changes in the processing of food resources and most likely the intensification of plant food collection (Story, 1981; Ferring and Yates, 1998). In general, the Early Archaic is characterized by adaptations to the modern fluctuating climate and environment that emerged during the Holocene. Cultural responses to these new ecological systems include a wider variety of projectile points and more variable artifact assemblages.

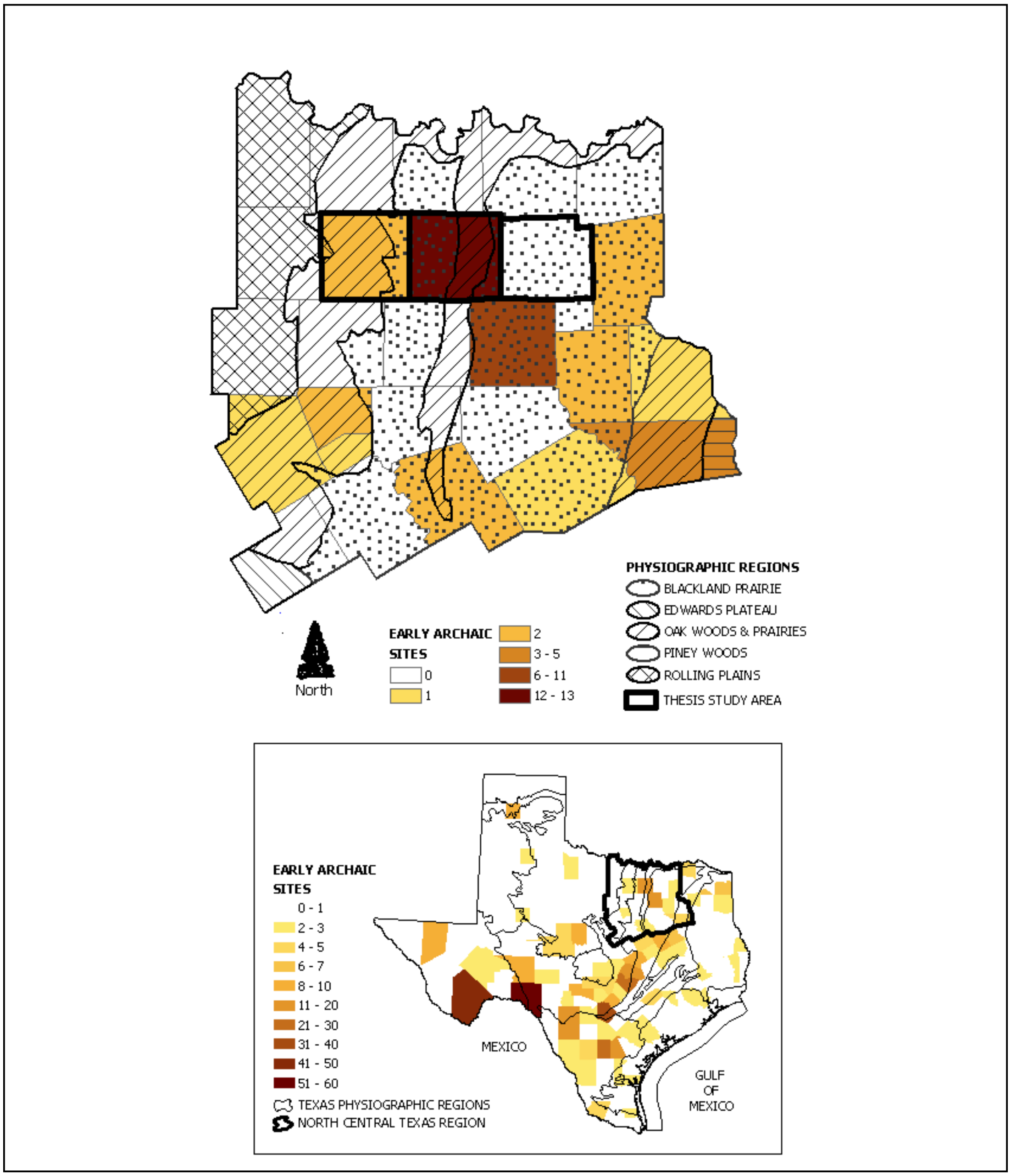

Figure 17. Distribution of Early Archaic Sites in Texas and north-centralTexas (data compiled from Nunley, 1973; Lynott, 1977; Biesaart et al., 1985; Prikryl, 1990; Ferring et al., 1997, 1998, 2001; TARL, 2002).

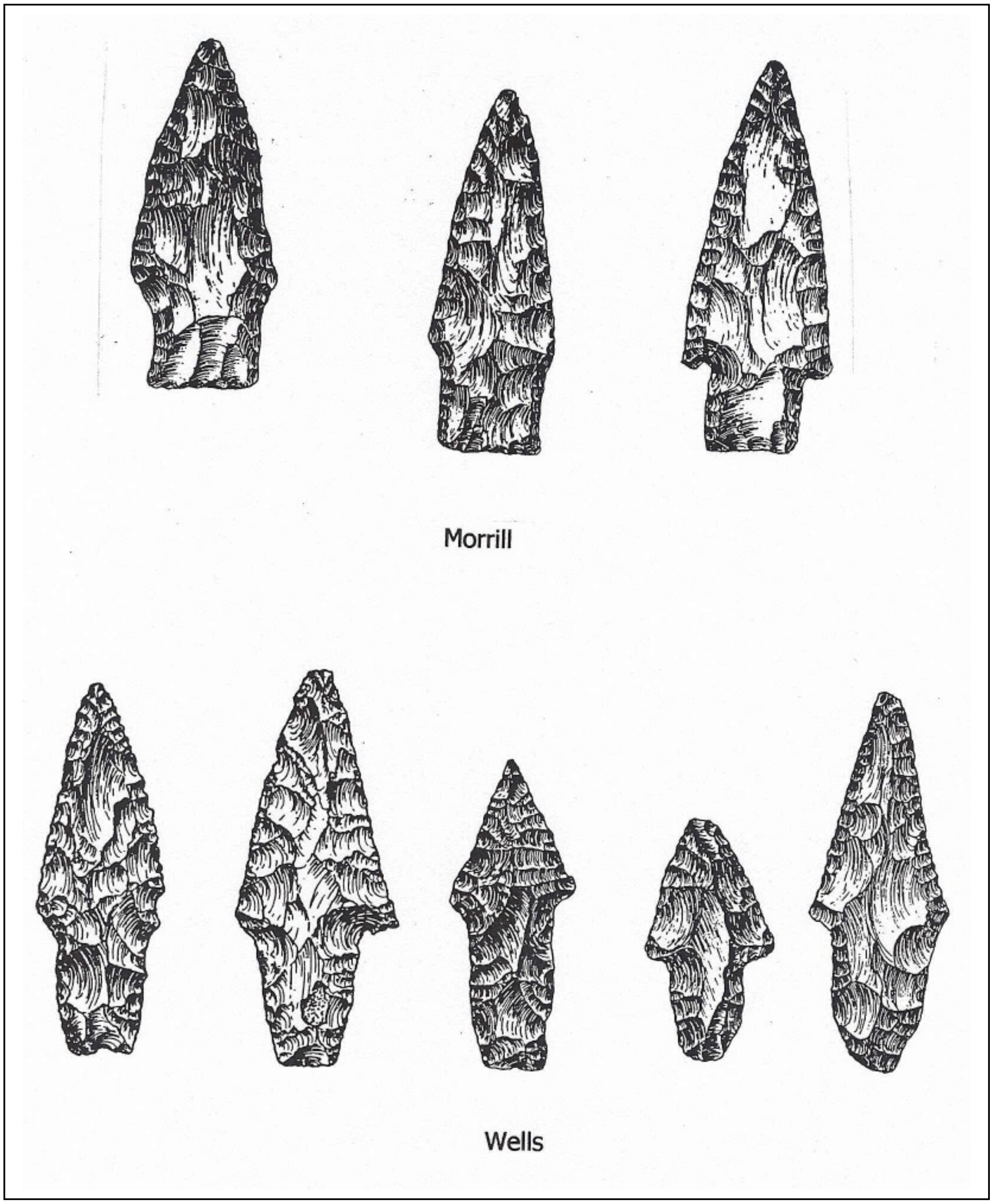

Figure 18. Early Archaic projectile points in north-central Texas (compiled from Turner and Hester, 1993; illustrations used with permission).

Middle Archaic (6,000-3,500 BP)

The geographical distribution of the Middle Archaic (figure 19) indicates a fairly wide distribution with an overall decreased population density. The Middle Archaic is defined essentially as a continuation of Early Archaic life-ways, with a few changes in adaptive strategies. Middle Archaic sites are rare in this region (Ferring and Yates, 1997). In the Elm Fork Trinity Valley, projectile points of this general age are found at fewer localities than are points of any other age (Prikryl, 1990). The only "in situ" site of this age, discovered in the study area, is 41DN102, the Calvert site (Ferring and Yates, 1997). Deep burial, dry climates and reduced occupation potentials are probably important factors in the small number of sites dating to this period.

The growing diversity reflected in the material remains is the defining characteristic that distinguishes the Middle from Early Archaic time periods. Generally, projectile point size increases from the Early Archaic to Middle Archaic. In north-central Texas, the Middle Archaic is characterized by an increased variety of projectile points (figure 20). Dart points (e.g. Carrollton, Elam, Morrill, Wells and Gary); basal notched projectile points (e.g. Andice and Calf Creek); and parallel, slightly contracting based points (e.g. Pedernales, Bulverde, Travis and Nolan) are characteristic of this time period (Prikryl, 1987: 162; Lebo and Brown, 1990). Regardless of the paucity of sites, enough archaeological evidence has been discovered to formulate two cultural subgroups referred to as the Trinity Aspect and Elam focus.

The Trinity aspect, which contains the early Carrollton focus, is one of the earliest well-defined Middle Archaic period cultural entities centered along the Trinity. The

Carrollton focus is defined solely on the basis of artifacts and primarily projectile points. The vast majority of the points are medium-sized to small in length. There is also tremendous variation in the sizes of the individual point types such as the Gary point.

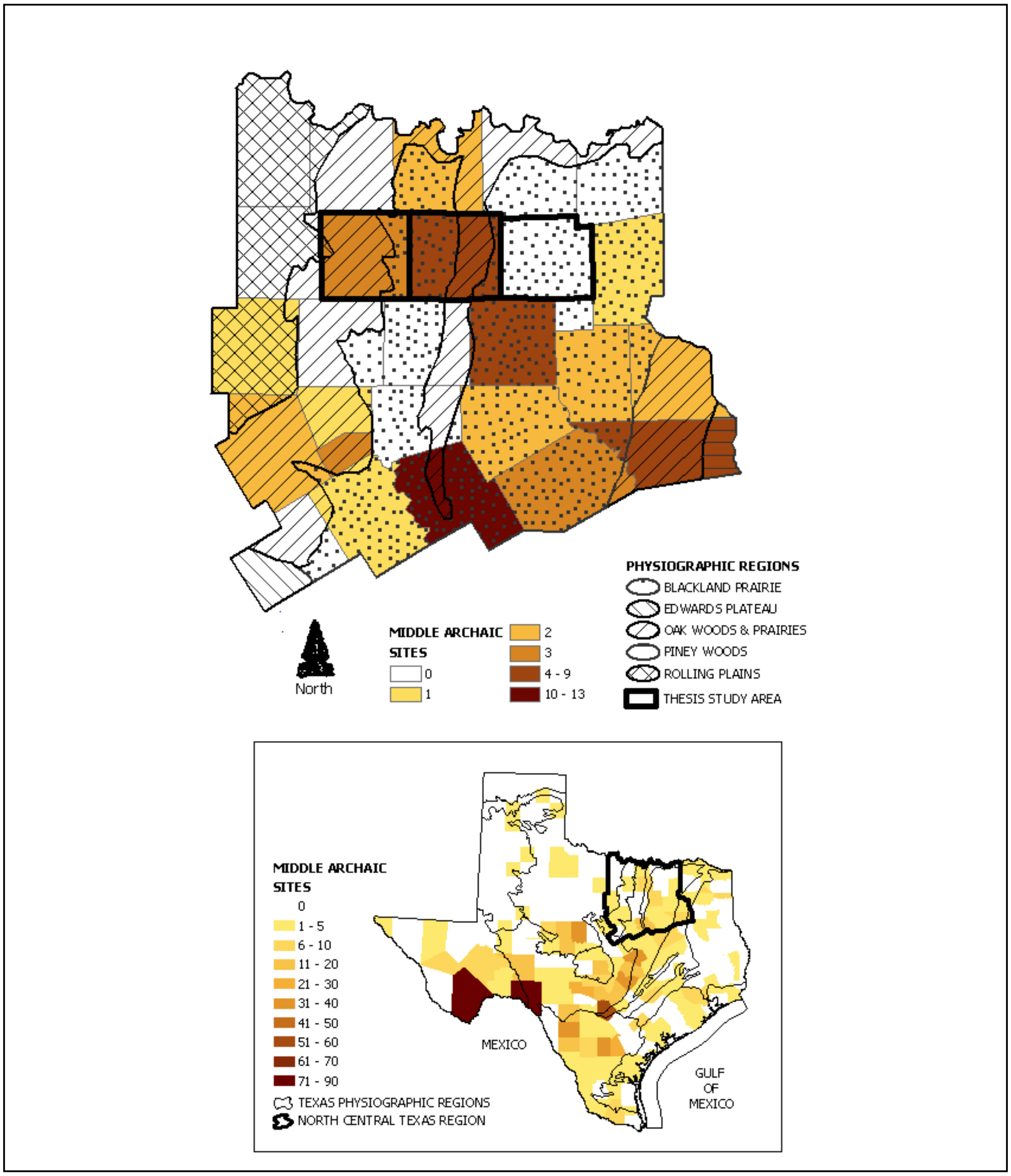

Figure 19. Distribution of Middle Archaic sites in Texas and north-centralTexas (data compiled from Nunley, 1973; Lynott, 1977; Biesaart et al., 1985; Prikryl, 1990; Ferring et al., 1997, 1998, 2001; TARL, 2002).

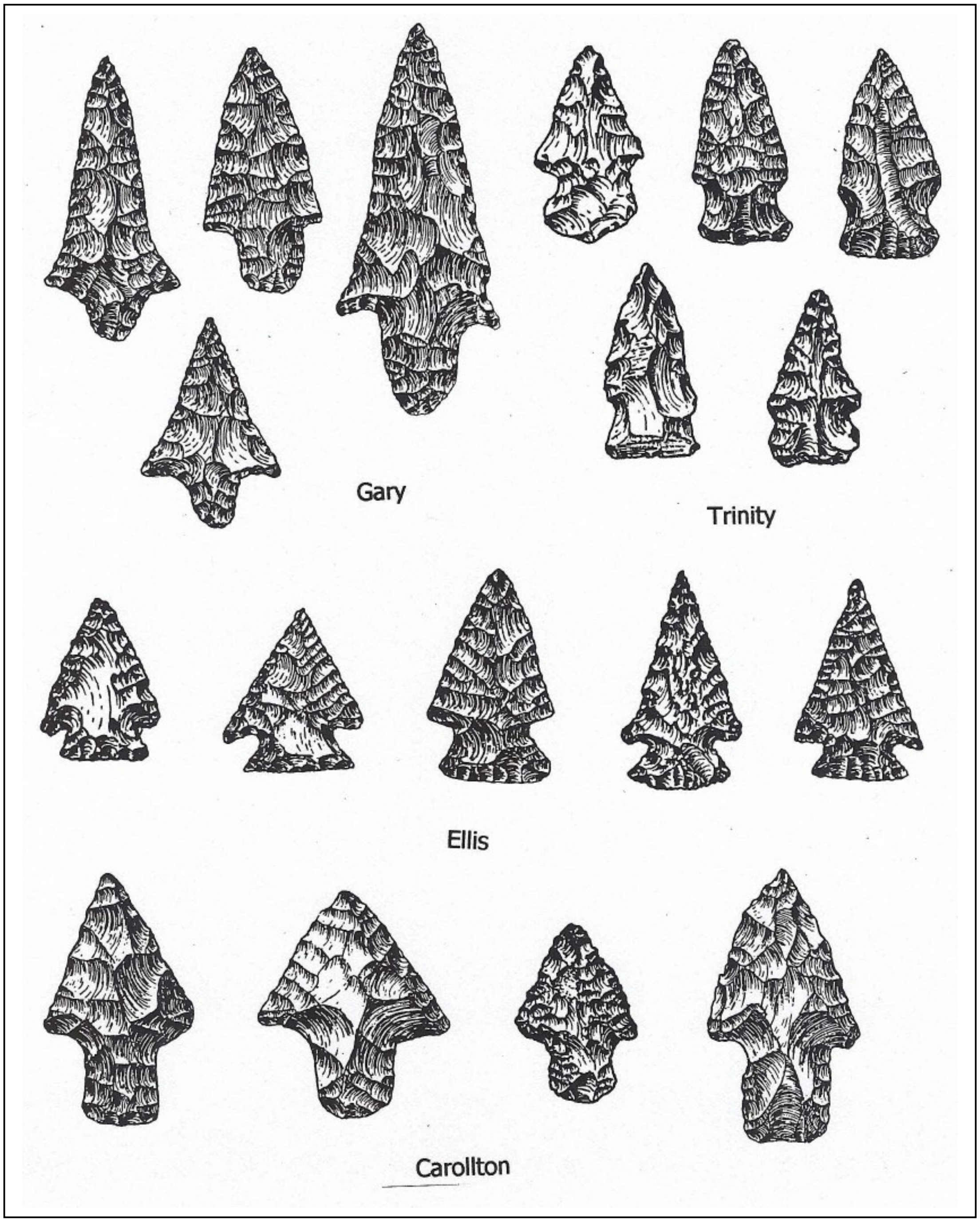

Figure 20. Middle Archaic projectile points in north-central Texas (compiled from Turner and Hester, 1993; illustrations used with permission).

A few of the Carrollton focus projectile points are similar to Plainview and others resemble the Gary types of the Late Archaic period. Other points associated with this "focus" include the Carrollton and Trinity dart points (McGregor, 1988:31). The tool kit includes spokeshaves, the "Waco sinker", the chipped stone Carrollton axe, scrapers, gouges, a few grinding stones, ground stone, drilling tools, knives, hammerstones and choppers (McGregor, 1988:31).

The most commonly recovered artifacts from Elam focus components are projectile points. Possibly the most common projectile point of this period is the Ellis dart point, followed by the Yarbrough and Elam types (McGregor, 1988:31). Similar to the Carrollton focus, drills, scrapers, knives, hammerstones and choppers remain a significant part of the tool kit. In comparison with the Carrollton focus, the Elam focus is characterized by a higher percentage of lithic tools made from locally obtained quartzite (McGregor, 1988:31). Overall, however, raw materials commonly used for Middle Archaic tools derive from locally available lithic resources. Typology is complex and often ambiguous requiring constant reevaluation. Nevertheless, the currently established descriptions of Middle Archaic typological characteristics offer an adequate overall cultural model for this time period.

Late Archaic (3,500-1,250 BP)

The geographical distribution (figure 21) of Late Archaic cultures indicates increased population densities across the state. Significantly more Late Archaic sites have been investigated in north-central Texas, than in previous time periods (McGregor and Bruseth, 1987; Prikryl, 1990; Peter and McGregor, 1988; Ferring and Yates, 1997). The abundance of sites is attributed to shallow burial below floodplains that has produced in-situ sites with well-preserved living surfaces, features and biotic remains. These sites have been found to be very common along the Trinity (Ferring and Yates, 1997:6). Intriguing evidence for Late or Transitional Archaic use and occupation of the region is related to large man-made depressions found at the Richland/Chambers Reservoir (Story et al., 1990; Lynott, 1975). These depressions, referred to as "Wylie Focus pits," are features that may indicate group aggregation and ceremonialism (Lynott, 1975; Bruseth et al., 1987; Story, 1990:235). Several sites excavated along the Elm Fork also provide excellent stratigraphic records of Late Archaic cultures.

Most evidence for the presence of Late Archaic cultures (figure 22) includes projectile points such as the Ellis, Edgewood, Elam, Gary, Dallas, and Godley varieties, as well as, the slightly earlier Yarbrough and Trinity types recovered from archaeological contexts (Prikryl, 1987; Brown and Lebo, 1991). Late Archaic occupations in the Lewisville Lake area are primarily based on the surface recovery of these point types with the exceptions of the excavations reported by Ferring and Yates (1997). New developments in the material culture for this time period include the use of pecked and polished stone in the production of ornaments and implements such as spear-throwing weights and axeheads (Story, 1990:213). Prikryl's (1990) analysis of raw material types indicates that 39% of the Late Archaic tools were made from non-local chert whereas Early-Middle Archaic and Late Prehistoric assemblages average 70%-80% chert raw materials. Intensive use of local materials is characteristic of the Late Archaic period (Ferring and Yates, 1997:6).

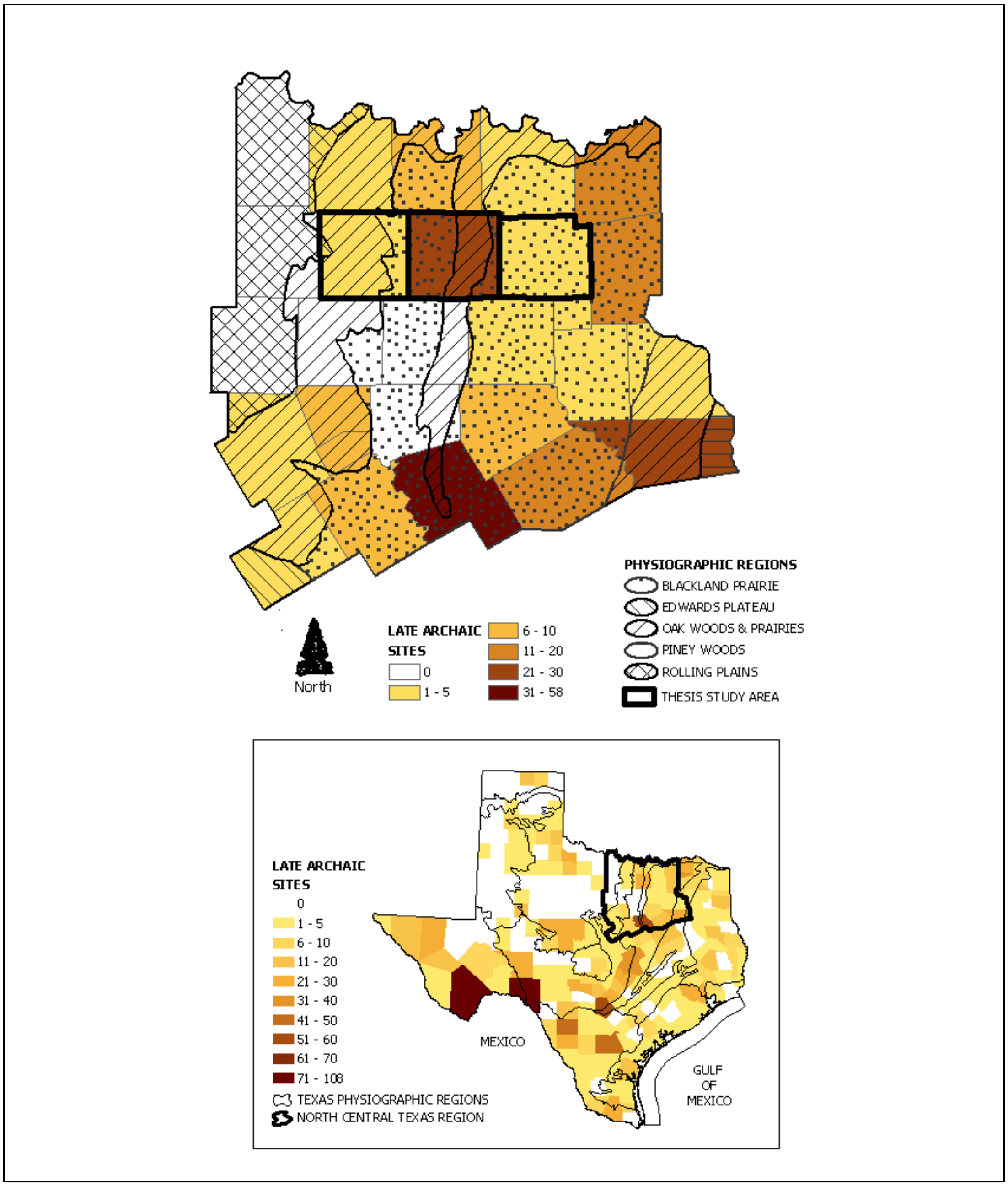

Figure 21. Distribution of Late Archaic sites in Texas and north-centralTexas (data compiled from Nunley, 1973; Lynott, 1977; Biesaart et al., 1985; Prikryl, 1990; Ferring et al., 1997, 1998, 2001; TARL, 2002).

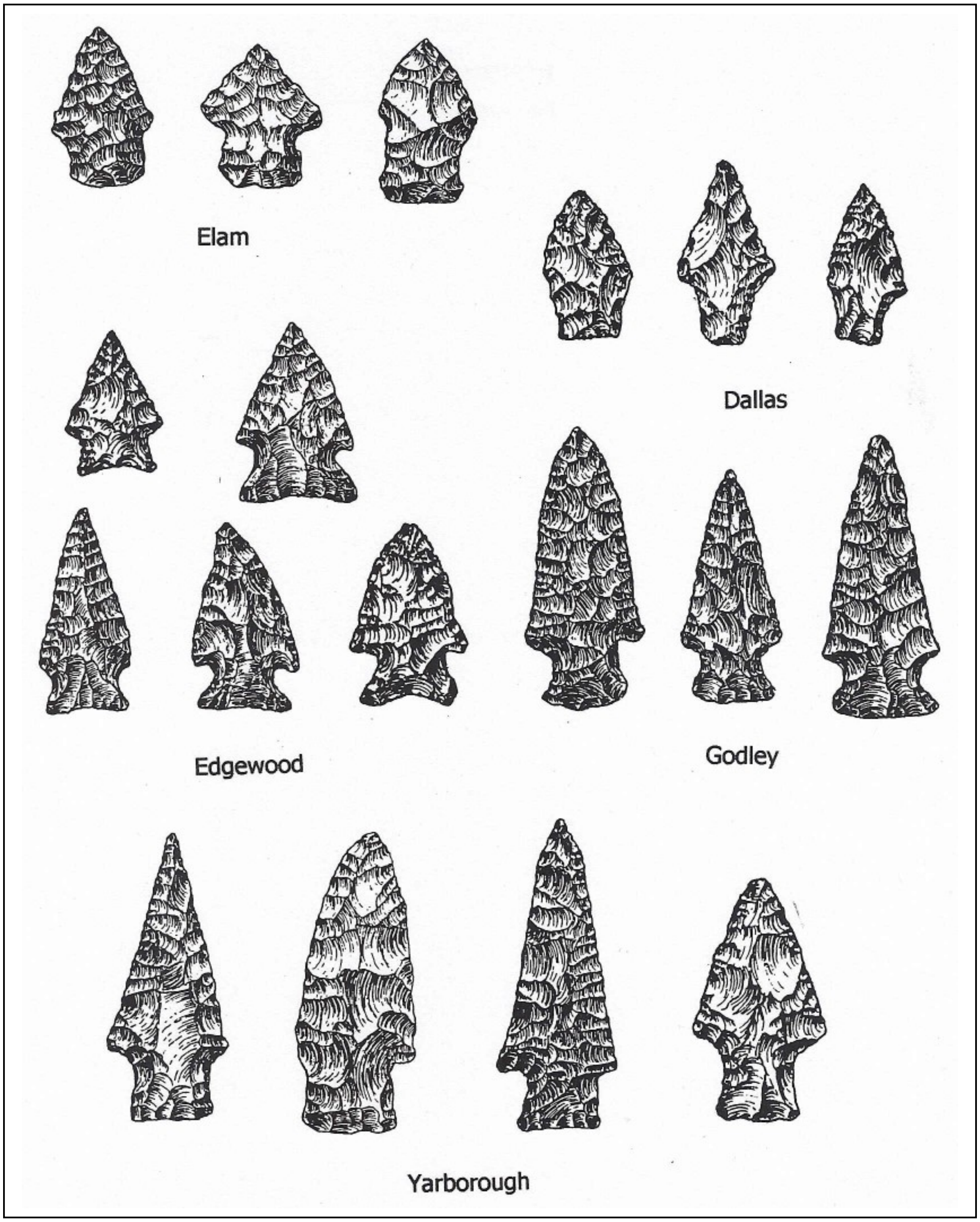

Figure 22. Late Archaic projectile point chronology for north-central Texas (compiled from Turner and Hester, 1993; illustrations used with permission).

Archaic Climatic Change (8,500-1,250 BP)

The Archaic is a time period marked by climatic change from the end of pluvial conditions through extreme xeric conditions (Johnson and Holliday, 1986: 46). These conditions led to the modernization of faunal and vegetational communities. Beginning in the Early Archaic period the gradual warming trend posited toward the end of the Paleoindian period significantly changed during the early Holocene toward the increasingly warmer, drier conditions of the Middle Holocene (Johnson and Holliday, 1986: 46). Although the trend towards a warmer, drier environment began in the Early Holocene, wetter climates predominated during the Early Archaic (Ferring and Yates, 1997). Grasses were dominant between 9,000 and 5,000 BP (Ferring, 1993; Prikryl, 1987:156) effecting the options and related choices these early populations made. Opening of new prairie uplands and retreat of hardwood forests to the floodplains is related to these climatic conditions (Lynott, 1981:103). Drier climates and decreased biotic resources are suggested during the Middle Archaic due to the presence of high grass pollen and low arboreal pollen between 7500 and 3000 BP (Ferring and Yates, 1998:36; Skinner and Ferring, 1999:10). Beginning 5000 BP, the north-central Texas environment underwent an increase in effective moisture and temperature that would have affected the variety of available plants. A return to wet conditions toward the end of this time period led to the beginning of the Late Archaic. Around 4,500 BP evidence suggests that a migration of oak savannah may have replaced a large portion of the grasslands (Prikryl, 1987:162). By 4000 BP the climate began to approach present conditions. The environment, as indicated by paleoenvironmental evidence, obtained from archaeological sites, experienced a slight shift to wetter conditions during the Late Archaic period. Additional supporting evidence of wetter conditions includes the development of the West Fork Paleosol (Ferring, 1986: 112). With wetter environmental conditions, it is expected that the density of vegetal resources would have increased, resulting in the expansion of the Cross Timbers woodlands. This would have resulted in an increase of the plants utilized for human consumption and biomass for game animals (Prikryl, 1987:170). The Late Archaic occurs during a return to moister and somewhat cooler conditions, perhaps similar to those of today (Johnson and Holliday, 1986: 47). However, climatically, the warm wet conditions continued for another 1000 years. Cultural adaptations throughout the Archaic appear to correspond with changes in climate. As such, it appears that the Archaic cultures were most dramatically affected by the fluctuating climatic conditions.

Archaic Subsistence Patterns (8,500-1,250 BP)

Throughout the Archaic in north-central Texas economies were based on hunting and gathering (McGregor, 1987). The subsistence pattern of the Early Archaic period is very similar to that of the Paleoindian period. Early Archaic cultures were also nomadic seasonal hunters except the annual range utilized by these cultures appears to be considerably reduced. In addition, emphasis appears to have been placed more on gathering a wider range of plant species within this annual range (Story 1981:144; Brown et al. 1987:5-6). Extinct bison are present into at least the beginning of the Early Archaic. During the Middle Archaic data indicates an increased modern bison economy and a diffuse subsistence economy that included a wide variety of available resources (Brown and Lebo, 1991:8). Faunal data from sites in north-central Texas indicate that Late Archaic populations exploited a mix of prairie, forest and riparian species (Ferring and Yates, 1997:6). According to data generated by excavations white-tailed deer, rabbits, turtles and mussels are the most common (Ferring and Yates, 1997). In addition, mast crop resources would have been particularly desirable to these early populations. Although the importance of hunting appears to be generally reduced throughout the Late Archaic subsistence evidence indicates continued hunting of bison and antelope in the upland prairie (Prikryl, 1990; Brown and Lebo, 1991). Procurement of riverine faunal and floral resources in the prairie, Cross Timbers and ecotones involved intensive exploitation of local bottomland resources and seasonal activities (Lynott, 1981:104; McCormick, 1990). In some cases subsistence economy is focused on the oak-hickory forests found along the floodplains of major drainages (Brown and Lebo, 1991:7). As a result of a more diverse economy, site types within the Archaic period are more varied than in the Paleoindian period. Site types include: open camps, bison kills, flint quarries and flint caches (Story, 1990: 211). In general, Archaic populations were hunter-gatherers that utilized a wide variety and abundance of wild food resources.

<u>Early Archaic Settlement Patterns (8500-6000BP)</u>

It is probably due to wetter conditions during the Early Archaic that sites are primarily found on stream terraces near primary water sources rather than bottomland settings (Skinner and Ferring, 1999:9). According to Prikryl (1990) there are fewer bottomland sites reported on the Elm Fork than during the previous period. However, Lynott (1981) suggests that there was an increased emphasis on the use of bottomland food resources (Skinner and Ferring, 1999:9). Subsistence patterns indicate a diffuse hunting and gathering strategy on the floodplains and in the prairie uplands (Brown and Lebo, 1991:7; Lynott, 1981:103). Given the various climatic interpretations the range of settings occupied during this time period could be an indication of a fluctuating climate or seasonal occupation in relation to drier or wetter conditions. The aggregation of Early Archaic period populations appears to have been confined to small groups of nomadic seasonal hunters who utilized briefly occupied hunting camps and followed seasonal rounds that focused on a variety of resident and migratory animals along the main stem of the Trinity and its larger tributaries. In general, previous investigations indicate an Early Archaic concentration in the floodplains, bottomlands, uplands and along major tributaries. Site locations are situated in both the prairies and cross timbers. However, no trends or patterns have been identified, on a regional scale, in relation to physiographic or topographic settings, to provide a clear explanation for site location.

Middle Archaic Settlement Patterns (6000-3500BP)

The few Middle Archaic sites that have been located are on the first terraces above the flood plains (Skinner and Ferring, 1999:9). These sites tend to be situated along the Elm Fork rather than the smaller tributaries (Skinner and Ferring, 1999:9). Evidence suggests that the subsistence economy was generally focused on the Oak-Hickory forests found along the flood plains of major drainages while other sites along the Elm Fork are located on terraces above stream floodplains (Brown and Lebo, 1991:7; Prikryl, 1990). Both cases indicate a direct correlation with major water sources that would have been highly desirable during the drier climatic conditions. As scheduling of hunting and gathering became more efficient, the size of territories became smaller (Brown and Lebo, 1991: 8). During certain seasons, it was possible for small social aggregates to form without exhausting local resources. Yet it would have been advantageous for these larger groups to disperse during times of food stress (Lynott, 1981: 104). The bison hunt requires large areas of land, as well as, a strategic system to find herds, corral and capture them. Seasonal scheduling of activities was necessary to synchronize with the migratory patterns and cyclical abundance of herds. However, this pattern has not been clearly illustrated in relation to site locations as they correspond with the necessary settings that would fulfill scheduling requirements while sustaining prehistoric populations.

Late Archaic Settlement Patterns (3500-1250BP)

During the Late Archaic there appears to be a notable shift of site location to floodplains, first order tributaries and minor tributary streams (Prikryl, 1990: 74; Skinner and Ferring, 1999:9). The development of the West Fork Paleosol toward the end of the Late Archaic reflects a wetter environment that would have influenced the range of settings appropriate for human occupation (Prikryl, 1990: 74; Brown and Lebo, 1991:8). Subsistence strategies indicate that a wide variety of settings (e.g. uplands, riparian corridors, bottomland hardwood areas) were utilized. An expansion of the Eastern Cross Timbers associated with the wetter environment would have provided a larger mast crop for consumption by humans and animals (Brown and Lebo, 1991:8).

Evidence suggests that subsistence in the upland prairie continues to focus on bison with some use of riverine faunal and floral resources (Brown and Lebo, 1991:8). Along major drainages, the subsistence economies reflect increased efficiency in the use of local floodplain resources (Brown and Lebo, 1991:8). This efficiency was probably related to better scheduling and exploitation technologies (Brown and Lebo, 1991:8). Although Late Archaic sites are distributed over a larger area and appear to have been larger or more frequently occupied there is no evidence to supports that sedentary villages existed during this period. Settlements appear to correspond with locations that contain access to abundant resources, with favored sites being repeatedly used over long periods of time (Brown and Lebo, 1991:8). A few sites contain clear evidence of repeated occupations and sites with higher artifact densities are thought to indicate repeated use as well (Ferring and Yates, 1997:6). Evidence suggests that camps and habitation areas were not occupied year-round yet group movements appear to be within particular territories (Story, 1981:146). In north-central Texas, the Late Archaic settlement patterns indicate increasing evidence for the reuse of campsites and a trend toward seasonal aggregation of populations when large quantities of food were locally available (Lynott, 1981: 105). Higher site densities and increased cultural complexity accompany the end of the Late Archaic.

<u>Late Prehistoric (1250-250BP)</u>

The classification of sites on a statewide scale combines the two phases of the Late Prehistoric (as defined in north-central Texas) into one time period. Therefore the generalized geographical distribution (figure 23) has been combined to form one overall view. The appearance of the bow and arrow in the archeological record is the hallmark of the beginning of the Late Prehistoric period (Story, 1990; Ferring and Yates, 1998).

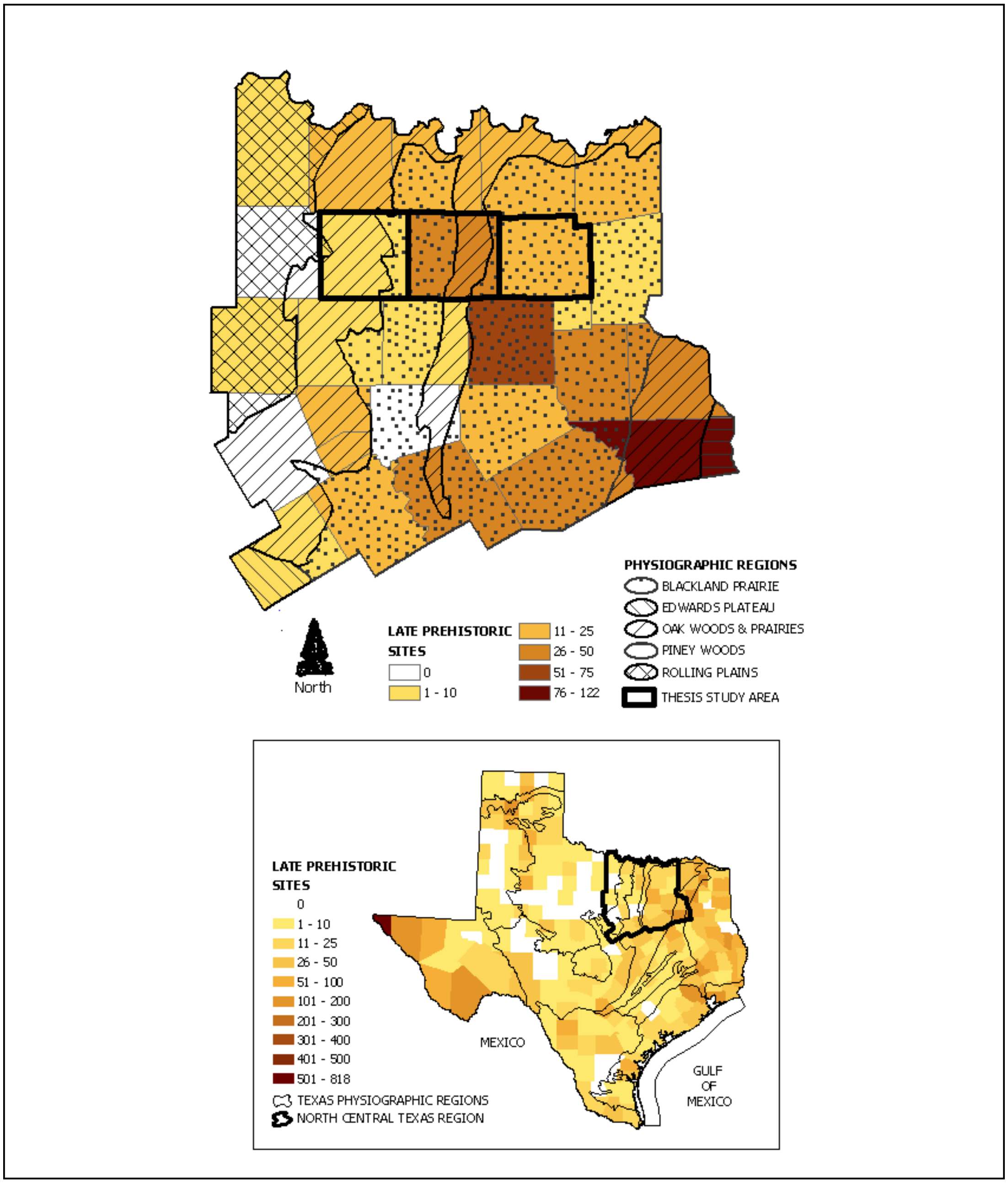

Figure 23. Distribution of Late Prehistoric sites in Texas and north-central Texas (data compiled from Nunley, 1973; Lynott, 1977; Biesaart et al., 1985; Prikryl, 1990; Ferring et al., 1997, 1998, 2001; TARL, 2002).

In addition, an increased dependence on plants led to the use of ceramics followed by the development of agriculture and a relatively sedentary lifeway. Prehistoric populations appear to have been receptive to these changes as suggested by the technological changes indicated by the archaeological record.

Although, Prikryl (1990) and others divide the late Prehistoric into two phases, Late Prehistoric I (1,250BP-750 BP) and Late Prehistoric II (750BP-350BP), based on projectile point types, "the number of sites with discrete assemblages is very small, and the great majority of the Late Prehistoric sites that he identified have points assigned to both phases" (Ferring and Yates, 1998). In the later parts of this period, Plains Village traits are found to be more common in assemblages from the Elm Fork Trinity (Ferring, 1986) while Caddoan traits are more common in sites from the East Fork Trinity (Lynott, 1975; 1981). As a result, in Late Prehistoric times both temporal and cultural factors contribute to archaeological complexity. Excavations of several Late Prehistoric sites at Lake Lewisville and Ray Roberts Lake and other local reservoirs (Skinner and Baird, 1985; Peter and McGregor, 1988; Lynott, 1975) provide examples of in-situ archaeological sites (Ferring and Yates, 1997:7).

Scallorn, Rockwall, Catahoula, Bonham and Alba arrow point types (figure 24) are diagnostic of Late Prehistoric I cultures (Prikryl, 1987: 133; Ferring and Yates, 1998). Prikryl (1987) maintains that most projectiles are made of quartzite, while chert was used more frequently to make arrows during the second half of the period. Signature artifacts include smooth, flat-bottomed ceramic vessels; Gary dart points and the appearance of small, expanding stem arrow points such as the Scallorn type and an

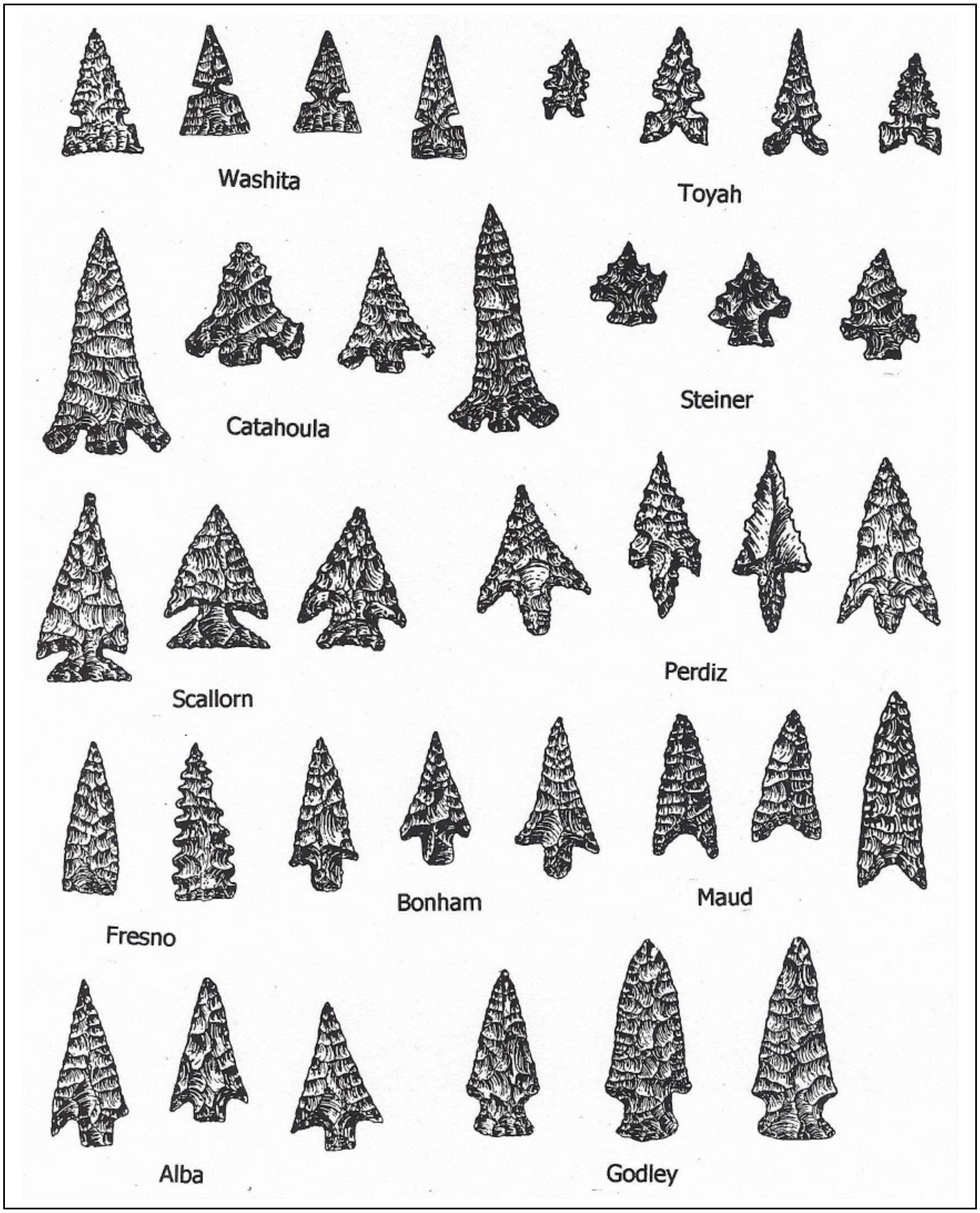

Figure 24. Late Prehistoric projectile point chronology for north-central Texas (compiled from Turner and Hester, 1993; illustrations used with permission).

assortment of tools including drills, scrapers, and grinding implements (Story, 1990:217, 356). Ceramics associated with Late Prehistoric I cultures are often tempered with grog and bone (Brown and Lebo, 1990: 8). The most common cultural features encountered are hearths and probable roasting ovens along with less frequently occurring storage pits, burials, and possible structural remains (Story, 1990:356). Limited evidence suggests that this period in north-central and east Texas evolved directly out of the earlier cultures associated with the Late Archaic period. However, it is important to consider the possibility of secondary information diffusion and recycling that may have occurred due to site reoccupation. Dating of these technological changes is speculative at best since a considerably earlier dating for the introduction of ceramics has been suggested for portions of the middle Trinity drainage and for east Texas.

Late Prehistoric II occupations, in north-central Texas, are signified by Washita, Harrell, Toyah, Maud, Perdiz, Steiner and Fresno arrow points (figure 24). Material culture exhibits a distinct change in the composition of lithic tool assemblages. Other material evidence includes bone tools; scrapers; edge-beveled knives; drills and shell-tempered pottery (Prikryl, 1987; Brown and Lebo, 1990). Ceramics, projectile points, and other material culture remains from archaeological contexts in north-central Texas appear to be related to sites in eastern Texas from this same period (Story, 1981). Introduction of the bow and arrow probably brought about a tremendous change in hunting technique and efficiency, probably leading to a higher abundance of food resources and a resultant increase in population. The shift from dart points to arrows also implies adoption of individual hunting strategies over group hunting strategies.

Late Prehistoric Climatic Conditions

Around 1060 BP it is posited that the end of the West Fork Paleosol indicates a return to a drier climate (Brown and Lebo, 1991:9). The presence of Paleosols between 2000BP and 1000 BP suggests a decrease in moisture during this period with a return to wetter conditions after 1000 BP indicated by an increase in arboreal pollen (Skinner and Ferring, 1999:10). The fairly steady decrease in the ratio of nonarboreal pollen to arboreal pollen inferred from the Ferndale Bog Sample reveals a general trend toward less dry conditions (Story, 1981). High grass pollen also occurs around approximately 1500 BP and during an interval between 500 to 400 years ago indicating that drier climatic intervals probably interspersed with the wetter conditions that are suggested by carbon isotope evidence (Ferring and Yates, 1998; Skinner and Ferring, 1999).

Late Prehistoric Subsistence Patterns

While changes appear to have occurred in most aspects of cultural lifeways, in the Late Prehistoric, subsistence patterns changed little from Late Archaic times. In general, evidence suggests that exploitation of riverine resources continues and the exploitation of bison increases after A.D. 1200. However, throughout the Late Prehistoric deer are considered to be the primary source of meat protein (Lynott, 1981, Skinner and Baird, 1985; Ferring and Yates, 1997). Smaller game that supplemented the meat portion of the diet predominantly includes rabbits and turtles. Plant foods played an increasingly larger role in subsistence as indicated by the increase of groundstone artifacts. Evidence from many sites in north-central Texas suggests that the most common plant food source is the hickory nut (Martin, 1987) that would have required grinding techniques in order to facilitate preparation for use. No tropical cultigens have been identified in floral assemblages, although squash and sunflower seeds are represented (Story, 1981: 146). Use of domesticates is indicated at several sites (Peter and McGregor, 1988), but is not presumed to have been a dominant economic focus. Corn horticulture prior to A.D. 1200 has only been found at a few sites. As Story (1981: 146) proposes, subsistence was probably based on an intensive foraging strategy and possibly included cultivation of native food resources. Ceramic vessels are also an important innovation that may reflect alternative food preparation techniques unknown during Archaic times (Story, 1981:146). This also may indicate the beginning of an intensified subsistence strategy that may help explain reduction of group mobility and population growth (Bruseth and Martin, 1987:284). In general, it is hypothesized that Late Prehistoric cultures participated in a nomadic broad-spectrum subsistence economy that included a primary focus on deer and seasonal scheduling.

The primary difference between the first and second phases of the Late Prehistoric is related to climatic conditions. A more xeric climate is believed to have been a dominant influence during the Late Prehistoric I era (Lebo and Brown, 1990). As such, there is no indication of bison at this time. During the Late Prehistoric II period the presence of bison remains at archaeological sites is considered to be supporting evidence of the return to moister climatic conditions (Dillehay, 1974; Lynott, 1979; Brown and Lebo, 1990). There is strong evidence from at least two archaeological sites identified in Dallas and Denton counties that suggests a shift back to bison hunting and a bison-oriented economy during the second phase of the Late Prehistoric time period

(Story, 1990:359; Ferring and Yates, 1997:6). One of these sites yielded two bison scapula hoes and a tibia digging stick, while the other produced of eight bison scapula hoes (Story, 1990:359; Ferring and Yates, 1997:6). Bison scapula hoes suggest a combined economy of bison and rudimentary horticulture (Brown and Lebo, 1990).

Late Prehistoric Settlement Patterns

During the Late Prehistoric period site locations are very similar to the Late Archaic in that they are situated along major tributaries such as the Elm Fork (Skinner and Ferring, 1999:10). Sites are often found in the floodplains of area streams, especially those of tributary streams. Strategic site selection is indicated in that sites were once again located on sandy terraces above the floodplain in optimum settings.

Settlement patterns during the Late Prehistoric I era were effected by climatic changes and technological adaptations. Important changes include shifts in settlement patterns to larger sites that contain features including possible house structures. Evidence such as the introduction of the bow and arrow suggests that there was an external influence (Brown and Lebo, 1991: 9). More permanently settled villages are expected related to the presence of maize. The transition from hunting and gathering to a fully sedentary lifestyle was gradual in north-central Texas, probably beginning during the Late Archaic but not established until the Late Prehistoric (Story, 1981:146).

Late Prehistoric II evidence suggests a shift in subsistence and settlement patterns of the previously nomadic bison hunting groups. During this time period subsistence became focused on riverine habitats with more sedentary settlements situated along the major drainages (Brown and Lebo, 1991:9). Increased sedentism resulted in more focal subsistence strategies (Brown and Lebo, 1991:9). These adaptations are thought to be the result of internal population growth and external population pressure (Brown and Lebo, 1991:9). Use of horticulture economies added another dimension to subsistence opportunities (Brown and Lebo, 1991:9). Bison appear to have been hunted on a more opportunistic basis rather than by the previous continual strategic pursuit (Brown and Lebo, 1991: 9). Increased sedentism indicated by site size and artifact assemblages is related to more focal subsistence strategies. Accordingly, in north-central Texas, most of the Late Ceramic period sites, affiliated with the Caddo, are concentrated at the eastern edge of the Eastern Cross Timbers. Over 80% of all sites dating to this period along the Elm Fork of the Trinity are found at the prairie-forest boundary (Prikryl, 1990:82). This concentration of settlement is hypothesized to indicate responses to drier climatic conditions. "Neo-American" groups, who are contemporaneous with Late Prehistoric cultures, followed a similar seasonal exploitation pattern until agriculture became an important part of their subsistence base. In general, during this time period the advent of agriculture led to the establishment of large base camps or permanent villages that were typically located in or adjacent to large standing alluvial bottoms of the more permanent water sources.

Unanswered Questions

Previous investigations have documented archaeological sites and formulated theories concerning prehistoric settlement patterns in north-central Texas. Based on these previous investigations it is possible to evaluate material culture, subsistence strategies and settlement patterns as they change through time. It is also possible to identify the gaps and questions that remain unanswered. While archaeological remains are a known there are many unknowns that remain regarding how the people interacted with the landscape and each other. Clues from prior investigations need to be assembled into a coherent whole, gaps identified and new hypotheses tested, in order to view the related behavioral patterns. Some of the unanswered questions can only be answered by future research. In the meantime, the current research is designed to synthesize and evaluate the results of previous investigations and formulate hypotheses to fill in these gaps, where possible, answer some of these questions and facilitate the construction of a regional model of prehistoric settlement pattern behavior in north-central Texas. In order to accomplish this task it is necessary to construct a unique methodology that has multi-scalar flexibility and a strong theoretical foundation.

CHAPTER 5

RESEARCH METHODOLOGY

Site catchment analysis (SCA) is an effective means to address hypotheses formulated to answer the variety of questions posed by previous investigations and to develop regional settlement models of prehistoric socio-economic behavior. Given the multi-facetted character of the landscape, it is necessary to look for ecological relationships that provide a strong economic resource base rather than one generalized characteristic in isolation. This extends beyond physiographic settings, to include soil interpretations, hydrological, geological and topographical relationships.

Ultimately the characteristics related to site location are the primary variables correlated with site function, site type, occupation frequency, site interaction and chronological relationships. The series of inter-connected relationships contribute to the overall ecological structure. These relationships are evaluated to determine the combinations of environmental features that influenced the choices and preferences of prehistoric populations which are reflected by the corresponding settlement patterns. The dynamic character of ecosystems requires that the inter-relationships of the various components are evaluated separately in relation to a variety of factors and then joined back together. Therefore it is necessary to test multiple hypotheses from a variety of angles in order to gain a deeper understanding of how these components work together to form a regional picture of prehistoric populations developing through time.

Essentially where a site is situated on the landscape is the primary geographical foundation for SCA. Based on the location of each archaeological site and the character of the artifact assemblage, a variety of research hypotheses are designed to evaluate previous settlement pattern theories to answer the questions that prior investigations left unanswered. In north-central Texas previous research has primarily evaluated site location with respect to resource concentration in relation to physiographic settings, hydrological patterns and topographic positioning.

For the current research, SCA is conducted on a regional scale to define the character of 1km site catchment areas around archaeological sites. Sites are collectively evaluated to formulate a regional model of prehistoric settlement patterns in north-central Texas. SCA is performed by depiction, extraction, measurement and evaluation of environmental data in correlation with archeological remains. Environmental variables are derived from modern habitat descriptions. Data are assembled on landforms (topographical, geological, hydrological) and potential of soil types to produce economically advantageous (edible, medicinal, supplemental) plant communities tabulated. Cultural variables are based on ethnographic analogy supported by the evidence of the artifact assemblages collected from Texas Archaeological Research Laboratory (TARL) files and a variety of reports. Criteria considered as viable explanatory mechanisms for site selection and related settlement patterns include:

1. soil settings (taxonomic, textural, topographic)
2. soil potential to provide suitable habitat for plants and animals
3. economic value (edibility, medicinal, supplemental) of soils
4. catchment diversity
5. geological resources (surface geology)
6. geomorphology (uplands, bottomlands, floodplains)
7. physiographic resources (prairies and Cross Timbers)
8. climatic variables
9. cultural factors (archaeological composition and character)

Most of these criteria are mapped by utilizing digital data layers derived from several sources. Some data layers did not exist prior to this research and had to be generated. Conceptual criterion such as cultural factors, climatic variables and catchment diversity are incorporated into the discussion rather than depicted on a map.

Pre-existing environmental digital data layers consist of County boundaries (NCTCOG), geology (USGS), soils (SSURGO), streams (NCTCOG), Rivers (TNRIS), lakes (NCTCOG), elevations (USGS) and physiographic regions (TNRIS). While the pre-existing digital data layers are highly accurate it is important to note that there may be slight inconsistencies, distortions or misalignment of the data layers, depending on the scale of the data layer combined with the source that created the data. For the most part, the data layers are seamless, consistent and accurate, especially those constructed as a regional dataset by the same group of investigators. However, in the case of the soils data layers there are slight inconsistencies in soil series classifications that create seams at the County boundaries where proximal soils were categorized into different soil series classifications. This is due to the fact that different investigators conducted the soil surveys at different times and any slight categorical variation, including utilization of a different name for the same soil type, will be enhanced when the data is in digital format. In some cases it has to do with the level of detail and in others the discretion of the particular soil surveyor. These differences are not significant enough to affect the validity of the SCA but are brought to the reader's attention so that they may be aware of possible inconsistencies in the digital data layers. This type of phenomena is taken into consideration in the current research and should be addressed in any research that involves digital data layers created by different sources.

Generated data layers include archaeological sites, site catchment boundaries, economic values (edibility, medicinal, supplemental), topographic settings, riparian corridors and ecotones. Environmental modeling of these data results in the mapping of the distribution of topographic settings, physiographic settings, geological structure and hydrological resources, plant and wildlife potentials and soil economic values.

While over the past tens of thousands of years there have been shifts from forests to prairie environments in north-central Texas palynological and climatic evidence indicates that over the past 8,000 years these changes are not extreme enough to abandon inferences about prehistoric environments based on modern environmental attributes. As such, modern soil types combined with their associated plant and animal communities are a viable source for reconstructing prehistoric adaptive strategies. The geological structure that forms the foundation for these soil types is stable enough to support the development of similar soil types through time. What differs is the degree of soil development and the climate that would have either facilitated abundant or sparse resources related to those particular soil types.

A conceptual diagram (figure 25) provides an overview of the links and the data that are collectively analyzed, in relation to archaeological site distribution, to shed light on prehistoric settlement pattern behavior. The procedures used to perform SCA include data collection, construction of databases, classification, scoring, data layer generation and a variety of GIS techniques. GIS software also provides an interface to organize,

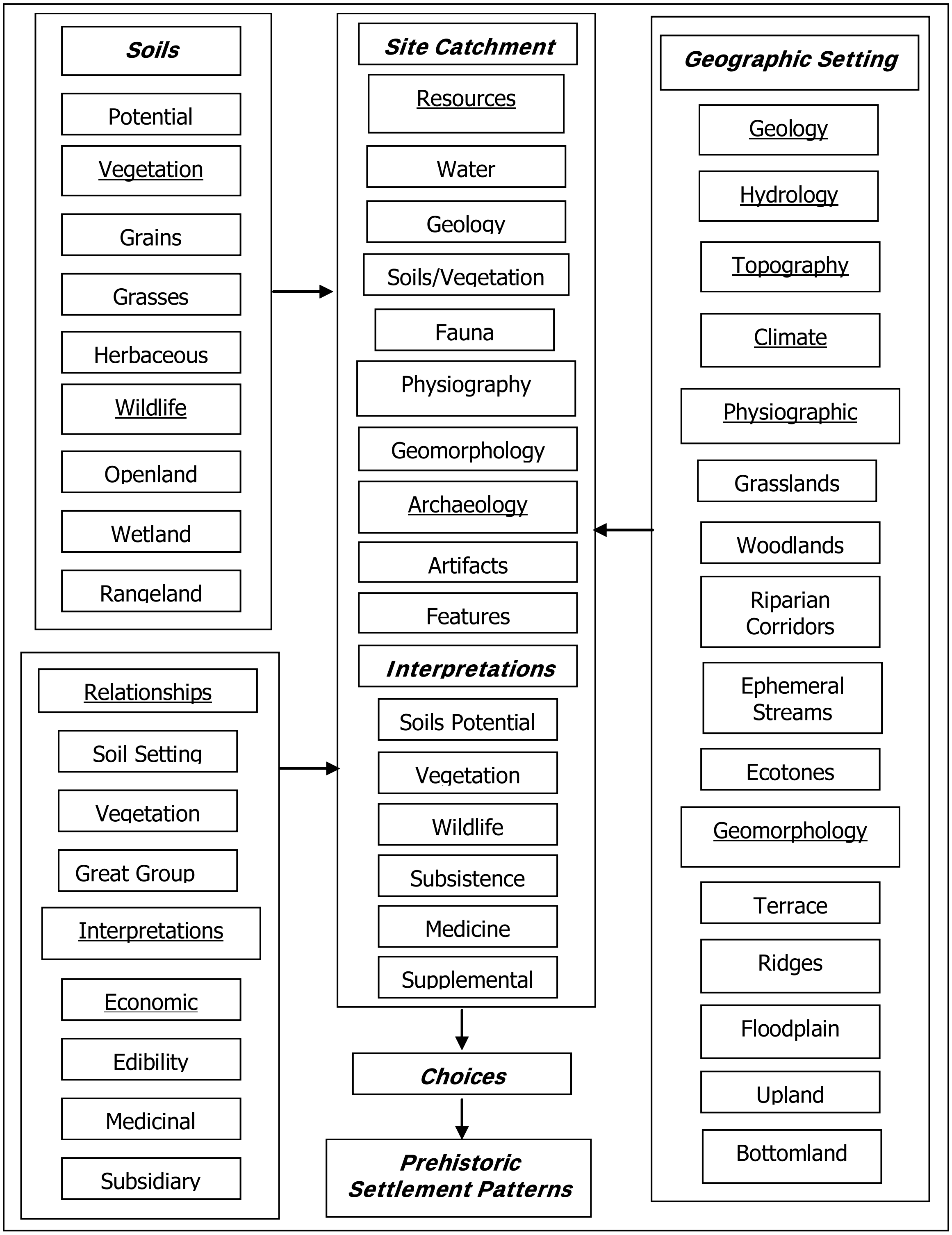

Figure 25. Conceptual diagram of data included in SCA.

manage, analyze and extract data to perform a variety of spatial and statistical analyses. Terminology related to these GIS techniques is defined in a glossary provided at the end of the appendix. GIS procedures are designed to conduct SCA and prepare the data to address a variety of research hypotheses that collectively serve to build a model of prehistoric settlement patterns.

Currently there are no known SCA studies that have set a precedent for the particular approach created for this research. The current methodology is innovated to respond to a series of questions regarding cultural affinities, contemporaneous environmental opportunities, activities and subsistence strategies. Theories based on past and present research are also tested to determine whether or not they are applicable on a regional scale.

Soils as a Diagnostic Tool

SCA involves reconstructing the natural environment in past tense. The most complex part of environmental reconstruction is associated with vegetation. In this particular study soil is selected as a primary diagnostic attribute for the vegetation. As a result a number of different investigators have employed a variety of techniques to accomplish this goal including use of pollen diagrams, field methods, General Land Office Surveys (GLO) and other historical surveys (Tiffany and Abbott, 1982: 314). However, in this research, vegetation reconstruction is primarily based on soil potential as inferred by soil survey data. According to Tiffany and Abbott (1982) the "systematic changes in soil properties across a toposequence serve as proxy data for detailed vegetative reconstruction" and "descriptions of soil types state the past vegetation responsible for the formulation of that particular soil type" (Tiffany and Abbott, 1982: 316). Various SCA studies have employed soils as an explanatory mechanism. Soils are utilized in the current research because they provide the foundation for the potential of vegetation. Geology and soils are the most stable components of the environment. Geology is the most stable as it is not subject to run-off and it is the parent material for the soils. As such if there is increased rainfall that contributes to erosion the soil formation process replenishes the ingredients of the soils that are subject to run off. The character of the geology ultimately determines the character of the soil that provides the matrix of possibilities for specific types of vegetation to exist. For example, sandstone tends to produce sandy soils that lead to forest vegetation and limestone tends to produce soils that are high in clay content creating an appropriate environment for prairie vegetation. Any variation within the geology will lead to variation within the soils which in turn leads to variation within the vegetation and this is what gives the environment its diverse character. This variation is described by soil taxonomy.

Climatic patterns in combination with topographic settings explain the abundance and spatial distribution of specific types of vegetation that exist in response to the soils and geology. Based on a sample of plant types, identified in the soil survey, research is performed to determine plant edibility, medicinal value and supplemental value. Economic potentials of soils are determined by soil survey correlations of soils to vegetation according to settings where particular soils are typically situated. This provides an interpretable view of potential prehistoric habitats. While the current research is highly dependent on soils to ascertain economic value other environmental variables are included to provide a more comprehensive view.

Soils Variables

Soil surveys contain an abundance of environmental information. Although many descriptive attributes are attached to soil types the particular attributes that are used for this study are limited to soil series, great groups, plant type potentials, wildlife potentials, soil settings and topographic settings. Soil series are consolidated or recoded to represent each of these variables. Pre-existing soils data layers exist for each of the counties included in the regional study area (the West Fork or Wise County, the Elm Fork or Denton County and the East Fork or Collin County). The only two comparable soil surveys from the study area that are amenable to detailed analyses are from Wise (West Fork) and Denton (Elm Fork) counties. Soils data for the East Fork of the Trinity are limited to great group. As a result there are no equivalent correlations with vegetation. Any relationships would have to be inferred. Although "great group" scale soils data provide a means of comparison between the environmental contexts of the East, Elm, and West Forks, the character of the environmental setting around the East Fork is not suited for comparative analyses. The East Fork is clearly a significantly different environmental setting than the Elm and West Fork of the Trinity. As such it does not make sense to statistically evaluate the three settings comparatively. Therefore, the East Fork is evaluated in a similar manner where possible and included in comparative discussion but not statistically compared. Due to the lack of data currently available statistical analyses involving the relative potential for vegetation types, wildlife habitat and economic potential of site catchment areas are limited to the Elm Fork and the West Fork of the Trinity.

Site catchment areas are composed of various scales of proportional values. Soils data can be consolidated into soil series, order, settings or great groups. During the organizational process of soils data it is important to note that a great group can consist of several soil series or settings and likewise soil settings can include several great groups. Soil series, however, are associated with one particular great group. Therefore, the manner in which the data is consolidated is dependent on the research question. For the current research the most appropriate approach is to conduct the initial analysis on a soil series level and then consolidate the data into larger categories when necessary. In order to recreate the variable potentials while considering soil variability a soil series level approach is appropriate and preferable. This facilitates the detection of variation within the great group while calculating plant potentials, wildlife potentials, soil setting, topographic setting and catchment diversity. For the economic analysis it is also necessary to work primarily from a soil series level and then consolidate to soil settings and great groups to summarize the results.

Soil Settings

Soil series data is connected to attributes that describe taxonomic, topographic and textural settings typically associated with certain soil series. These settings are depicted by adjusting the symbology of pre-existing soils data layers in ArcMap.

Topographic settings associated with soil types include alluvial terraces, bottomlands, floodplains, low hills and ridges, old terraces and valley fills, plains, Pleistocene terraces, ridges, stream divides, stream terraces, terraces, upland ridges and uplands. These settings are often referred to in the literature. While this provides a sketch of the topographic setting the interpretive value of the particular setting is increased when related to climatic conditions, physiographic settings, economic values, related soils and faunal assemblages. Research conducted by Ferring and others suggests that prehistoric populations primarily selected sites located in terraces and upland settings in ecotonal transitional zones between prairie and woodland settings. Hayes classifies sites on the Elm Fork into floodplain, terrace and upland settings. According to previous investigations, during the Early Archaic, sites are situated on stream terraces and in bottomland settings. Given the wet climate during the Early Archaic it is expected that populations were concentrated in upland settings near ephemeral streams. Given the dry climate during the Middle Archaic it is expected that populations were concentrated in the bottomland, floodplain and riverine settings associated with major tributaries. During the Late Archaic moister conditions are expected to have increased the availability of plants for human consumption and biomass for game animals. Vegetation retreated into the floodplain while drier conditions prompted a return to the stream banks. Evidence also suggests utilization of upland prairie settings. However, in general, subsistence strategies appear to have been focused in riverine and bottomland settings within the prairies and Cross Timbers. SCA techniques are designed to evaluate this combination of factors in relation to occupation frequency and change through time. Patterns are also considered comparatively between the Elm, East and West Forks of the Trinity. In order to gain insight on these patterns hypothesis testing includes topographic settings in discrete statistical analysis to evaluate site location with respect to occupation frequency and change through time.

Soil textural settings include blackland, clay loam, clayey bottomland, claypan prairie, deep Redland, deep sand, eroded blackland, loamy bottomland, loamy prairie, loamy sand, low stony hill, Redland, rocky hill, sandstone, sandy loam, sandy, shallow clay, shallow, steep adobe and tight sandy loam. These groups are primarily utilized in the economic study to provide a linking mechanism between the vegetation and the soil series. Great groups that are included in the study area (table 2) are evaluated in both multivariate and discrete statistical analyses.

WEST FORK AND ELM FORK	EAST FORK
GREAT GROUP	**GREAT GROUP**
ARGIUSTOLLS	CHROMUDERTS
CALCIUSTOLLS	CHROMUSTERTS
HAPLUDERTS	OCHRAQUALFS
HAPLUSTALFS	HAPLAQUOLLS
HAPLUSTEPTS	HAPLUSTOLLS
HAPLUSTERTS	PALEUSTALFS
HAPLUSTOLLS	PELLUSTERTS
PALEUSTALFS	RENDOLLS
PALEUSTOLLS	USTOCHREPTS
RHODUSTALFS	
USTIFLUVENTS	

Table 2. Soil taxonomy classifications.

Soil series are consolidated into these great groups based on links established by the soil survey. In order to attach economic value to these settings a “dissolve” operation is performed rather than adjusting symbology. This allows the economic values to be summed in relation to the consolidation of soil series into soils settings or great groups. The relationship between the economic value and the particular soil setting is important to the current multivariate analyses. For other parts of the analysis the archaeological data and soil settings are evaluated to facilitate discrete analysis. In order to create contingency tables ArcMap tools are used to select the particular settings by "attributes" and archaeological sites (grouped into occupation frequency and according to chronology) by "location" in relation to the particular selected settings.

Soil Potential for Plants and Wildlife

Plant types and wildlife potentials are associated with soil series based on soil survey estimates within the overall study area and within each site catchment area. These attributes are recoded (table 3) from soil survey ratings that were "high", "medium", "low" and "very low". Based on the frequency of "very low" categories for these types of wildlife habitat, "low" and "very low" were combined. Soils that were considered to have a "high" suitability for each type of habitat were given a value of 0.64. The soil types with "medium" potential were given a value of 0.29 and the soils with "low" potential were given a value of 0.07. These weighting techniques are derived from "Ranking Procedures" in GIS and Multicriteria Decision Analysis (Malczewski, 1999:180).

		Rank Sum		Rank Reciprocal		Rank Reciprocal	
Soil	Rank	Weight	Normalized	Reciprocal	Normalized	Weight	Normalized
Suitability	r = rank	n = # of categories	Weight	Weight	Weight		Weight
	r	$(n-r_j+1)$	Weight/ Total Weight	$(1/r_j)$		$(n-r_j+1)$ p, where p=2	
HIGH	1	3	0.50	1.00	0.55	9	0.64
MEDIUM	2	2	0.33	0.50	0.27	4	0.29
LOW	3	1	0.17	0.33	0.18	1	0.07
Total		6	1.00	1.83	1.00	14	1

Table 3. Weighting procedure for plant and wildlife soil survey estimates.

Essentially this procedure transforms discrete into continuous variables so that they may be proportionately assigned a value and evaluated in relation to their relative representation within site catchment areas. These weights are attached to soil series digital vector data by utilizing ArcMap to perform an "attribute join" operation. Once the attribute data is joined to soil series location, with GIS tools, the spatial distribution of these factors can be included in a multi-scalar spatial and statistical analysis. Resulting data layers provide an overview of the spatial distribution of wildlife and vegetation potentials for the entire County surfaces. In relation to archaeological sites these data layers can be "clipped" based on the extent of site catchment areas with ArcMap geoprocessing tools. Associated values that remain within the site catchment territory can then be measured, described and statistically evaluated.

Interpretations: Potential Economic Value of Soils

Locally available botanical resources that could have been utilized by prehistoric populations are of primary importance to SCA and settlement pattern investigations. Although, ethnographic botanical information is sparse, a variety of publications have been written that provide extensive information on the edibility, medicinal, and toxic properties of plants that are native to Texas. In 1999, a comprehensive study documenting the flora of north-central Texas compiled by Diggs, Lipscombe and O'Kennon, was published. Tull (1987) put together a guide that discusses edible and useful plants in Texas and the Southwest. Duke (2000, 2002) has written a number of books that provide information about medicinal plants and herbs in the United States. McCormick, Filson and Darden (1975); Skinner and Baird (1985); Lynott (1977); Martin and Bruseth (1987); and others also provide information regarding the potential of botanical resources in north-central Texas. According to Prikryl (1990), one of the best publications concerning floral resources of the lower Elm Fork area is that of McCormick, Filson and Darden (1975), who studied the terraces of an area where Timber Creek enters the Elm Fork floodplain. Situated on the boundary of the Eastern Cross Timbers and Blackland Prairie, this locale provides a healthy representative sample of the vegetation composition in this area (Prikryl, 1990: 12). In addition to the archaeological investigations a floral resources study was performed in immediate vicinity of a major site. Of the 122 plant specimens collected, 97 were identified and 56 believed to have been utilized, for food, medicines, or technologically by the aboriginal inhabitants of north-central Texas (McCormick et Al., 1975: 77). These resources are utilized to aid in the interpretation of the botanical data retrieved from archaeological sites and their site catchment areas.

For the purpose of the current research it was decided that vegetation would be the primary determinant of soil economic value given its strength for interpretation and correlation with soil types. Archaeological faunal data, although economically valuable, is not incorporated into the determination of relative economic value of the soils even though it contributes to the knowledge base of prehistoric choices. In the current research economic value refers to the potential of a given soil type to provide vegetation that would be economically valuable to prehistoric populations. The relationship between certain soil types and specific plant types is an assumption that has been empirically verified by soil scientists and can be tested by future research.

The lack of archaeological fauna in relation to all of the sample soil types and soil settings would have created an inconsistency in the representation of economic values. The relationship of archaeological fauna to soil type is also less predictable although future research could test relationships between soil type and archaeological fauna to try to predict where comparable fauna and their corresponding prehistoric populations might be located. Faunal data are incorporated into the "overall" economic value and soils portion of the analysis by mapping the potential for specific wildlife types, in relation to their habitat, associated with soil types. During the final synthesis the recoded soils categories, including potential for wildlife habitat, are combined to determine the overall economic value. However, the correlation between soil type and economically valuable vegetation is the strongest and provides the highest resolution.

Mapping soils data across a region is one of the most detailed views available of the environmental character of a particular landscape. Vegetation data, correlated with soils, sheds light on the potential of the particular types of soils. When the vegetation is interpreted into use-categories, as related to human populations, the soils provide culturally significant information. Economic values were determined by evaluating the botanical, ethnographic and archaeological literature to determine if the sample vegetation, associated with soil types, was edible, medicinal or supplemental. Edible vegetation is defined by whether or not the vegetation could be ingested, if it has served as a food resource for prehistoric or modern populations and the likelihood that it would be utilized for food based on the relative caloric value. Medicinal vegetation was defined by the known use of particular plants to be used to cure internal ailments or topical wounds. Many of these plants are highly toxic and require a certain degree of preparation. Therefore, it was decided not to factor in the toxicity of plants as a negative impact on whether or not the plant was used by prehistoric populations. Supplemental vegetation primarily includes wood for fires or construction and plants that would have been utilized for dyes, basket making, or various types of construction.

Codes are assigned to a sample size of 242 vegetation species collected from associations made in the soil surveys and archaeological literature. Based on the edibility, medicinal value, and supplemental potential of the plant the relative values are translated into economic values per category. The resulting scores are arbitrarily calculated by assigning a percentage to the applicable category. For example, if a plant has both medicinal and edible properties each category is given a value of 50 percent. If a plant is primarily edible with limited medicinal value edibility would be given a value of 90% and medicinal properties a value of 10 percent. Each percentage is determined based on the information provided in the descriptive literature. Often a several resources were evaluated to determine the edible, medicinal and supplemental properties of the plant in order to take into consideration the likelihood that these particular plants would have actually been utilized by prehistoric populations. The resulting scores are provided in the appendices.

Plants are associated with the appropriate soil setting and resulting economic values are related to soil series. Therefore the 242 vegetation species in the sample are consolidated into 22 soil settings. The general procedure followed to assign economic meaning to the landscape is summarized by a conceptual diagram (figure 26). The economic values of the soil settings are linked to the soil series and are proportionally evaluated within site catchment areas. Ultimately, soil series are consolidated into the 11 great groups that are represented in the site catchment areas so that they may be summarized. Consolidation of the appropriate soils series provides a relative economic value for the great groups within each catchment. These values are summed and assigned to the catchment area to provide an overall economic value. Each catchment area is also assigned three other thematic economic values (medicinal, edibility, supplemental) by establishing the same data links. Proportional distribution of the soil series within the catchment areas is constant. What changes are the economic values associated with the soil series. This is how the relative edibility, medicinal, supplemental and economic values are measured in relation to each site catchment. Economic values and potentials for specific wildlife and vegetation habitat that are assigned to soils help interpret resource concentration patterns. It has been posited that sites are primarily located near a major source of food. SCA can shed light on the estimated economic value of such settings, the kinds of food or environmental resources that were accessible in the immediate vicinity of site locations and answer questions related to specialization, diversity and optimization. Furthermore, resource availability in correlation with site location can shed light on the theories regarding the use of this region for seasonal migration as suggested by McCormick. Skinner and Baird hypothesize specialized ecological approaches in the northern reaches of the Elm Fork correlated with high yield mast crops in the uplands and central locations of the Cross Timbers. McCormick (1975) noted that sites along the southern reaches of the Elm Fork

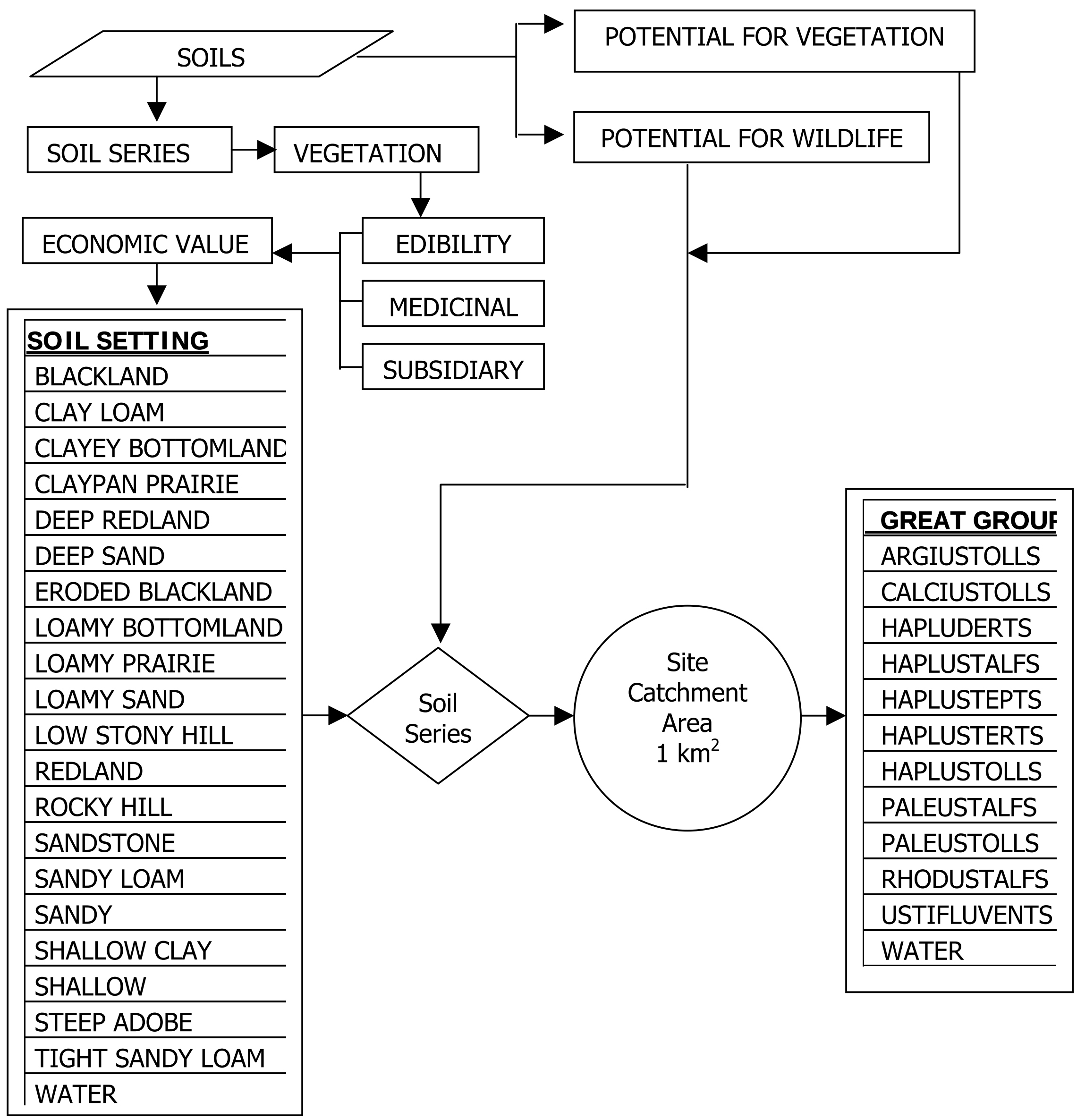

Figure 26. Procedure to link economic value to site catchment.

are primarily located along the upland edge where maximized resource zones are accessible. Riparian fauna are associated with archaeological remains along the Elm Fork indicating concentrations in riverine settings. Sites located along the East Fork are unquestionably situated in the Blackland Prairie. However, West Fork sites have not been previously evaluated in prior investigations in relation to their respective physiographic settings. Observation of site patterning along the Elm Fork in correlation with these settings, on a larger scale, sheds light on regional behavior. Given that information about these sites is primarily derived from state files there are many unanswered questions. SCA facilitates the evaluation of site placement within particular physiographic settings and comparisons of these locations according to occupation frequency, density and change through time.

Economic values are represented in a series of analytical maps by recoding attributes associated with the pre-existing soils data layers. These values are associated with archaeological sites with respect to time period, occupation frequency and site contents. Then they are statistically evaluated to test a series of hypotheses.

Site Catchment Soils Diversity

Soil series associated with sites provide the best resolution in terms of variation within a catchment area. Each catchment area contains a square kilometer of soil series. Each great group contains proportional distribution of soil series relative to the location of the site. Therefore, the diversity is more accurately expressed by the soil series. In order to gain a deeper understanding of the diversity within site catchments each catchment is evaluated with regard to the proportional representation of each soil series within each site catchment to calculate diversity. Environmental diversity indices for site catchments measure the potential of an area for the presence of archaeological sites based on the premise that site location is associated with increased diversity (Tiffany and Abbott, 1982). For the current research an environmental diversity index is developed that differs from previous studies in that it is based on the soil proportions of soil types within site catchment boundaries. Given that all of the sites are in the vicinity of water and that there is a strong correlation between geology, soils and vegetation a different technique was chosen. This technique is referred to as the Shannon-Weiner Diversity Index (Colinvaux, 1993: 316),

$$H_1 = -\Sigma\, p_i \log_2 p_i,$$

where pi= relative abundance of soil type i to total soil, is employed to evaluate the relative diversity of each catchment. By creating an environmental diversity index based on proportional soil types within the site catchments the current research seeks to evaluate if there is a correlation between environmental diversity and prehistoric preferences for selection of site location in north-central Texas.

Site catchment diversity is evaluated in relation to occupation frequency and change through time in order to determine how variable diversity is at sites that contain evidence of single versus multiple occupations and how diversity changes through time in relation to site location. The diversity values in relation to these factors are analyzed with an ANOVA statistical test.

<u>Geological Variables</u>

Geological formations provide the parent material and foundation for the range of soils that can develop in a certain location. Given the minor differences in the climatic regime of this region the majority of variation is dependent on the character of the bedrock lithology. The geological structures (table 4) that are associated with archaeological site catchments in the region provide a means to view similarities and differences in more generalized site settings. This component influences the character of the physiographic setting and is evaluated with respect to change through time and occupation frequency in a discrete statistical analysis. The West Fork and Elm Fork of the Trinity are generally associated with similar geological sequences. Geological formations associated with the East Fork are notably different in character as listed in table 4. While there is a strong correlation between soils and geological settings geology is also culturally significant in that it serves a source for lithic procurement. In addition, it provides a means to cross-check the results of the soils analysis and to explain the particular variation of correlated soil types. Statistically, the geology is tested in a different manner than the soils with a Chi-Square analysis rather than with an ANOVA. As such, geology is evaluated independently of soils even though they are inter-related.

WEST FORK AND ELM FORK	EAST FORK
ALLUVIUM	ALLUVIUM
ANTLERS SAND	AUSTIN GROUP
BOKCHITO FORMATION (UNDIVIDED)	FLUVATILE TERRACE DEPOSITS
EAGLE FORD FORMATION	MARLBROOK MARL
FLUVATILE TERRACE DEPOSITS	OZAN FORMATION
GLEN ROSE LIMESTONE	PECAN GAP CHALK
GOODLAND LIMESTONE/WALNUT CLAY (UNDIVIDED)	WOLFE CITY SAND
GRAYSON MARL AND MAIN STREET LIMESTONE	
KIAMICHI FORMATION	
PALUXY SAND	
PAWPAW FORMATION	
SURFICIAL DEPOSITS (UNDIVIDED)	
TWIN MOUNTAINS FORMATION	
WILLOW POINT FORMATION	
WOODBINE FORMATION	

Table 4. Geological formations associated with site catchment areas in study area.

Physiographic Variables

Physiographic variables that are evaluated in relation to archaeological sites include the Western Cross Timbers, Grand Prairie/Fort Worth Prairie, Eastern Cross Timbers, Blackland Prairie, riparian corridors, ephemeral riverine settings and ecotonal settings. The "Buffer Wizard" in ArcMap is utilized to generate transitional zones around water resources and physiographic boundaries. Ecotones are generated in ArcMap by creating 2 km buffers around physiographic boundaries. Riparian corridors are generated in ArcMap by creating 2km buffers around major and minor tributaries in the streams data. Ephemeral streams are also included but relative to their influence on the landscape and intermittent character 1km buffers are constructed around these areas. In the case of the current research physiographic settings include hydrological resources because these areas are considered to be unique microenvironments.

Physiographic settings are often referred to in the literature in relation to site location. While this is informative the interpretive value of physiographic settings can be enhanced with data regarding economic value, faunal assemblage, vegetation habitat, wildlife habitat inferred from the soils which are related to these physiographic settings. In addition, larger patterns that emerge in relation to site function, occupation frequency and change through time can shed light on prehistoric settlement pattern behavior. A variety of investigators report that grassland, woodland, riverine and ecotonal settings were utilized by prehistoric populations. Hypothesis testing sheds light on more specific patterns that emerge in relation to these settings. It is likely that given the various climatic conditions, availability of seasonal resources, and socio-cultural conditions that certain areas were occupied more intensively than others.

If sites are situated primarily within grassland settings prehistoric populations would have access to a high variety of grasses, legumes, grains, seed crops, rangeland and openland wildlife. In addition, site selection along major tributaries would ensure the availability of supplemental economic resources such as wood for cooking. If the sites are situated primarily within woodland and riverine settings they would have access to a high variety of wild herbaceous plants, fish, wetland wildlife and various smaller fauna. In addition, woodland settings provide a greater abundance of supplemental material such as wood. Woodland settings also provide access to an increased supply of nuts and berries. It is expected that the potential for various types of vegetation within these areas reflects an economically advantageous positioning. Given that both grassland and woodland settings have a riverine component other factors must be correlated.

If the pattern detected in the Lewisville report (Ferring and Yates, 1998) that "prehistoric populations exploited whatever was available to them within well-defined territories" is true then statistical analyses should reveal that a random effect is operating. However there may be a pattern that reveals differential utilization of the landscape. If clearly defined territories exist it is possible to infer the degree of social influence on these boundaries in relation to site distribution and economic values. If these populations were primarily effected by socially defined territories economic values associated with site catchments should reveal that site selection was random in these locations. Further, it is possible to evaluate the environmental variables contained by site catchments and consider the possibility of environmentally defined territories.

Sites reported in the Lewisville report (Ferring and Yates, 1998) are situated primarily in the ecotone between the Eastern Cross Timbers and the Blackland Prairie. Sites in the Ray Roberts area are reported to be centrally concentrated in the Eastern Cross Timbers. It has been suggested that sites are situated to equally utilize forest, riparian and prairie environments. If it is true that these environments were equally utilized then all of these types of soils should be within site catchments. Hypothesis testing provides a means to determine if similar sites are situated in similar settings. SCA can help determine what type of site is located in particular settings or where equivalent sites are located. Sites should reflect the setting through faunal remains and contents preserved by the archaeological record. Further, it is expected that economic values of vegetation and wildlife within catchment areas support conclusions. Physiographic settings are a dynamic variable that interacts with other physical environmental factors. As such this generalized setting must be evaluated from a variety of micro-environmental perspectives.

Physiographic settings reflect the inter-relationships between all of the components that have been forming the modern landscape for millennia. A wealth of information is related to the available faunal and floral communities contained by these settings. This particular variable is tested for significance between site catchment areas with a Chi-Square statistical test. In this case, the goal is to find out if certain physiographic locations were preferred over others.

Climatic Variables

Climatic data available for past environments is sparse but correlations have been made based on palynological data collected from peripheral locales. Pollen types are selected from the Ferndale Bog sample only if they are represented in the vegetation sample utilized for this research. This vegetation is correlated with soil series and therefore can be depicted on the map. Vegetation and pollen being both associated with "Plant Family" provided a means to link the results from the Ferndale Bog sample data (figure 27) to the digital soils data layers and the correlated economic values associated with site catchment areas. Prior to linking these data to the soil settings they were calculated to take into consideration the relative representation of these plant types within site catchment areas. In order to preserve the raw economic values the pollen data is added to the original values associated with the same settings and adjusted to reflect the change through time by building economic values for each time period. These values are depicted a series of maps and correlated with sites in order to evaluate if sites are situated in areas that are expected to be relatively abundant during certain climatic intervals. The raw data values and the series of maps that depict these associations per time period are included in the appendix.

Dawson and Sullivan propose that the character of the environment where prehistoric sites are located is such that it was necessary for prehistoric groups to remain small and scattered in order to maintain balance with minimum cycles associated with climatic and seasonal fluctuations. This type of theory can be tested by evaluating the correlations between occupation density, economic values and climatic data. Site selection as related to topographic setting can be further enhanced by incorporating climatic data. For instance, it is suggested that the terrace and upland settings represent site selection and occupation during wetter climatic episodes. This inference is tested by relating site locations to the fluctuations of pollen abundance data based on the Ferndale bog sample. Hypotheses testing can determine if site locations as they shift and change through time corresponds with climatic conditions.

SCA can reveal if site positioning is a deliberate selection that met the needs of these populations given the character of the landscape combined with climatic data. If so, SCA can help ascertain if there is any additional information that facilitates increased understanding of these choices. If not, such studies can generate evidence to provide alternative theories.

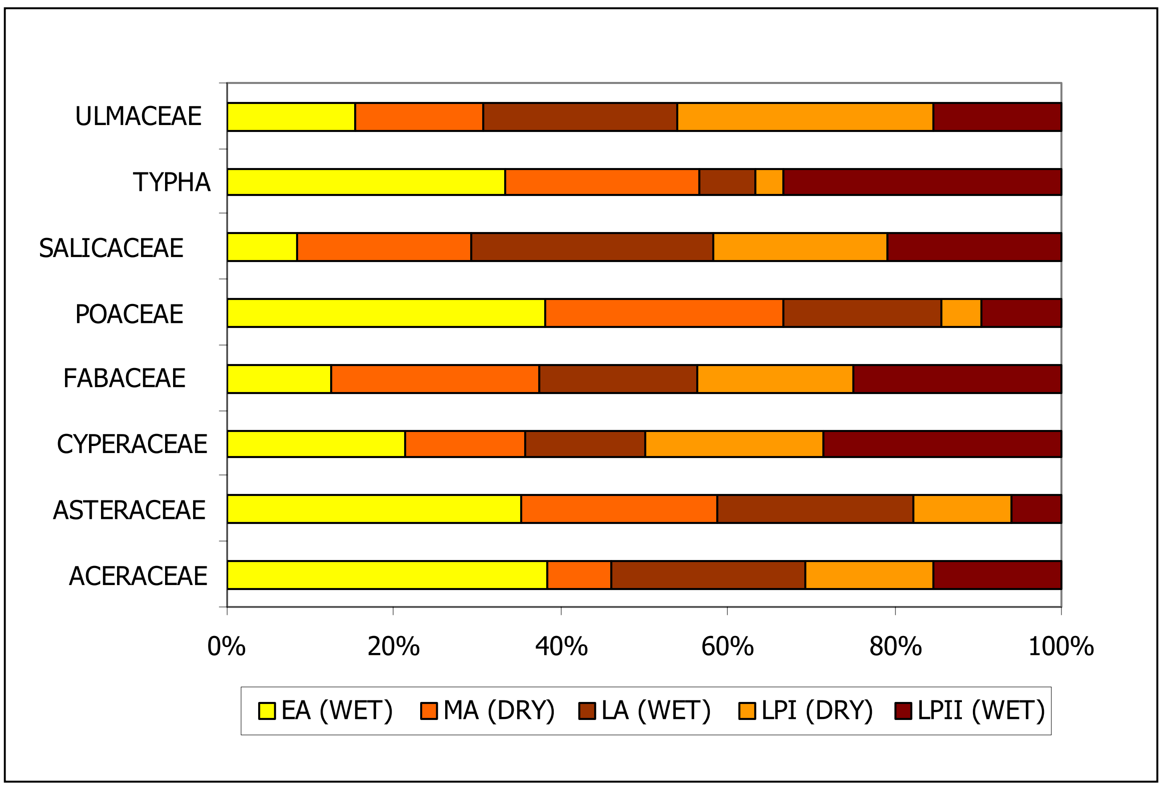

Figure 27. Relative Abundance of Plant Family in Study Area.

Archaeological Variables

Archaeological site coordinates were collected from TARL records, converted to points in ArcCatalog and projected with ArcToolbox. Site catchment boundaries are established in ArcMap with the "Buffer Wizard". Although it is possible to construct time contours with GIS techniques, the character of the landscape in the study area did not provide a return on investment equal to the time it took to create the contours. Therefore, the site catchment area is established for the 150 sites in the study area by performing a buffering technique to construct an arbitrary 1-kilometer radius around each archaeological site in the study area. Site catchment areas are constructed for 50 sites that contain diagnostic material and 100 surface sites that do not contain time diagnostic material. The diagnostic sites are valuable in that they provide clues as to the specific time period and duration of occupation. The non-diagnostic sites are valuable with respect to providing evidence of prehistoric activities in relation to location. When these sites are associated with the specific characteristics of the site catchment areas they provide fruitful behavioral information in relation to the time diagnostic sites. One could hypothesize that the sites containing lithic scatter are ephemeral hunting, gathering, eating or resting spots. Whatever their purpose might be they provide valuable comparative information in the fine scale analysis of vegetation and soils data related to site catchment areas. Proximity to time diagnostic sites also provides an informative view of the possibilities of inter-relationships.

Archaeological site data is categorized into groups to test for statistical significance between site contents and catchments with respect to environmental variables, occupation frequency and change through time. Activity groups include: tool manufacture, food preparation, hunting and lithic scatter. Site files are evaluated to infer activities. Lithic manufacturing activities are inferred if the artifact assemblage at a site contains cores, hammerstones, performs, bifaces, debitage or a variety therein. Evidence for food preparation includes tools, groundstone, ceramics, animal bones and fire cracked rock. Any variety of these items is sufficient for the site to be listed as including food preparatory activities. Hunting activities are inferred by the presence of diagnostic projectile points. A separate category of lithic scatter is created to account for sites where no functional diagnostic information is available. There are enough cases where various densities of isolated lithic scatter are reported to prompt the inclusion of this category. An increase in the number of activities represented by tool types at a site indicates an increase in artifact diversity. It is a basic premise of SCA that site function and site location are correlated and that inferences can be made about function from knowledge of location (Roper, 1979:121). Based on previous studies it is possible to form expectations regarding site function. For instance, sites that contain a substantial amount of debris have often been classified as "home base" sites, whether they were occupied year round or only during certain seasons. Previous investigations report specialized activity sites such as "manufacturing stations" have been located in the Cross Timbers. Hayes references the archaeology and suggests that sites on the floodplain represent characteristic mussel procurement sites referenced by Skinner. He does not specifically reference Skinner's work but makes an association between the faunal and artifactual remains, possible activities and topographic settings. Hayes notes that terrace sites consist mainly of lithic scatter and upland sites are found in areas where lithic raw materials may have been procured. During the Middle Archaic projectile point size and diversity increases while mobility generally decreases. It is expected that this type of phenomena is reflected in site function and location. These types of relationships are investigated and enhanced by environmental information. Hypothesis testing evaluates site types in other localities to determine if they are concentrated or randomly distributed. McCormick et al. (1975) reference similarity of activity at site locations regardless of time period. Factoring in change through time will shed light on these types of temporal considerations. The current research correlates site contents with the catchment to determine site function. Site activities are initially inferred based on the character of the relative artifact and faunal assemblages. This is intended to provide a simplified means to relate the site contents to the site catchment. After hypotheses testing site function is verified or revised.

Occupation density includes ephemeral, moderate and intensive categories. These categories are formulated on the basis of the number of artifacts reported at a site. Ephemeral occupation is defined by sites that contain one diagnostic artifact or limited lithic scatter. Moderate occupation is defined by sites that contain more than one but less than ten diagnostic artifacts and/or moderate lithic scatter. Intensive occupation is determined based on more than ten diagnostic artifacts which are often found in combination with more intensive lithic scatter and a variety of tool types. Previous reports often reference the density of archaeological content at a site. A model based on correlations with migratory patterns of bison rests on the assumption that these prehistoric populations were following the herds. Sites related to this pattern are expected to be more ephemeral in character. SCA facilitates testing for the presence of temporary camps in relation to seasonal resources and if these sites are fewer in number than during the Archaic as suggested by McCormick et al. (1975). It is anticipated that during the Late Prehistoric time period temporary hunting camps will be found in association with more sedentary base camps due to the opportunities that bow and arrow technology offers. McCormick also posits that the zone of movement was along the prairie-cross Timbers boundaries where sites are considered to be "more permanent". Sites reported to have the largest collections of Late Prehistoric I artifacts are located on the Cross Timbers-prairie boundary. Ephemeral sites in some areas are related to seasonal occupation that focused on harvesting the mast crop resources in the region. Hypotheses regarding site function and occupation density can test for the presence of permanent village, temporary campsites and activity-specific sites in the study area. Occupation density is more meaningful when associated with environmental attributes present at site locations.

Occupation frequency refers to how many times a site was occupied based on the number of time periods represented at the site by diagnostic tools or radiocarbon dates. The categories for occupation frequency include single, dual, tri and multi. Some investigators have suggested that north-central Texas is a "marginal" setting and others that the grassland, woodland and riverine settings are "highly opportune". In order to evaluate this facet economic value is assigned to soils to identify areas that provide a more marginal or opportune setting. It is possible that during certain time periods the region provided a marginal setting while during other time periods it provided an opportune setting. Site density provides a means to evaluate where prehistoric populations were focusing their efforts during these time periods. If certain locations provided resources with a relatively higher economic value it is likely that these areas contain evidence of multiple occupations. Economic values and site density in relation to change through time provide the basis to test hypotheses that have been formulated to answer these questions.

Younger surface sites often contain cultural materials of older time periods. This creates a complex situation that makes it difficult to ascertain if these sites were occupied by cultures from different time periods or if they represent one culture that was reusing materials left behind by previous occupants of the area. To add to the complexity it is unknown if these points were being recycled on location or if they were collected from other locations and brought back to a central location. It is posited that identical projectile point types were made by the same individuals or those who shared technological knowledge. Therefore, it follows that these same individuals would have also shared knowledge regarding effective plant utilization, hunting techniques and paired with information regarding suitable locales to exercise these subsistence strategies. As such it is possible that site catchments that contain the same projectile point types are either similar in character suggesting that these individuals preferred certain settings, or very different in character indicating resource concentration in association with specialized activities and in either case exhibiting a relatively high or low diversity. Hypotheses designed to test for significance evaluate site catchments in relation to projectile point type.

Established relationships between projectile points and time periods provide the temporal foundation for the current research. These data are the primary basis for the evaluation of change through time. Given the types of projectiles found in north-central Texas research hypotheses look for correlations between point types and environmental features found in catchments. It is expected that similar point types would be found in similar settings. If these point types are contemporaneous it is expected that the people who utilized these tools not only shared technological knowledge but environmental knowledge. As such it is expected that the prehistoric populations that utilized these particular point types employed similar subsistence strategies. Given that the environment would have offered a range of similar optimal opportunities during the associated time period it is expected that environmental characteristics in association with similar point types will reflect these opportunities. However, it is also possible that given seasonal variation strategies will reflect the necessary adaptations. To evaluate this facet a hypothesis is tested for statistically significant differences between site catchments in relation to projectile point types. The sites are evaluated to determine the range of settings that were being utilized during these time periods. Tool kits will also be evaluated with respect to composition and occupation density to evaluate activities.

Prikryl (1990) reports that there is a strong cultural continuity between the Late Archaic and the Late Prehistoric at sites situated on the Elm Fork of the Trinity. Of the

36 sites containing Late Prehistoric I artifacts, 34 also contain Late Archaic tools. Seventeen of the 34 sites were first occupied during the Late Archaic. Similar to the Late Archaic, 35% of the Late Prehistoric I assemblages are recovered from sites whose closest water source is the Elm Fork, while the other 65% are recovered from sites whose closest water source is a tributary stream. Late Archaic settlement patterns indicate increasing evidence for the reuse of camp-sites and a trend toward seasonal aggregation of populations when large quantities of food were locally available (Lynott, 1981: 105). Patterns indicate that certain locations were preferred over time (Skinner, 1981) but the nature of these locations is not clear. SCA provides a means to define these preferences and determine if sites contain evidence of repeated occupation concentrated in one particular physiographic setting or multiple physiographic settings. Hypothesis testing identifies favored environments and preferred settings and is expected to reveal patterns that explain occupation frequency.

Change through time is determined based on the time periods represented by diagnostic point types recovered from the site. The time periods that are evaluated during the course of this research include Early (8,500-6,000 BP), Middle (6,000-3,500 BP) and Late Archaic (3,500-1,250 BP), Late Prehistoric I (1,250-750) and Late Prehistoric II (750-350 BP). Sites are assigned to these time periods based on a variety of site files, contract reports and academic publications. Evaluating change through time in relation to site location provides a dynamic view of the interplay of these variables that respond to climatic and socio-cultural conditions. As such, change through time is an important facet that can address theories related to site positioning.

Correlation of site function and density with site catchment characteristics and change through time can test theories that have been proposed regarding prehistoric settlement patterns.

Topographic settings take on enhanced meaning when associated with change through time. Dawson and Sullivan propose that Archaic sites in the East Fork situated on ridges and Late Prehistoric sites are situated primarily in bottomland areas. If such theories are reliable hypothesis testing should provide support or reveal differential patterning that may be related to other factors.

Physiographic settings are expected to change in response to climatic conditions and thus exhibit change through time. McCormick et al. (1975) claim that temporary campsites occupy similar ecological niches and that this remains the case in both Archaic and "Neo-American" sites. McCormick et al. conclude that Archaic seasonal camps are located in eco-tonal settings and secondary activity-specific sites situated with respect to "specific outcroppings, plants and water". If Archaic camps are primarily located in eco-tones SCA can help determine the "specific outcroppings, plants, and water" that they are referring to. Hypothesis testing with respect to change through time can also test whether or not Late Prehistoric populations follow similar patterns as McCormick et al. (1975) suggested.

During the Early Archaic, cultural responses to new ecological systems include a wider variety of projectile points, more variable artifact assemblages, decreased mobility, seasonal scheduling, and changes in food processing. Subsistence patterns involve a wider range of plant collection. During the Middle Archaic evidence suggests that a wide variety of vegetation continued to be utilized paired with an increase in openland economies. Although the importance of hunting appears to be generally reduced throughout the Late Archaic evidence suggests the continuation of hunting in the upland prairie. Utilization of a mix of prairie, forest and riparian species is also indicated during the Late Archaic. Hypothesis testing with respect to site catchment diversity, economic values and soil potential for wildlife and vegetation should reveal such patterns or provide alternative perspectives. The added dimension of change through time delineates types and varieties of resources utilized by prehistoric populations of different time periods. SCA facilitates evaluation of site placement within their respective physiographic settings and provides a means to compare these locations to site content, occupation frequency and density.

A detailed analysis of 100 of the sites, along the Elm Fork and the West Fork of the Trinity, is performed to evaluate the pattern of site distribution, land use, and possible function, based on the assemblages and catchments of each site. The purpose of this portion of the study is to analyze the catchments of diagnostic and non-diagnostic sites for comparative analysis. The 45 time-diagnostic sites provide a means to observe site characteristics with respect to change through time and occupation frequency. Since the East Fork provides a clearly significantly different environmental setting than the Elm and West Fork the 50 site catchments from this area are included in comparative discussion but not in statistical analysis. Mapping the economic value of the entire landscape reveals the overall distribution of valuable resources as they relate to site location. This can help explain why certain areas were selected over other areas or provide a means to predict likely site locations. Once the intra-site settlement patterns are evaluated these data can be compared to non-surveyed areas of the Upper Trinity drainage basin in order to ascertain the kinds of environments associated with the various prehistoric utilizations of the basin.

The character of investigations in the region introduces a sample bias that influences the results of the current research. The Elm Fork bridges Ray Roberts Lake and Lake Lewisville. Professional contract work associated with the construction of these reservoirs has led to the discovery of a very dense distribution of sites along this corridor. Academic work conducted at the University of North Texas and Southern Methodist University has also produced a number of reports along the Elm Fork. Site distribution in the West Fork portion of the study area is very limited. This is due to the fact that most of the sites were discovered by amateur archaeologists or land owners. No formal professional investigations and no contract work, related to reservoir construction, have been conducted in this portion of the study area. East Fork sites have been discovered by limited excavation efforts related to academic research. Even though distribution currently reflects the intensity of archaeological contract work, it is clear that the Elm Fork found favor with prehistoric populations. Future professional research should be conducted along the West and East Fork to further explore the benefits offered in these areas and to substantiate or refute proposed settlement models. Regardless of sample bias, the current sample provides valuable information from which to form future hypotheses and conduct research on the settlement patterns of prehistoric populations in north-central Texas.

Site Catchment Analysis of Prehistoric Sites in North-Central Texas

Geographic Information Systems (GIS) permits archaeologists to conduct sophisticated spatial analyses by providing an extremely useful methodological structure through which quantitative approaches to environmental attributes and cultural remains can be spatially addressed. SCA is performed with ESRI ArcView 8.3 ArcMap and SPLUS 2000 statistical software. GIS techniques (figure 28) are an active component, throughout the entire process of SCA, from data collection to hypothesis evaluation. GIS provides an ideal set of tools to facilitate the process of performing SCA. The ability of a GIS to extract environmental information and perform spatial analysis has led to its utility in SCA. GIS software plays a central role in data collection, input, management and analysis within site catchments.

Essentially the GIS component provides an organizational mechanism (figure 29) to manage large data sets from a variety of sources, generate new data sets and integrate these data to view the dynamic relationships that help explain prehistoric human behavior. GIS software provides tools to facilitate the construction of databases and a means to link the archaeological record with the environment, on a regional scale. It is with these tools SCA is performed and with ecological, anthropological and geographical theories that settlement patterns are interpreted.

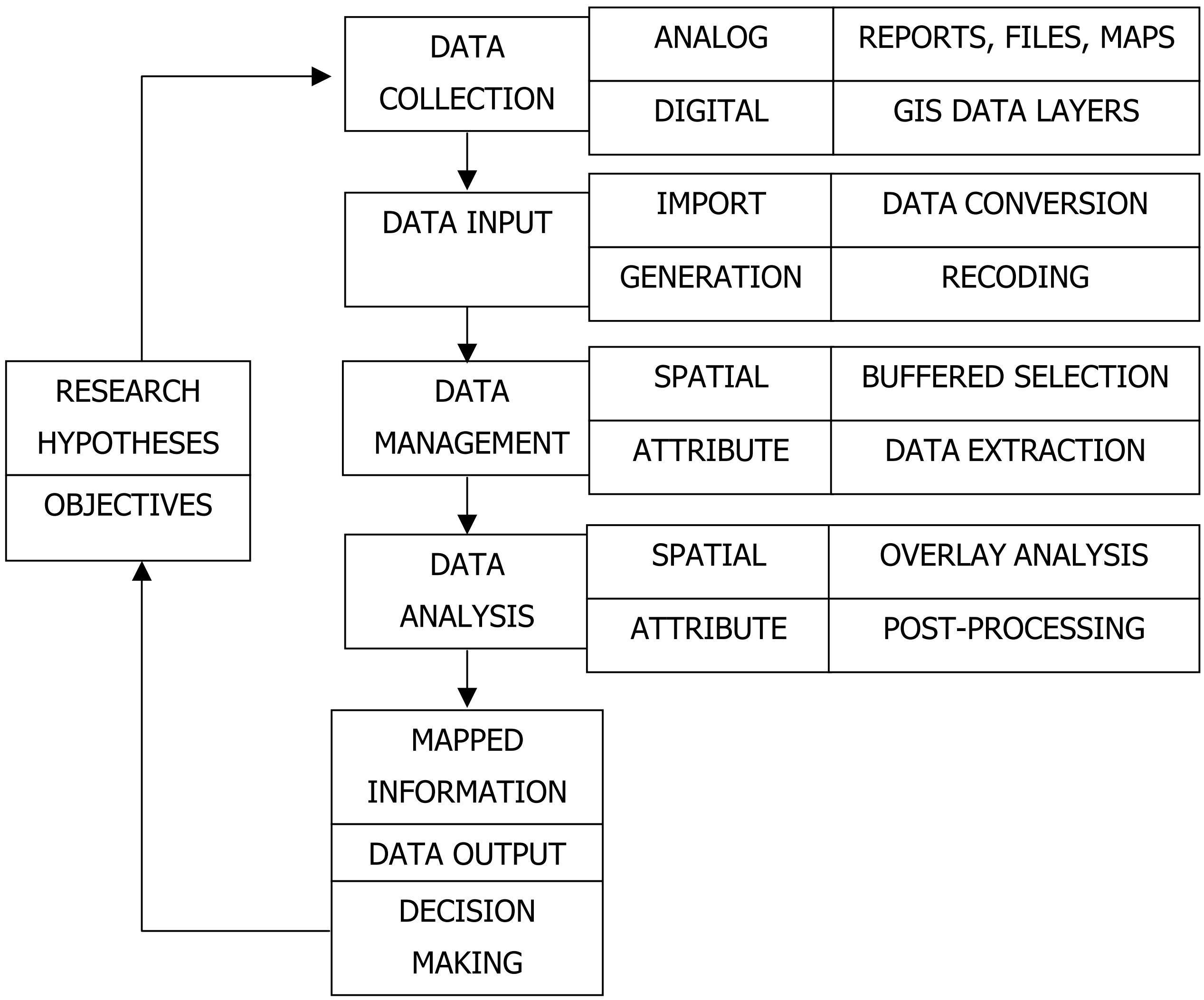

Figure 28. Diagram of GIS data processing design in SCA.

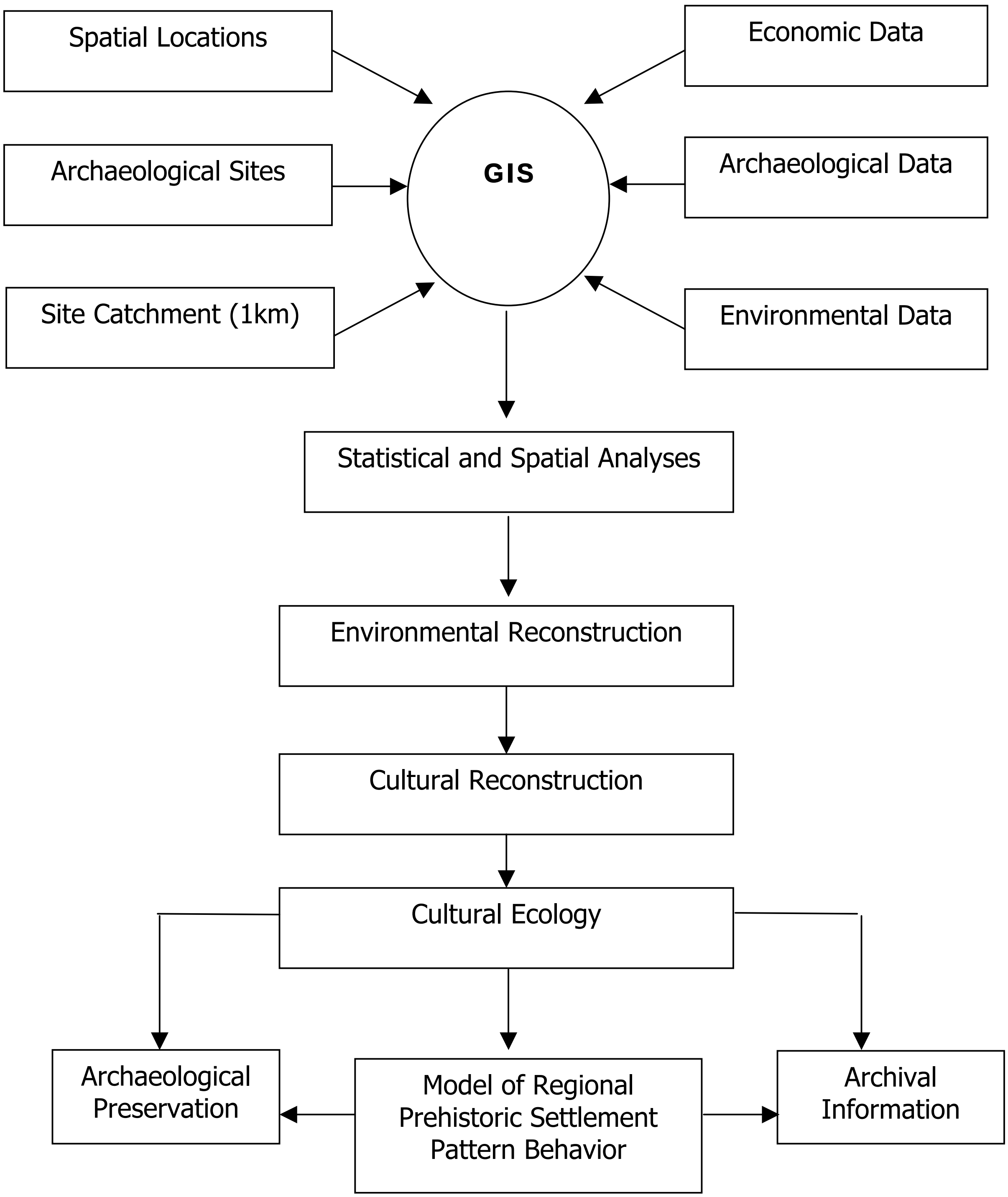

Figure 29. GIS in relation to components of the settlement model.

In general, the SCA, which is a synthesis of archaeological, environmental and ethnographic data, includes the following procedures:

1. Soil survey soil series level data are evaluated with respect to vegetation.

2. Vegetation, associated with specific soil types in the soil surveys are identified by common name, family, genus and species.

3. Research is conducted to determine the relative values, per plant species, of edibility, medicinal value and supplemental value.

4. Values are attached to soil series level data in ArcMap GIS interface to the digital soils data layer.

5. Soil series are recoded with economic values, vegetation and wildlife potentials using ArcMap "joining" operations to relate to site distribution in light of chronology, site frequency and artifact density.

6. Archaeological sites are projected with ArcCatalog and ArcToolbox and then imported into the ArcMap GIS interface where 1 km catchment areas are constructed around the sites with ArcMap buffering techniques.

7. Soil types within catchments are proportionately extracted, recorded and interpreted into measures of diversity, plant and wildlife potential and economic worth with ArcMap selection and extraction techniques.

8. Overlay analysis is performed using ArcMap to provide a visual representation of the intersecting data layers that form the environment in association with sites and facilitate evaluation of spatial patterning.

9. Observable topographical, geological, hydrological, physiographic and ecotonal resources are related to sites chronologically, with respect to occupation frequency and assemblage composition, by selection and extraction ArcMap techniques to compile contingency tables for chi-square analyses.

10. Descriptive and multivariate statistical tests are performed with SPLUS 2000 software to objectively compare the economic values, wildlife potentials, vegetation potentials, topographic settings, great groups, geological and physiographic settings within site catchment areas to look for patterns in site occupation, composition and change through time.

Results generated from the SCA are, in part, presented in a series of maps. A series of thematic databases, charts, histograms, and graphs summarize the proportional distribution of soil types, geological settings, topographic settings, physiographic settings, economic potentials and catchment soil diversity. Site catchments are summarized with descriptive and multivariate statistical techniques to describe, quantify and compare the resource potentials of site territories. Based on the prior research a series of hypotheses are tested and a model of prehistoric settlement patterns is formulated.

Hypotheses Testing

In order to understand prehistoric human socio-economic settlement patterns in north-central Texas this thesis specifically aims to formulate a model that can help explain why prehistoric populations selected certain locations for single or repeated occupation between the Early Archaic (8,500 BP) and Late Prehistoric (500 BP). Explaining site selection is the driving research problem because location influences the range of available economic opportunities and cultural adaptations. In order to address this challenge a series of hypotheses have been formulated. These hypotheses are designed around two general themes. The first theme is descriptive while the second theme is interpretive.

Description oriented hypotheses focus on the descriptive character of the site catchments to define the features related to site re-occupation and chronological change. The first set of hypotheses is formulated to evaluate the physical characteristics (topographic, physiographic, geological, great group and soil setting) of site catchments in relation to occupation frequency (single, dual, tri, multi) and change through time (from Early Archaic to Late Prehistoric II). This set of hypotheses is formulated to provide a means to determine the specific physical characteristics typically associated with sites that have been variably occupied and to provide a view of how this changes through time. Evaluation of the relationships between site catchments and the prehistoric activities that occurred at these locations require hypotheses designed to examine site catchments in relation to site function (lithic scatter, tool manufacture, hunting, food preparation) occupation density (ephemeral, moderate, intensive) and cultural affinities (projectile point types). In order to factor in the element of time, site function and occupation density are evaluated in relation to occupation frequency and change through time.

Interpretive hypotheses are designed to test change through time and occupation frequency in relation to potentialities for prehistoric utilization of certain environmental resources. Environmental information is translated into a meaningful ecological context related to human decision-making processes. Essentially, this portion of the analysis is designed to test relationships between site locations and interpreted soil potentials. Therefore the data are extended beyond the physical to the possible. Potential for habitat suitable for certain types of wildlife and vegetation provides general insight on what types of animals and vegetation were suited to certain soils.

Economic value extends interpretation beyond soils to vegetation linking these data to possible prehistoric utilizations of plants that have the potential to exist given certain soil types. Climatic interpretations link soils data to pollen data providing a means to estimate the relative abundance of certain plants during wetter or drier climatic intervals that have been documented in correlation with past patterns. Wildlife (openland, rangeland, wetland); vegetation (grains and seed crops, grasses and legumes, wild herbaceous plants); economic value (edibility, medicinal, supplemental); and climatic interpretations of soils data are evaluated in relation to site catchment characteristics, site contents, occupation frequency and change through time.

Relationships between the diversity within site catchment areas and the variability of archaeological assemblages are examined. Variability between site catchments relative to occupation frequency and change through time is evaluated. Defining the character of the site catchment areas to determine diversity within and variability between these areas helps explain why sites were selected repeatedly or ephemerally. Interpreting the relative economic value of these variables provides a means to evaluate prehistoric behavioral choices and adaptations as they change or stay the same through time. A multi-scale investigation into landscape diversity within and variability between site catchments of archaeological sites is selected to test these hypotheses. As such, the SCA requires the ability to superimpose the archaeological record upon the micro-environmental setting. Collectively, cultural and environmental data are analyzed, with a unique methodology, to shed light on the character of multi-dimensional expression of prehistoric decision-making processes.

As a part of the SCA process, environmental modeling is expected to reveal that archaeological sites are strategically situated in areas that yield protection or in areas that provide advantageous economic positioning. Correlations are expected between select topographic settings, physiographic settings, soil potential, economic values and climatic conditions. Given the physiographic character of north-central Texas, it is expected that site selection strategies should reflect an equal utilization of the ecotones. In relation to this, increased environmental diversity within the site catchment area is expected. On the other hand, it is possible that certain areas were utilized for specialized resource gathering. If this is the case, decreased environmental diversity is expected. SCA also facilitates the inference of site function based on the economic potential of the microenvironments that surround each site in conjunction with the assemblages from them. It is anticipated that decisions made in relation to environmental structure will provide comparable inferences regarding settlement patterns to those drawn by other hunter-gatherer settlement studies.

In order to test the hypotheses archaeological and environmental data layers are evaluated to test for differences between the environmental settings of site locations in relation to assemblage composition. Occupation densities combined with activity groups represent cultural behavior. Economic values (medicinal, edible, supplemental); soil potential (vegetation and wildlife habitat); physiographic settings, topographic settings, soil settings and geological settings are environmental attributes that are factored into the statistical analyses. Hypotheses are either accepted or rejected on the basis of how well the distribution of soils, geologic, hydrologic, topographic, physiographic and economic variables met expectations in relation to assemblage composition (lithic scatter, lithic manufacture, hunting, food preparation); occupation density (ephemeral, moderate, intensive); occupation frequency (single, dual, tri, multi) and change through time (Early Archaic-Late Prehistoric II). Variables and methods utilized to evaluate each null hypothesis are addressed and summarized in this section.

Catchment diversity values, economic values, soil potentials, soil settings, great groups, geological, physiographic and topographic data layers are utilized to test the following hypotheses (table 5). The first predicts differences between site catchments with respect to visitation frequency. The second evaluates change through time. The third factors in site function. The fourth compares relationships and occupation density.

Null Hypothesis	There is no statistically significant difference between site catchments in relation to:
1	occupation frequency
2	change through time
3	site function
4	occupation density

Table 5. Site catchment hypotheses.

Economic data layers are evaluated to look for relationships that may emerge regarding specialized or generalized activities. Diversity data layers are evaluated to look for relationships between catchment diversity and site occupation. Economic and diversity values are both expected to correspond with increased site occupation frequency. An ANOVA is conducted to evaluate economic values and diversity values in relation to occupation frequency. A series of Chi-Square statistical tests are performed to test for statistical significance of the great groups, soils, geological, topographic and physiographic settings within site catchments in relation to occupation frequency. If differences are statistically significant, frequency tables are evaluated to determine what type of site selection patterns emerge in relation to these factors.

Chi-Square statistical tests are performed to test for statistical significance of site function and occupation density in relation to change through time. If differences are statistically significant, frequency tables are evaluated to determine what type of site selection patterns are prevalent. These hypotheses are expected to shed light on the relationship between site function and occupation density in relation to change through time and occupation frequency (table 6) without factoring in the environment.

Null Hypothesis	There is no statistically significant difference between site function in relation to:
5	change through time
6	occupation frequency
Null Hypothesis	There is no statistically significant difference between occupation density in relation to:
7	change through time
8	occupation frequency

Table 6. Site function hypotheses.

This facet is important because it provides a statistical view of prehistoric occupations as they change through time. It reveals if inferred prehistoric activities and their associated densities are similar or different with respect to change through time and in relation to occupation frequency.

ANOVA is performed on a collection of databases that contain time diagnostic site catchments and their associated proportional wildlife (openland, wetland, and rangeland) potentials; vegetation (grains and seed crops, grasses and legumes, wild herbaceous plants) potentials; and economic values (edible, medicinal, supplemental). This multi-variate statistical test will evaluate a series of hypotheses (Table 7).

Null Hypothesis	There is no statistically significant difference between wildlife potentials associated with site catchments in relation to:
9	change through time
10	occupation frequency
Null Hypothesis	There is no statistically significant difference between vegetation potentials associated with site catchments in relation to:
7	change through time
8	occupation frequency
Null Hypothesis	There is no statistically significant difference between economic values associated with site catchments in relation to:
9	change through time
10	occupation frequency

Table 7. Economic values hypotheses.

Determining the relationship between the character of site catchment areas and the variability of archaeological assemblages relative to occupation frequency and change through time provides explanatory mechanisms for prehistoric settlement patterns.

Purposeful behavior is patterned and based on socially transmitted information that facilitates successful adaptations. If site selection is the result of purposeful human activity, it should likewise be patterned. Although it is expected that the patterning of site selection is reflective of the human behavior that produced it, these similarities must be demonstrated and not assumed. Human actions are processes in time and space that have structure and can be presented as a network of inter-related behavior. Inferences can be made based on what is known about the character of the environments that provided the range of possibilities for prehistoric adaptations. When site distribution is calibrated with the environmental setting, given a variety of scenarios, it is possible to build a model of regional prehistoric settlement patterns.

Study Area

The area in north-central Texas (figure 30), selected for this research, is defined by the three major tributaries of the Trinity that intersect three distinctive physiographic zones. For the most part sites are situated along or near these waterways. On a regional scale, SCA is performed on 150 surface sites selected from the West Fork, Elm Fork and East Fork of the Trinity, with projectile point typology as the means to establish chronology and occupation frequency. Data gathered from these regional site locations are evaluated using 10 excavated sites from the Elm Fork of the Trinity that produce a well-documented and well-stratified chronological record. These excavated sites provide a means of temporal control for the regional model. The time span of this study ranges from 8500 years before present, during the Early Archaic, to the Neo-American era, 500 years before the present era. Excavated sites selected for this research provide a discontinuous record of occupations, in north-central Texas, from the Early Archaic to Late Prehistoric. Excavated sites are useful for this research since they provide a detailed account of artifacts, features, fauna and radiocarbon dated materials. These materials are particularly suited to SCA because the level of detail facilitates a more complete reconstruction of economic activities in space and through time. In addition, excavated sites provide empirical field data as a means to test validity of the extrapolated data derived from digital map layers that form the basis for the analysis. Selected study sites facilitate a chronological examination of diversity within site catchment areas and variability between site locales to consider the variety of factors that could influence site selection. In addition, an opportunity to examine site

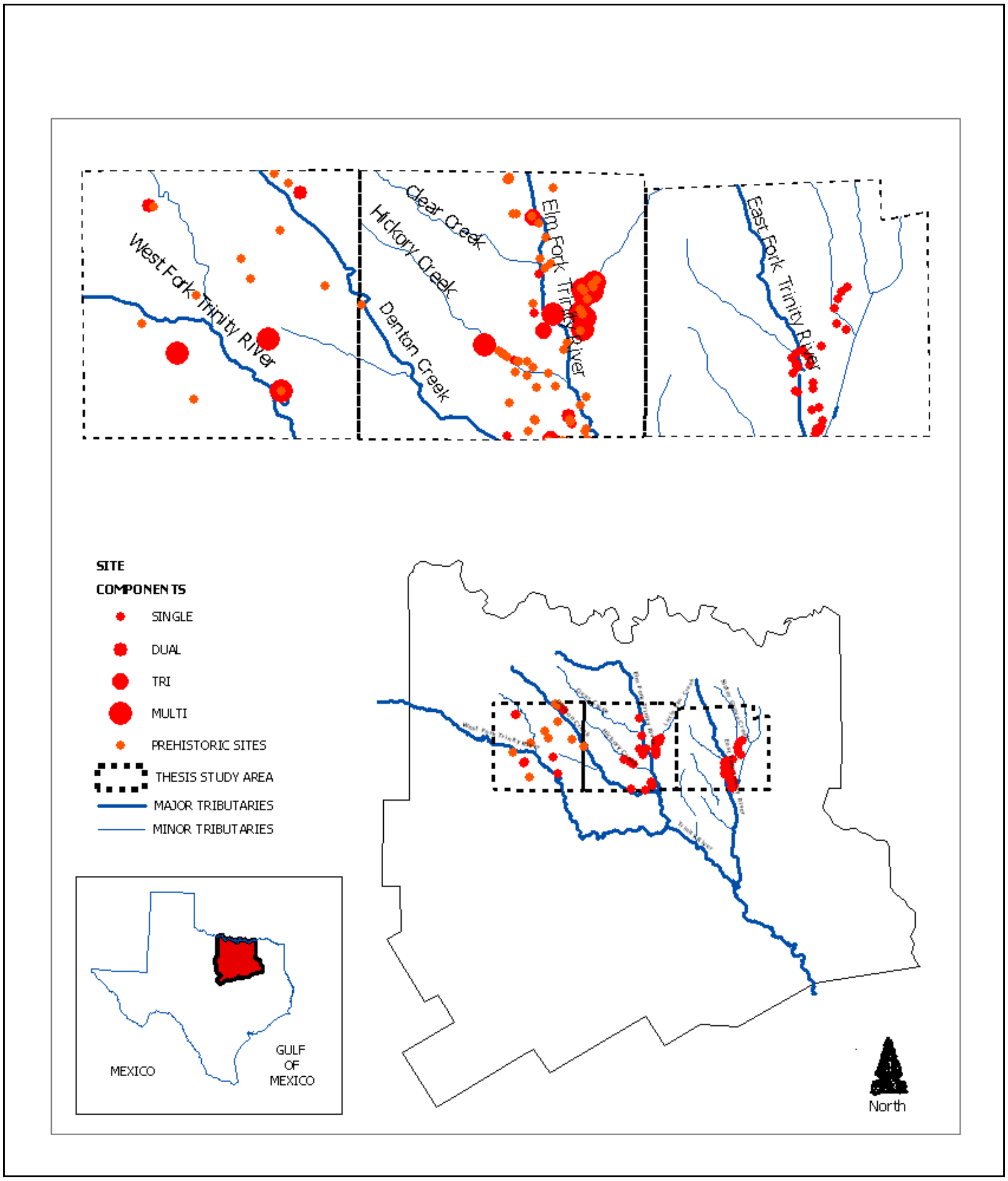

Figure 30. North-central Texas research study area.

catchments for evidence of functional constants that may be associated with site selection is provided. The regional scale analysis that includes the 150 surface sites provides a basis from which to infer site type, function, examine trends and evaluate the environmental diversity and relative economic value on a regional scale. According to Ferring (1986), archaeologists must continue to develop research methods that enhance the study of intra-site variability with respect to the larger, multi-site cultural system. Although, Ferring is referring to artifacts and fauna, the same concept is true for the environmental setting. This research views the catchment area as an extension of the archaeological remains. As such the results of the SCA are an important facet of the regional settlement pattern model formulated for this region.

CHAPTER 6

RESULTS

The most analytically informative data produced by conducting the site catchment analysis (SCA) in north-central Texas is contained by a series of maps, graphs and tabular data. In this chapter results are evaluated with respect to each variable that is evaluated either spatially or statistically and contributes to the development of the regional settlement pattern model. A discussion of the distribution of sites in relation to the geological, physiographic, topographic and soils settings, as well as, site function and site activities are followed by a synopsis of the statistical results.

Geological Setting

The geological setting of sites in the study area (figure 31) provides tremendous utility for environmental reconstruction and behavioral interpretation. Closer observation of this variable reveals strategic decision-making. Sites located in the West Fork study area are predominantly situated in sandstone settings with secondary presence in alluvial settings and tertiary presence in limestone (figure 32-33). Elm Fork sites follow a similar pattern however shale settings replace limestone settings. East Fork sites are typically associated with alluvial settings, marl or a combination therein.

In the Elm Fork study area 48% of the Archaic sites are on fluvatile or alluvial deposits, 41% on sandstone and 9% on shale. Late Prehistoric sites are situated in water deposited sediments (40%), sandstone (45%) and shale (13%). Hunting sites in the Elm Fork area are fairly equally represented in both water deposited sediments (44%) and sandstone settings (37%) with the remaining in shale (9%) and limestone

(3%) settings. Lithic manufacture camps are primarily associated with sandstone (45%) with a secondary presence (34%) in alluvial and fluvatile terrace deposits.

In the West Fork area 56% of the Archaic sites are associated with sandstone and 22% with water deposited sediments. Of the Late Prehistoric sites 25% are found in association with alluvium or fluvatile terrace deposits and 50% with sandstone. Sites that contain evidence of lithic manufacture, hunting and even base camps are found in association with sandstone (75%) with the remaining 25% found on fluvatile terrace deposits. Only one site was found in relation to limestone and upon closer inspection it appears to be situated directly on the dividing line between the Goodland Limestone Formation and the Antlers Sandstone. Sites in the West Fork area are actually a very good example of sites oriented in an ecotonal setting with a notable precision. Interestingly, in almost every case cases the sites are on the sandstone side of the ecotone about a half of a kilometer from the limestone. The alternative scenario is illustrated by one site in particular situated almost half way between the West Fork and the Elm Fork. In this case, where Goodland limestone dominates the setting, a small fluvatile terrace deposit was selected and the site was placed on the edge overlooking a stream valley. This is an excellent example of how geology can be used to reconstruct prehistoric behaviors that appear to be influenced by past environments.

In the East Fork portion of the study area Archaic sites tend to be associated with alluvium (27%) and fluvatile terrace deposits (33%). An opposite pattern occurs during the Late Prehistoric when sites are primarily located in alluvial deposits (34%) with a

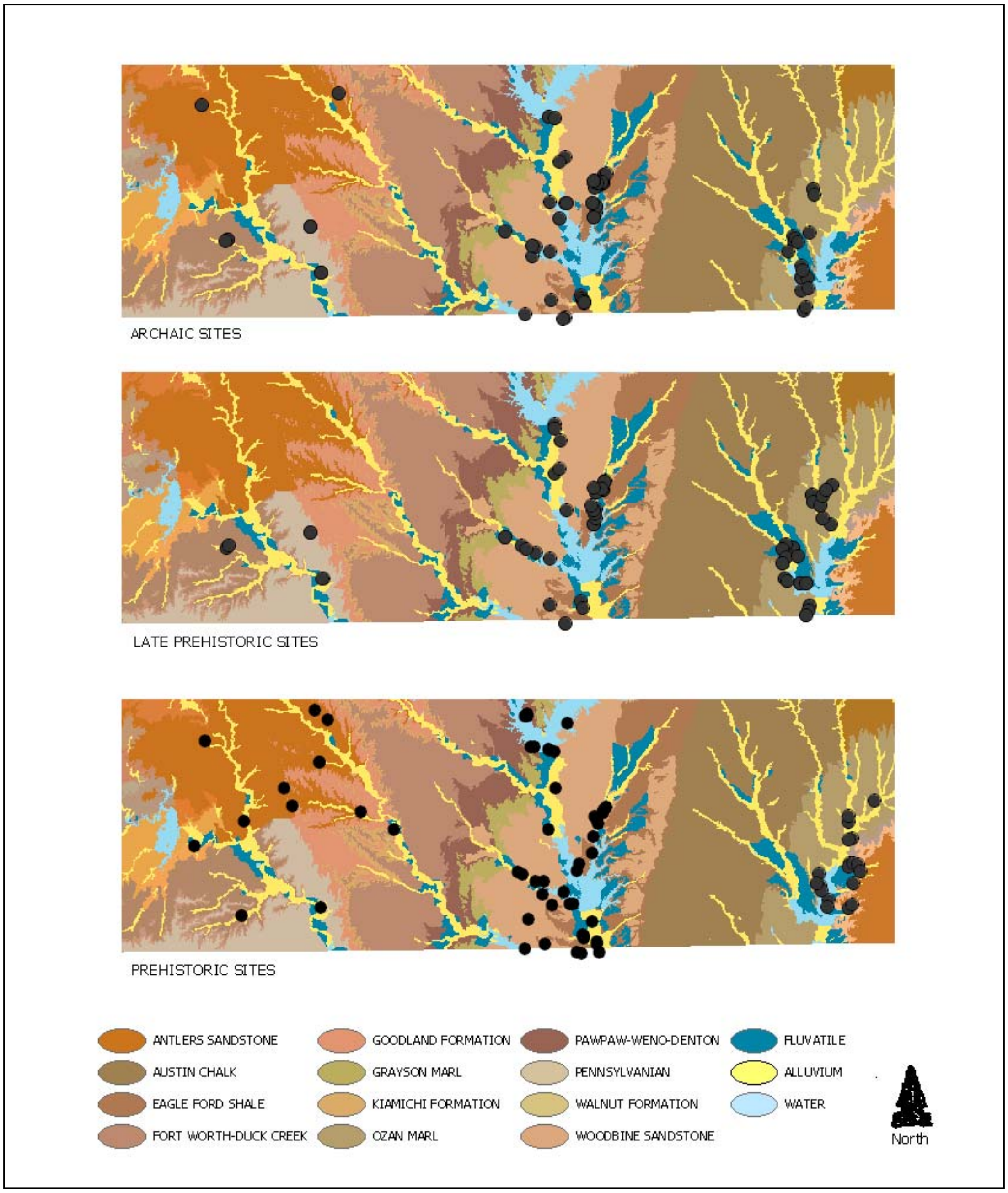

Figure 31. Geological Setting of Sites in Study Area.

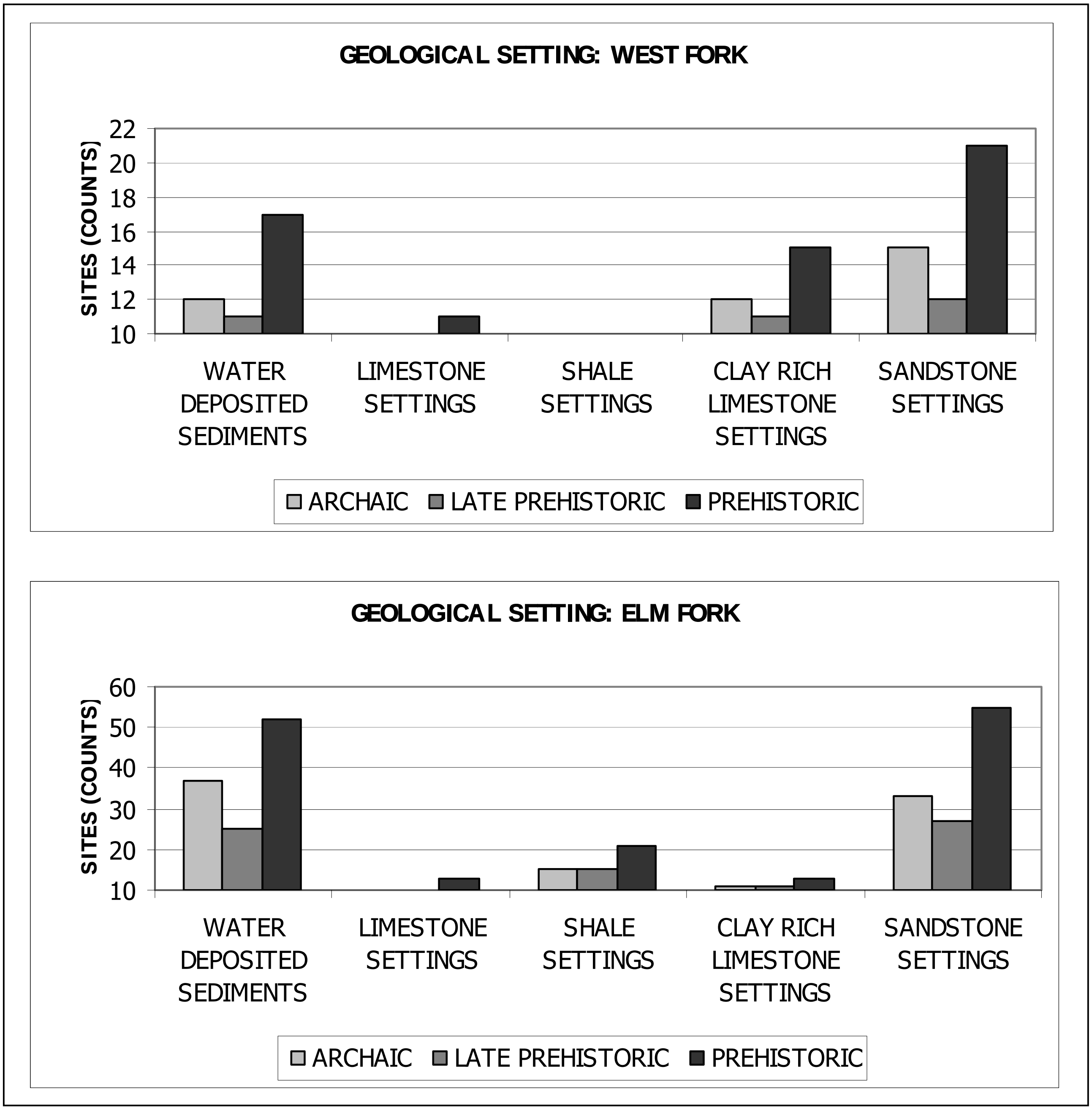

Figure 32. Geological Settings and Time Periods. This figure illustrates the relationships between the number of sites that contain each particular geological deposit. For the sake of clarity in illustration combined with the fact that there is a significant overlap of site selection with respect to change through time it was necessary to consolidate the subdivisions of the particular time periods. Early, Middle and Late Archaic are grouped into "Archaic". The first and second phase of the Late Prehistoric is combined into the "Late Prehistoric" category. The "Prehistoric" "category consists of sites that do not sites are associated with marl. Although functional differences between the Prehistoric contain diagnostic materials. Geological deposits are also consolidated into their more generalized "Parent" groups.

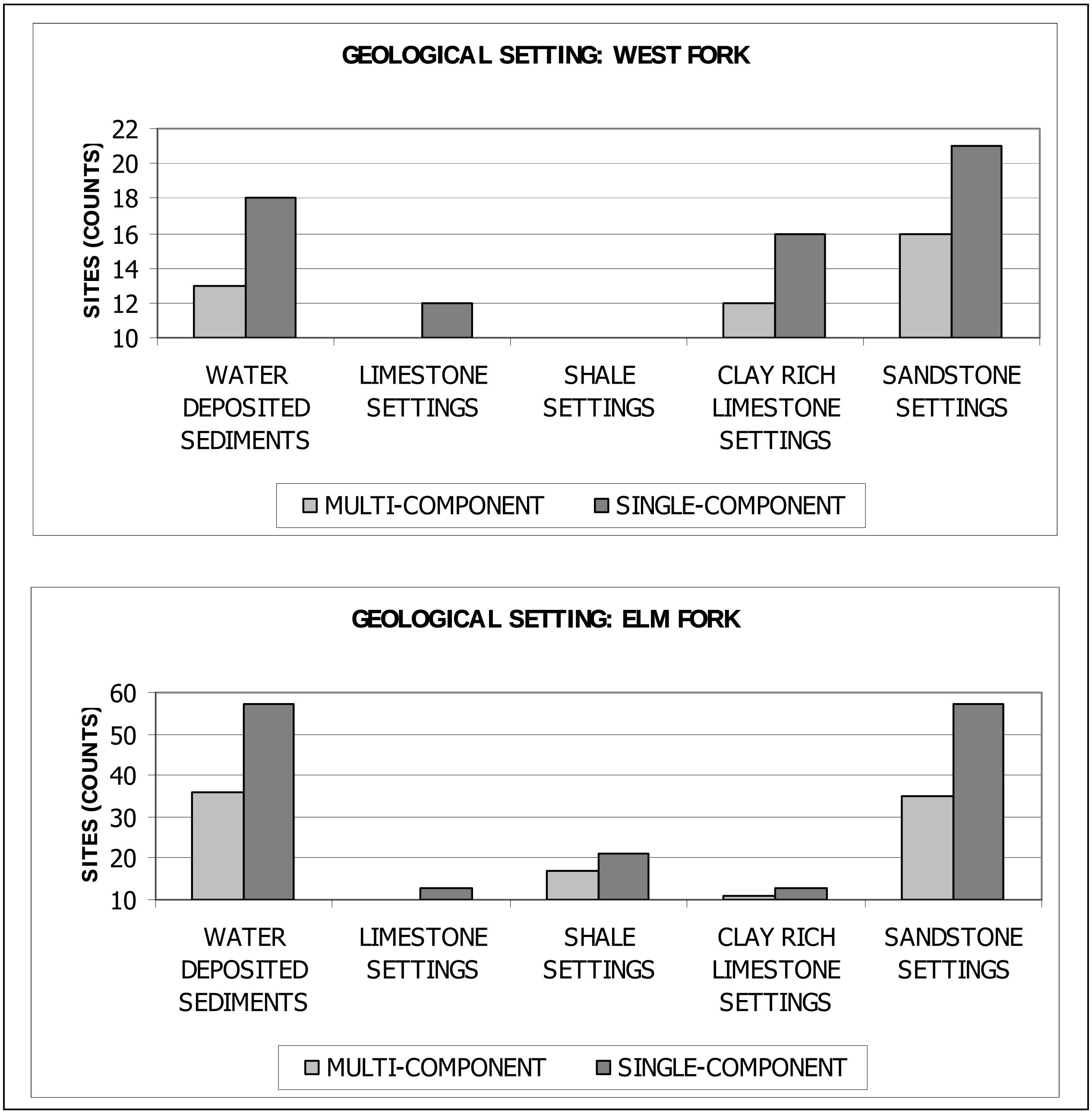

Figure 33. Geological Settings and Occupation Frequency. This figure illustrates the relationship between geological deposits and occupation frequency. Sites are consolidated into single or multiple occupancy and geology into generalized lithology.

secondary presence in fluvatile terrace deposits (19%). In addition, 26% of the Late Prehistoric sites are associated with marl. Although functional differences between the sites along the East Fork are not currently clear due to lack of data there is a strong correlation between the four sites that contain the "Wylie Focus Pits" and the Ozan Marl formation. This is significant due to the fact that most of the landscape is dominated by the Austin Chalk to the West and Marlbrook Marl to the East. However, given that alluvial deposits and the associated major tributaries are carved into the Ozan Marl, this appears to be a logical choice that provided immediate access to water resources. In addition, this geological deposit is less resistant than the surrounding geology which would have facilitated the construction of the characteristic deep ceremonial pits.

Geology in correlation with occupation frequency follows similar patterns as change through time. This is probably due to the fact that sites that exhibit reoccupation are occupied during more than one time period and the majority of sites with diagnostic materials exhibited reoccupation. This is a problematic facet of the current sample. As such, it is emphasized that the bias in site distribution is influencing the overall trends but when the sites are observed individually there is clearly a pattern of strategic site selection with respect to specific geological settings. In this case, sites are typically situated in water deposited sediments nested within sandstone settings.

Physiographic Setting

Physiographic (figure 34) settings of the Elm Fork include three vegetation zones. East to West they are: Blackland Prairie, Eastern Cross Timbers and Grand Prairie or Fort Worth Prairie. Most of the Elm Fork of the Trinity is included in the Eastern Cross

Timbers. The Elm Fork of the Trinity includes a wide band of the Eastern Cross Timbers flanked on the west by the Grand Prairie and on the east by the Blackland Prairie. Regardless of the effects of change through time (figure 35) and occupation frequency (figure 36) most of the archaeology along the Elm Fork is in the ecotone between the Cross Timbers and Prairies.

The West Fork of the Trinity (figure 34) is in a transitional zone between the Western Cross Timbers and the Fort Worth/Grand Prairie. The cultures that occupied this area lived precisely within the eco-tone between woodlands and prairies even when change through time (figure 35) and occupation frequency (figure 36) are considered. Sites situated in these areas have a high degree of flexibility between the prairies and the woods increasing the success of various subsistence strategies.

The East Fork of the Trinity is situated in the center of the Blackland Prairie. The only access to woodland species is along riparian corridors. As such sites tend to aggregate along the main stem of the East Fork (figure 34) rather than along minor tributaries and ephemeral streams. Bottomland hardwoods also provide access to the benefits offered by a wooded environment. Physiographically, the options open to prehistoric populations were limited. However, the variation in the limestone and marl geology, combined with the riparian settings, provided a fairly diverse environment.

Utilization of the ecotone occurs along both the West Fork and the Elm Fork. Change through time appears to be more affected by the number of known sites than due to prehistoric preferences. Ecotonal settings on the fringes of the eastern and western edges of the Cross Timbers appear to be the most heavily utilized areas along the Elm Fork. Sites are equally distributed between the two prairie/woodland ecotones with a scatter of centrally located sites in the Cross Timbers.

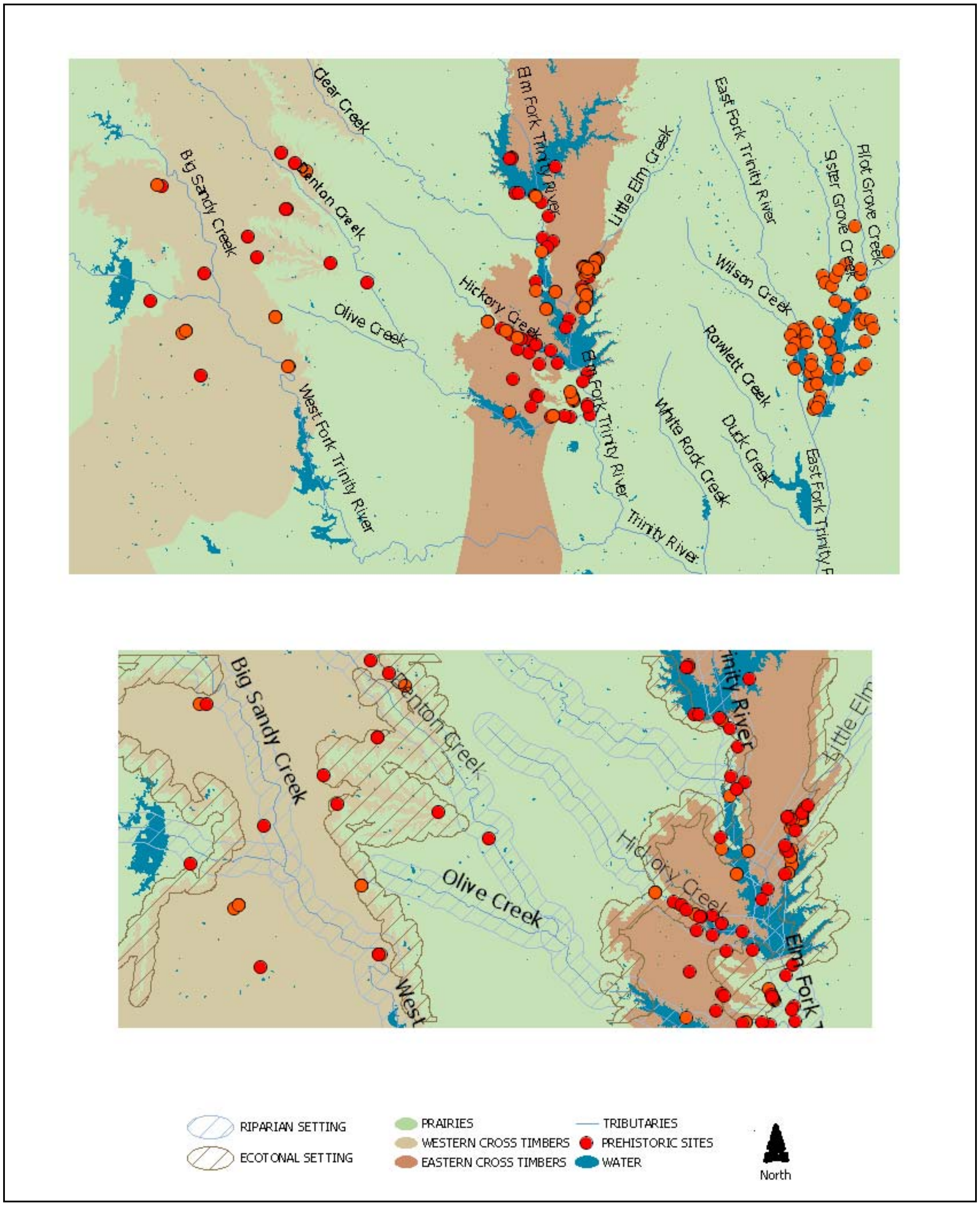

Figure 34. Physiographic settings in north-central Texas study area.

Minor riparian corridors (41%) in both the West and the Elm Forks are utilized most often. Major River corridors (30%) and ephemeral stream settings (29%) are utilized fairly equally. Along the East Fork there are no ecotonal areas immediately present unless the riparian environments are included in this category. East Fork sites are

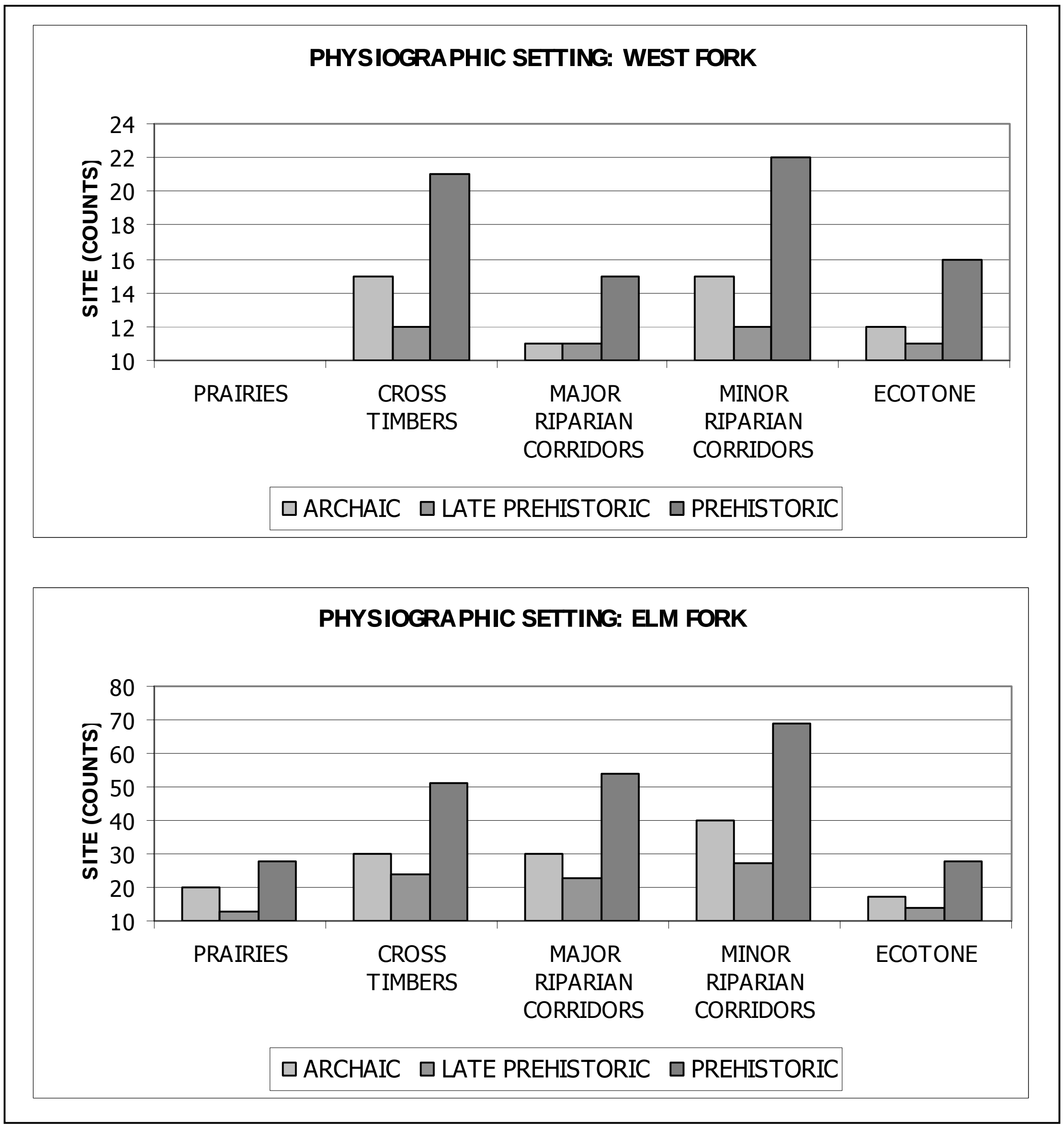

Figure 35. Physiographic settings and time periods.

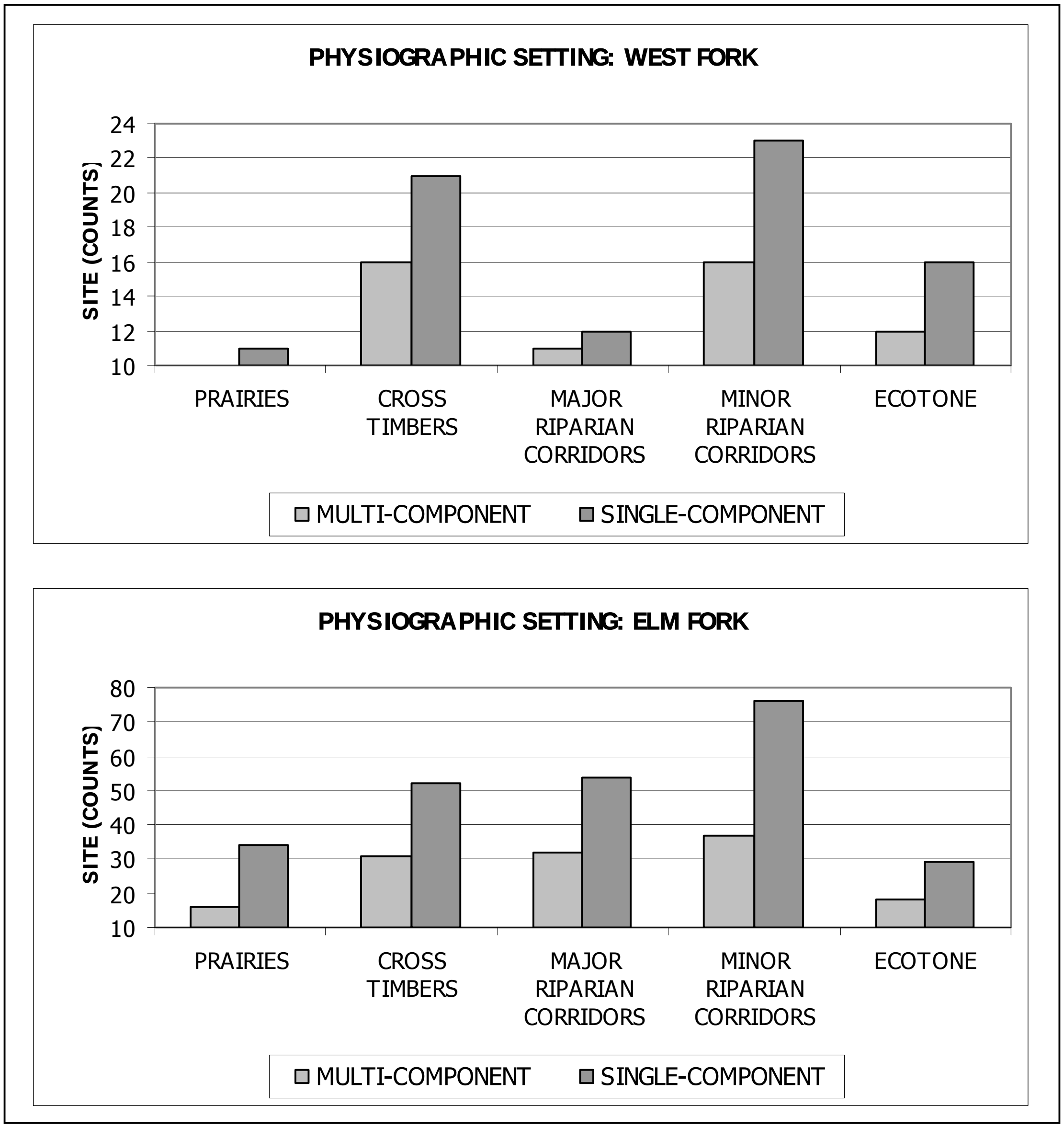

Figure 36. Physiographic settings and occupation frequency.

situated primarily within grasslands along major tributaries (26%), minor tributaries (26%) and ephemeral streams (52%) providing immediate access riverine resources.

Observations from previous investigations that reported grassland, woodland, riverine and ecotonal utilization are substantiated. The observation that sites are situated to equally utilize forest, riparian and prairie environments appears to be true in relation to the Elm and West Forks but is not the case along the East Fork. Although there is inherent ecotonal utilization in the East Fork area by virtue of the riparian corridors nested within the prairie environment. Given the spatial patterning and reoccupation of sites through time it is likely that the environment was a more significant factor then socially defined boundaries. Although, it is also possible, very much like today, that environmental boundaries coincided with social boundaries. It appears that these populations strategically placed themselves so they would have access to a variety of economically valuable resources.

Topographic Setting

Topographic settings of site catchments in the Elm Fork (figure 39) and West Fork (figure 40) provide a means to compare the orientation of sites from a variety of perspectives. Archaic and Late Prehistoric sites located on the West Fork are predominantly situated in terrace (47%) and upland (26%) settings near primary and secondary water sources. Drainage settings (21%) and floodplain (5%) settings are represented by 3 single and 2 multi-component sites. Archaic and Late Prehistoric Elm Fork sites are predominantly located in upland (45%) and terrace (41%) settings. Only 12% are located in the floodplain and 1% in drainages. Archaic East Fork populations selected alluvial terraces (41%), floodplains (25%), and uplands (33%). During the Late Prehistoric a slight decrease in terrace settings to 38% is countered by an increase in floodplains to 30% while upland settings (32%) remain about the same. Fairly equal distribution of sites in upland and terrace settings in both the West and the Elm Fork exist regardless of change through time (figure 37). Overlapping of time diagnostic sites creates complexity in this respect. A similar distribution between topographic settings occurs in relation to occupation frequency that is fairly consistent between the East, West and Elm Forks of the Trinity (figure 38).

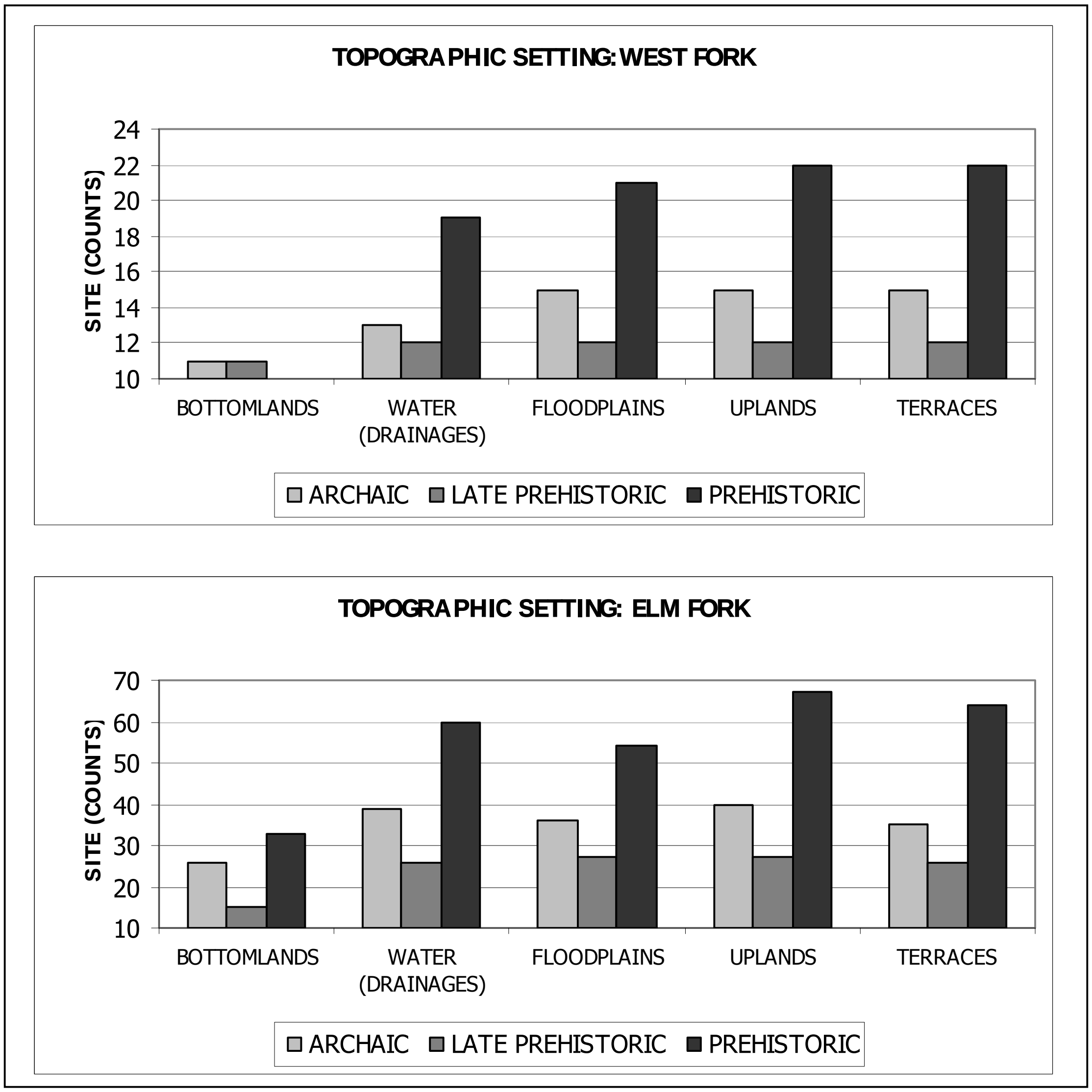

Figure 37. Topographic Settings and Time Periods.

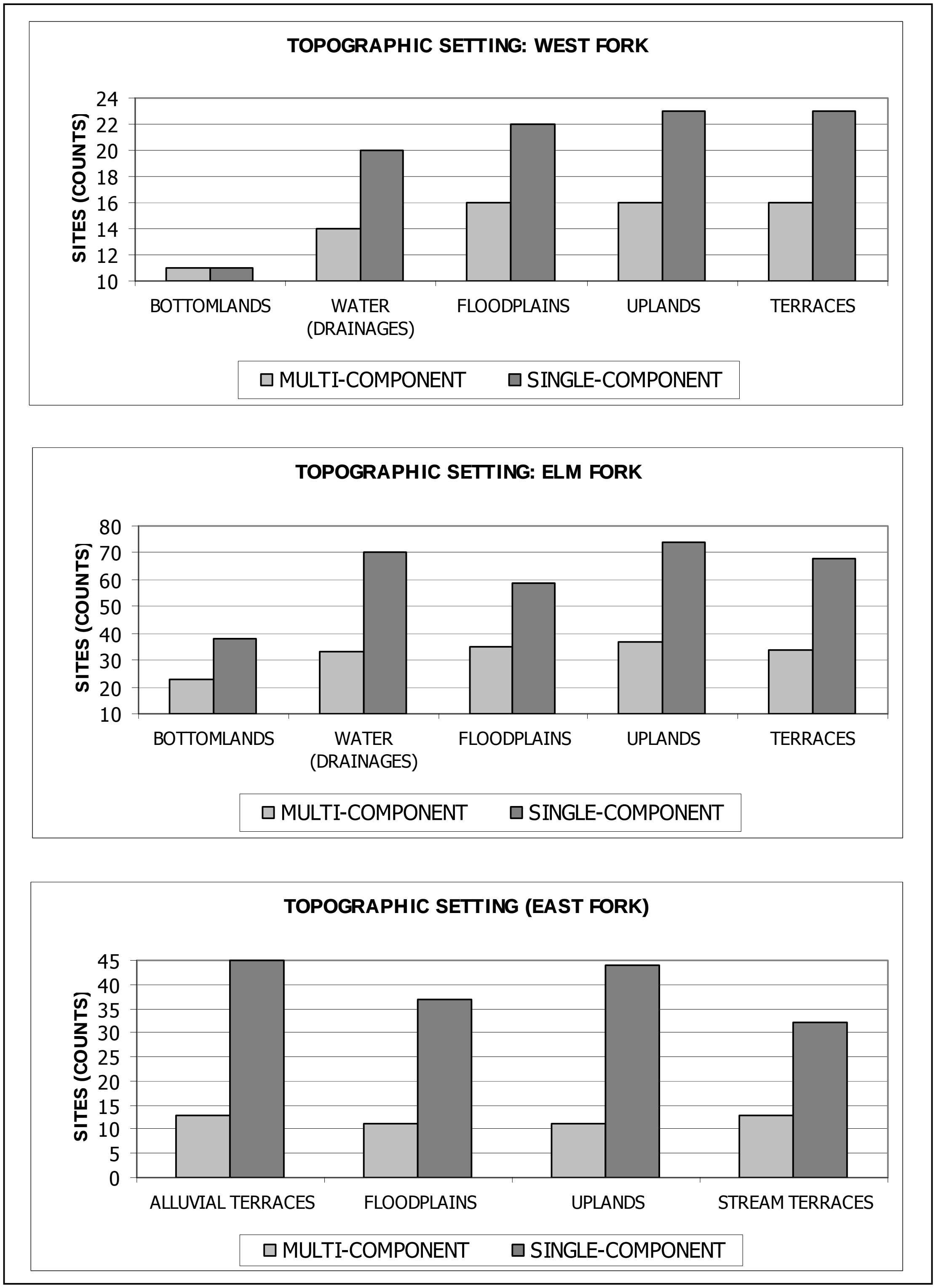

Figure 38. Topographic Settings and Occupation Frequency.

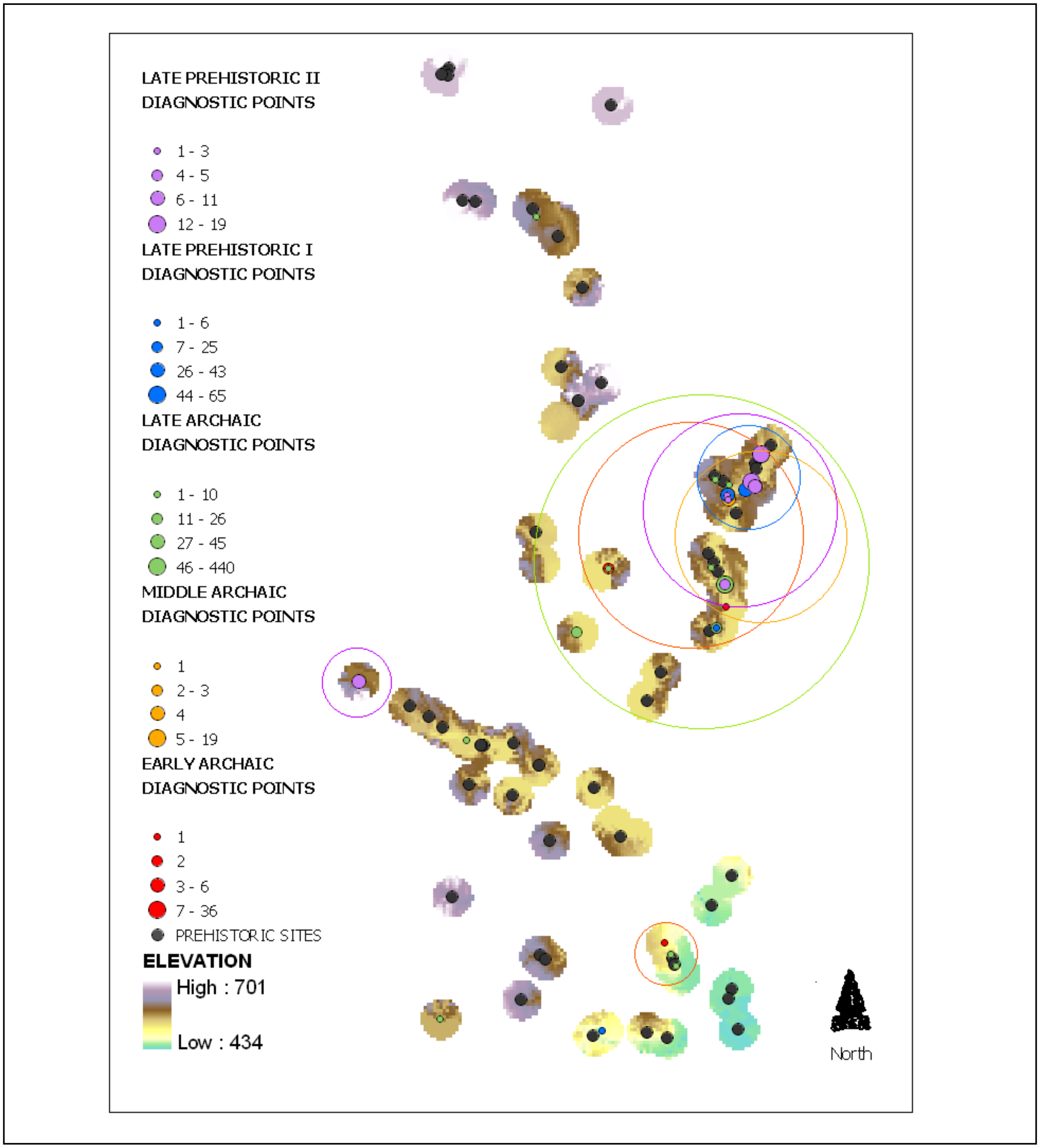

Figure 39. Elm fork site catchment elevations, change through time and projectile frequency. This figure is a screen shot of the GIS interface where the sites are evaluated from two perspectives (change through time and frequency of diagnostic points) juxtaposed over top the elevation. The larger circles are meant to show the clusters that are occurring per time period. With a few exceptions, catchments outside of the clusters are non-diagnostic general prehistoric sites.

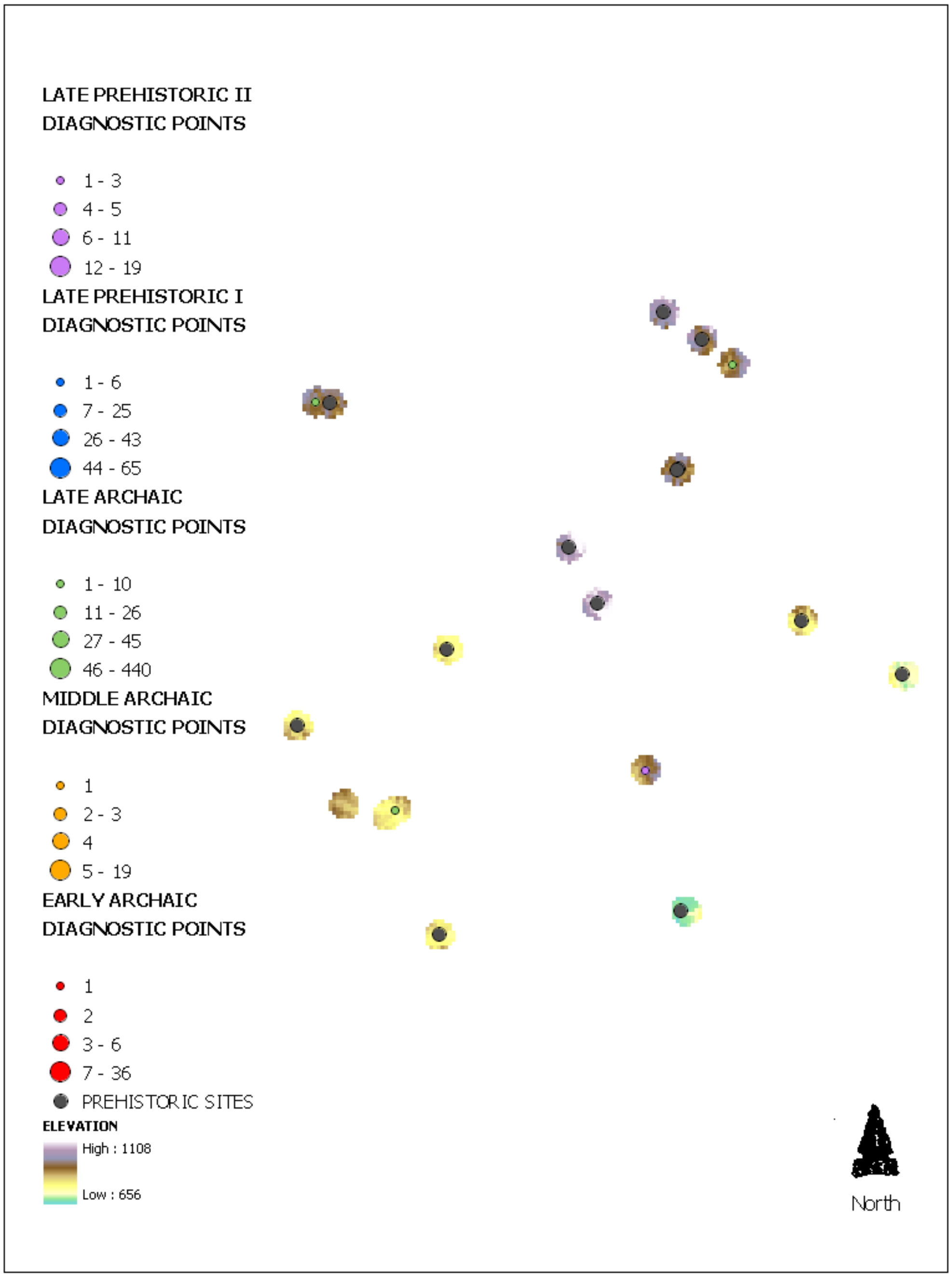

Figure 40. West fork site catchment elevations, change through time and projectile frequency. This figure is a screen shot of the GIS interface where the sites are evaluated from two perspectives (change through time and frequency of diagnostic points) juxtaposed over top the elevation. In the West Fork portion of the study area there is very little diagnostic evidence as reflected by the lack of indication of change through time. Only two sites contain evidence of change through time.

Results support the observations made during previous investigations that suggest that prehistoric populations primarily selected sites located in terraces and upland settings in ecotonal transitional zones between prairie and woodland settings. Terrace and upland settings along both the West and Elm Fork of the Trinity indicate reoccupation. East Fork sites contain evidence of occupation in uplands, floodplains, and terrace settings near bottomland riparian environments. In this respect the East Fork is very similar to the West and Elm Forks of the Trinity.

Soils: Great Groups

Soil taxonomy provides a means to interpret the potential of soils to produce vegetation and provide habitat for wildlife. Given the similar geological foundations of the Elm and West Fork results indicate a fairly equal correlation with Alfisols, Mollisols and Vertisols. Paleustalfs, Haplusterts, Haplustolls, Haplustalfs, Hapluderts and Calciustolls. All of these great groups have a common denominator that indicates a fairly moist environment with dry intervals probably related to seasonality or climatic fluctuations. Evaluating soil distribution (figure 41) for the West and Elm Forks across the study area and in the diagnostic catchment areas provides an overview of the variability. It is the distribution of these soils in relation to sites that determines the relative accessibility to economically valued resources by prehistoric populations. The primary difference between the great groups in the study area regardless of change through time (figure 43) and occupation frequency (figure 44) is in the level of horizon development and soil order. Otherwise in all portions of the study area there is a proportional distribution of Alfisols, Mollisols, Vertisols and Inceptisols.

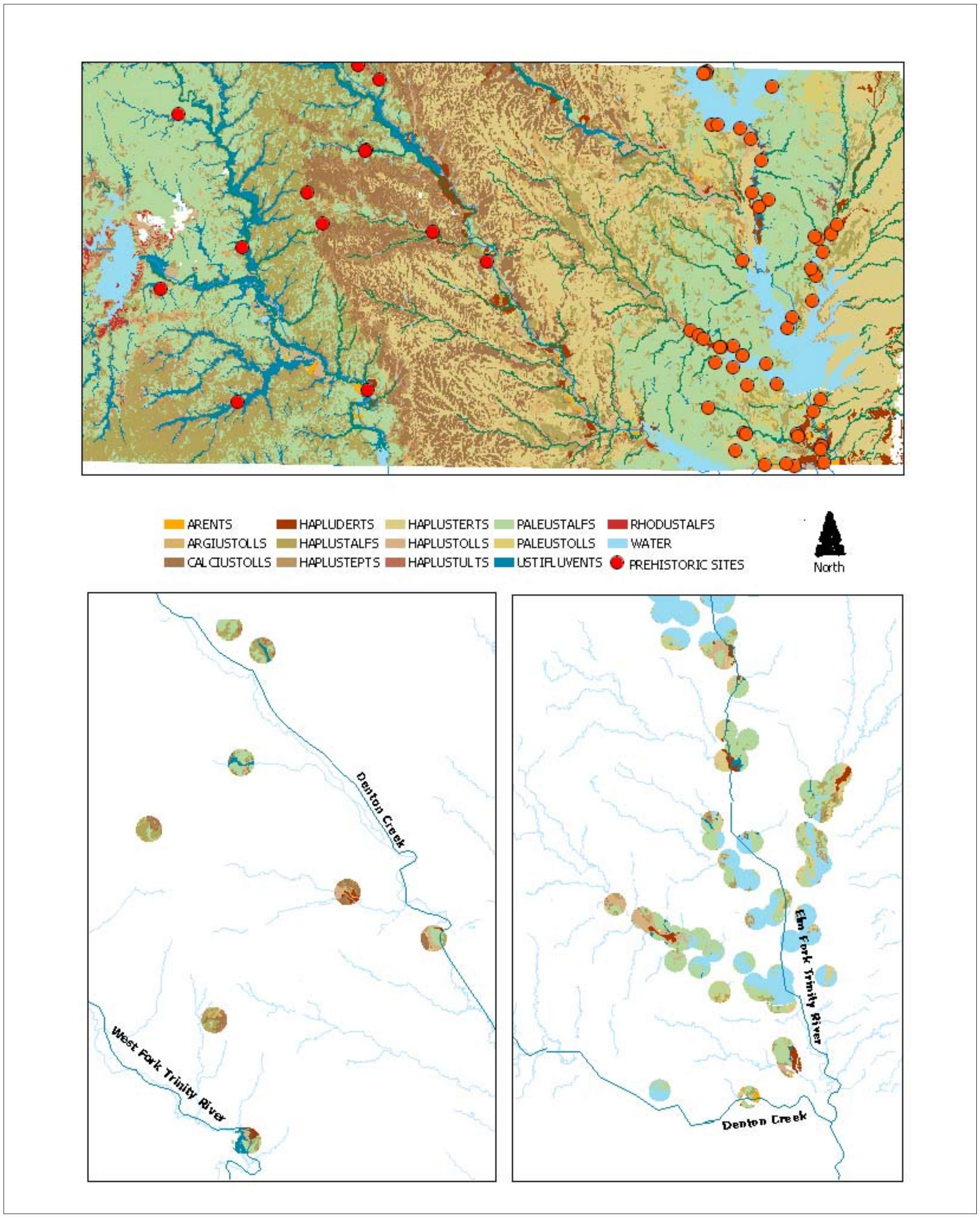

Figure 41. Great group distribution and site catchments.

East Fork soils (figure 42) are considerably different from the West Fork and Elm Fork. Pellusterts, Chromuderts and Chromusterts indicate a strong presence of Vertisols with varying degrees of organic content. The ustic component indicates a fairly moist setting with dry intervals whereas the udic setting indicates a higher moisture regime

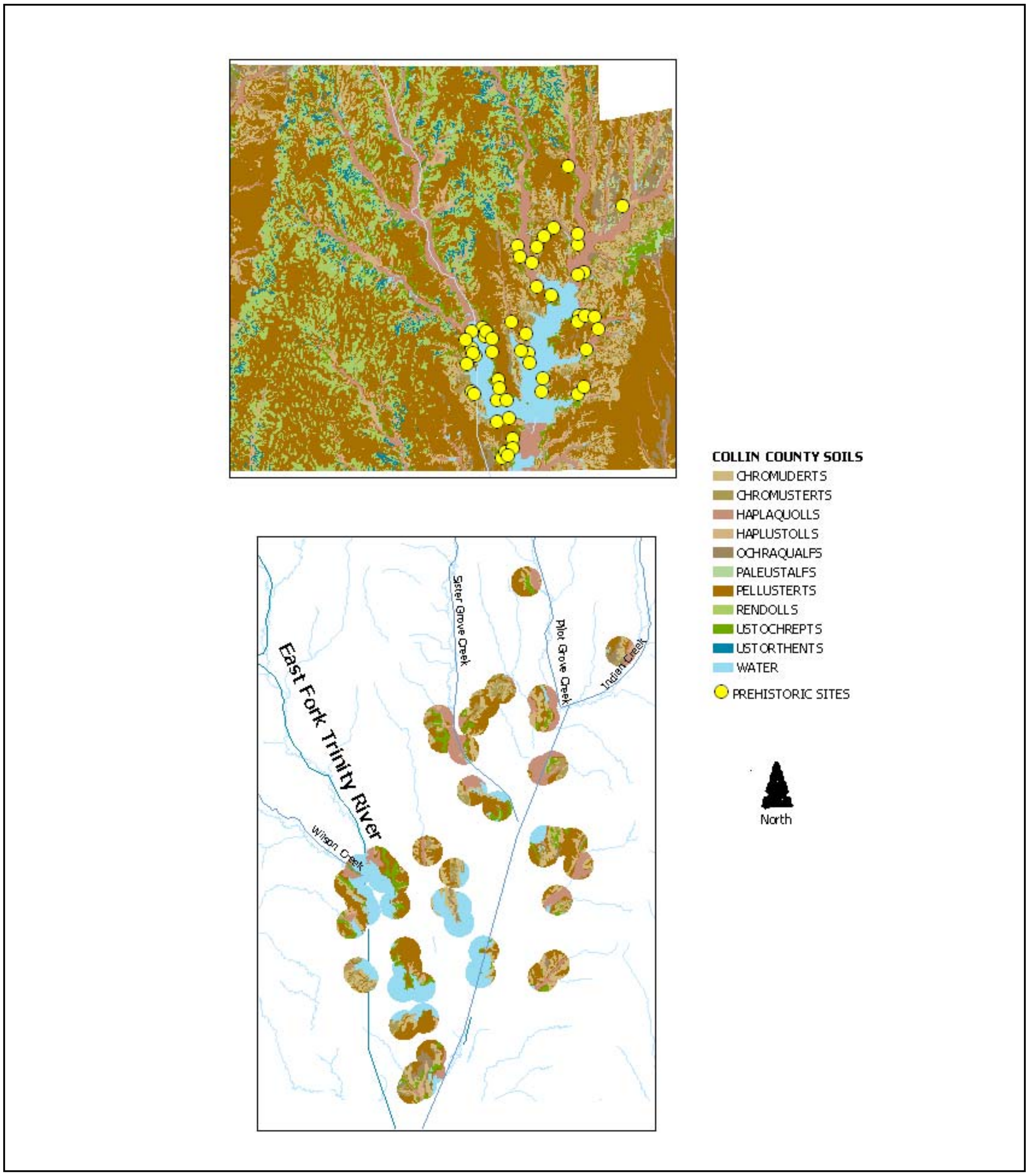

Figure 42. East Fork great group distribution and site catchments.

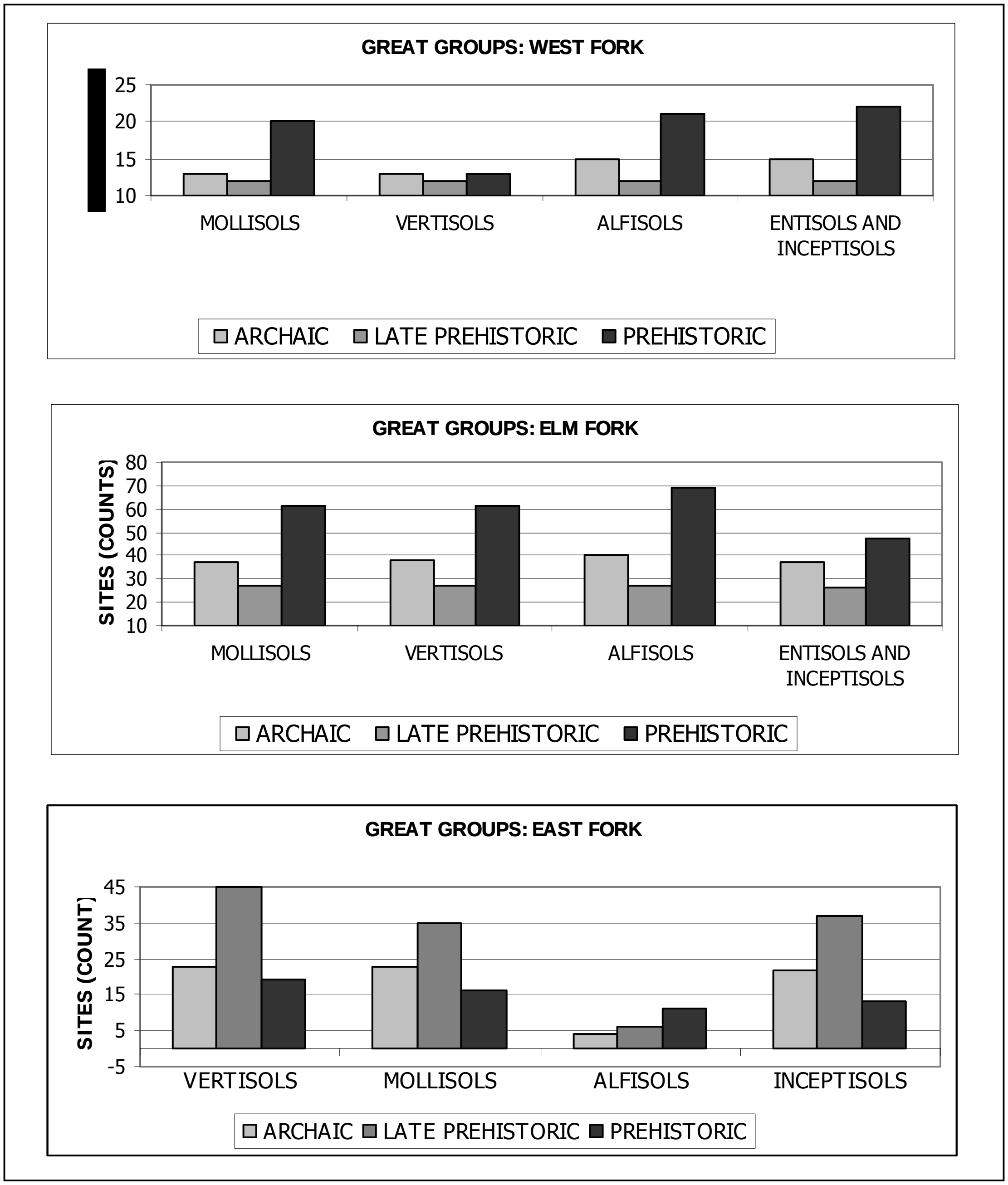

Figure 43. Great groups and time periods.

year-round. Haplaquolls and Haplustolls represent the typical Mollisols that are associated with the Austin Chalk. Hapluquolls are associated with a wetter environment then the Haplustolls probably indicating a closer proximity to the proximal water resources. Higher organic content is associated with these taxonomic units which is attributable to vegetation associated with the characteristic prairie setting.

Comparatively East Fork sites provide a significant contrast to the West and Elm Fork of the Trinity. The East Fork is dominated by Vertisols with a secondary presence of Mollisols and tertiary presence of Alfisols regardless of change through time (figure 43). In relation to this it is interesting to note that multi-component sites tend to have a fairly equal distribution of great groups indicating that these populations were probably strategically selecting base camp locations in areas that provided access to the highest diversity of vegetal resources. On the other hand single component (figure 44) site catchments all contain Vertisols. West Fork single component sites show more variation in the great groups within their respective catchments whereas the multi-component sites have more of an equal distribution of great group types with a slightly greater emphasis of Alfisols. Given that these sites are associated with sandstone settings this situation is anticipated. In addition, the number of sites situated on the ecotone, along the Elm Fork, there is a fairly equal distribution of great groups within the site catchments regardless of occupation frequency (figure 44). Soils provide a situation that is quite different from the more generalized categories. This variable has much more overlap than any other due to the level of detail it provides. In all cases site catchments contain more than one soil series and more than one great group.

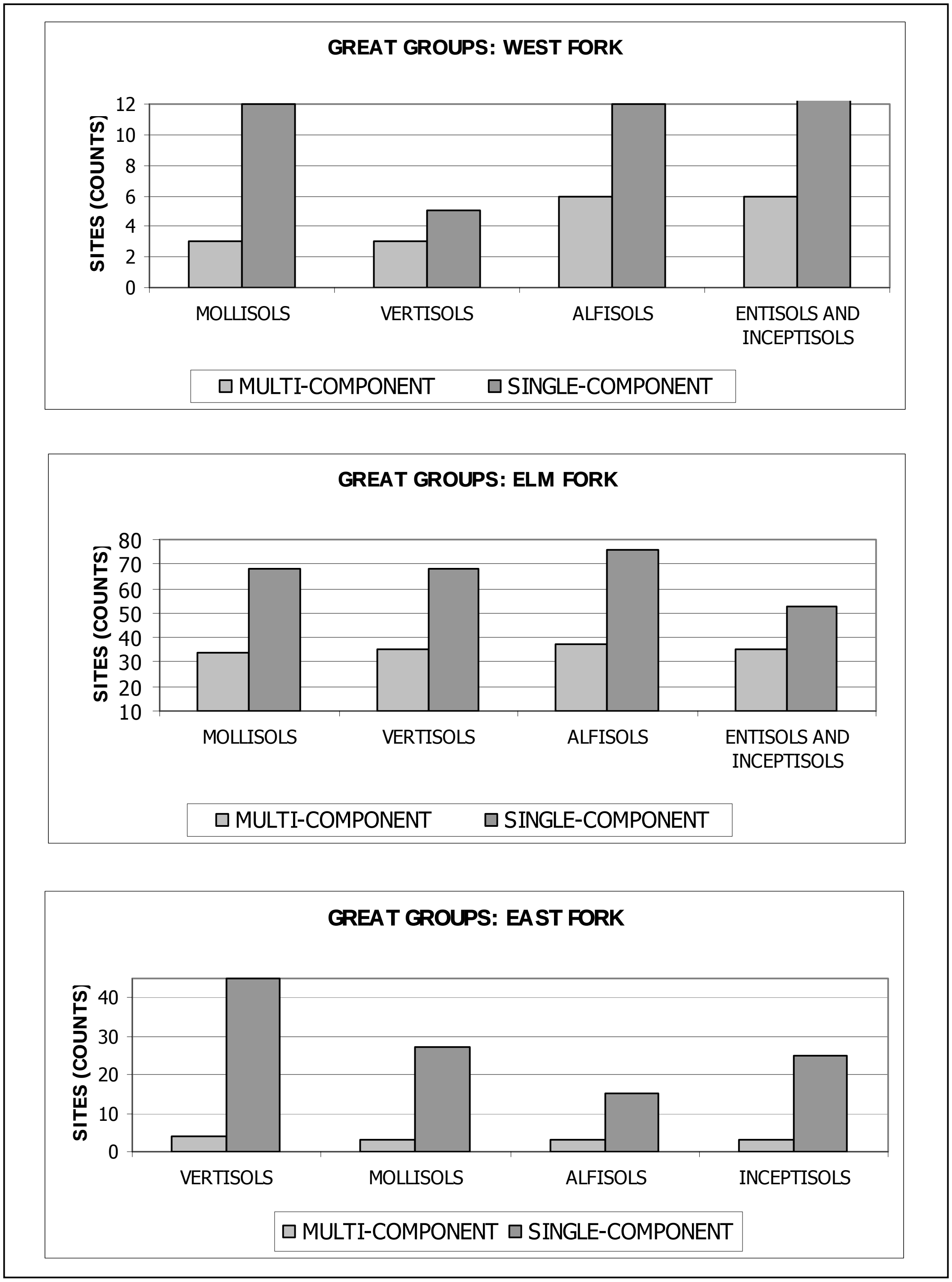

Figure 44 Great groups and occupation frequency.

<u>Soils: Soil Settings</u>

Soil settings in the Elm and West Fork are fairly similar. Due to the level of detail provided by the soil surveys the East Fork is not included in this portion of the analysis. The most dominant groups are clay-rich and loamy settings. Sandy soils for the most part have a high clay content which has created soils that are loamy in character. There appears to be an equal representation of each setting along the Elm and West Forks in relation to change through time (figure 45) and occupation frequency (figure 46).

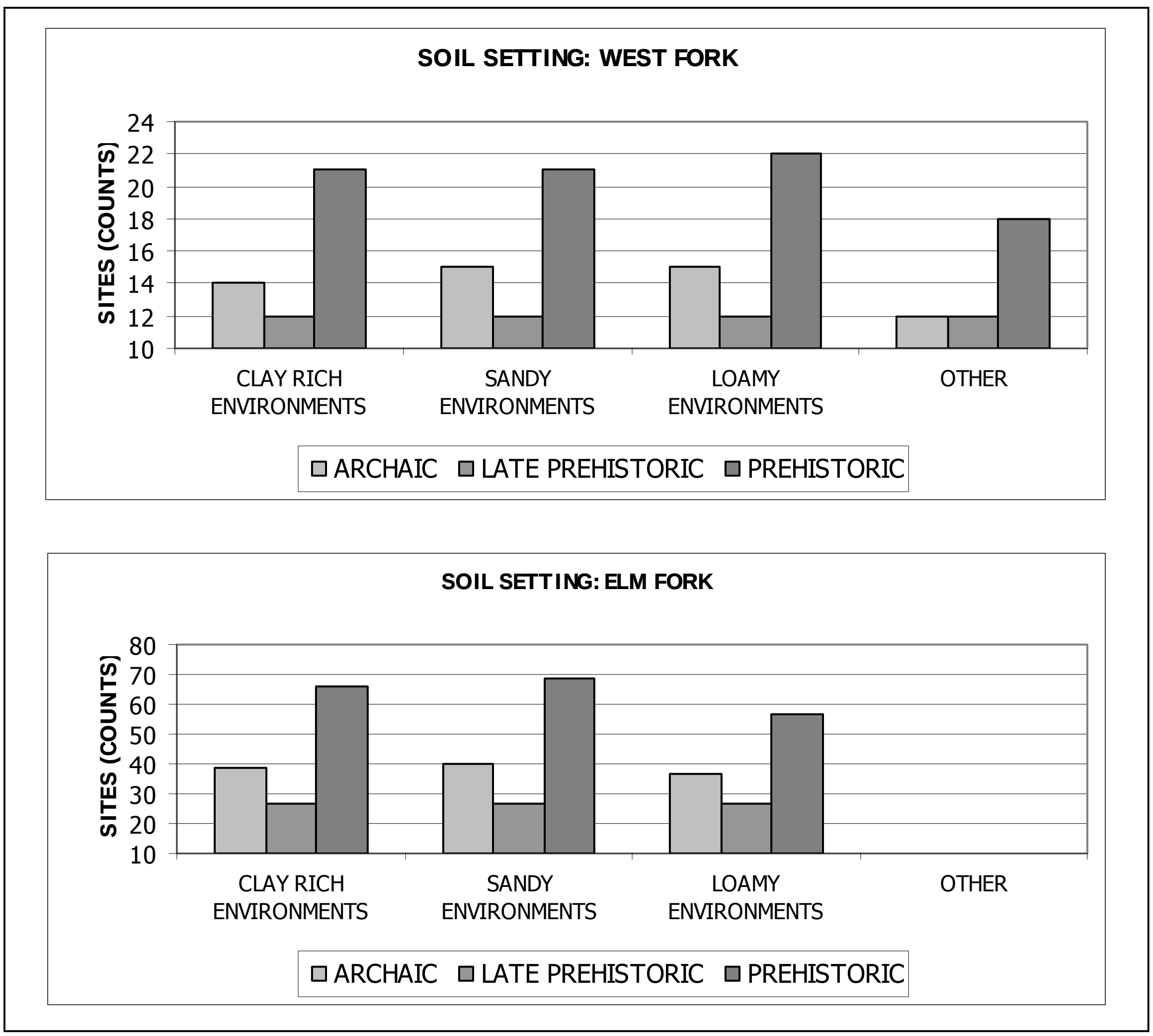

Figure 45. Soil settings and time periods.

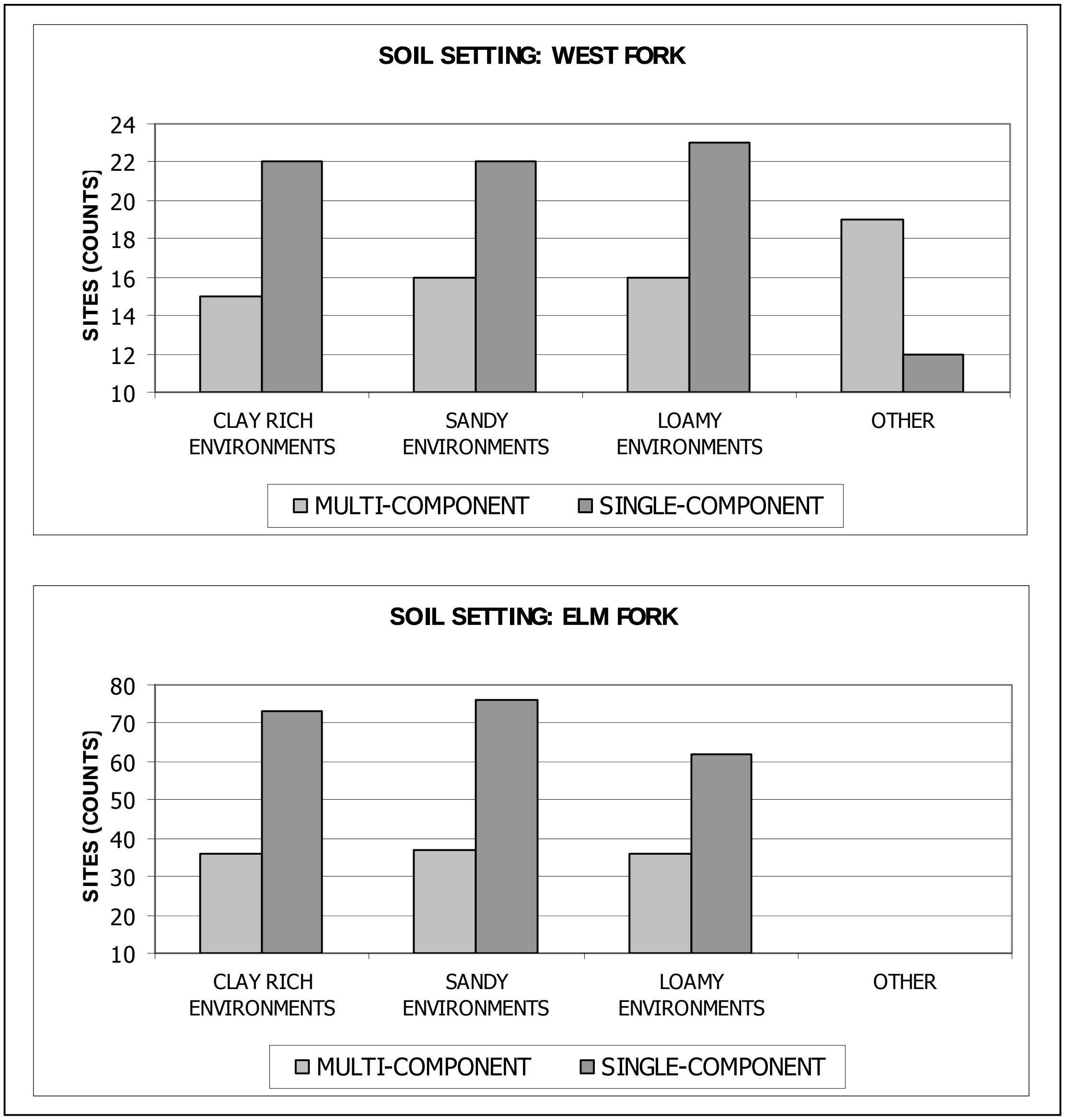

Figure 46 Soil settings and occupation frequency.

Soil settings from the West and Elm Forks reflect the utilization of eco-tonal settings. These characteristic settings are essentially the basis for vegetation correlations. As such, the frequency of sites associated with a given soil setting provides important information regarding prehistoric preferences of habitat. The general categories illustrated here are intended to show overall trends. Interpretive views are available when this data is evaluated in correlation with the types of associated economic values.

Soils: Economic Interpretations

Economic interpretations for soils provide enlightening information in relation to site distribution. While there is not a statistically significant difference, between site catchments, there are similarities that indicate strategic selection of locations on the landscape that provide important resources to sustain prehistoric populations. One of the few statistically significant results between site catchments are associated with soil settings. This is directly related to the particular economic value of the site catchment as established by the current research. Mapping of the distributions of economic value with respect to edibility, medicinal value, supplemental value, wildlife and vegetation provides visual cues that reveal patterns. These patterns can be viewed in relation to change through time, occupation frequency, density, projectile point distribution and a variety of other facets. A series of maps are provided in the appendix (A1-A22) to illustrate the relationships of the sites to the resources relative to their interpretive values as site location changes through time. Maps provided in this section illustrate relationships between soil values and occupation frequency, as well as, site locations and varying degrees of economically valuable resources. Graphs provided in this section summarize data extracted from the site catchment areas in relation to occupation frequency and change through time.

Sites are evaluated in relation to the relative economic values represented within the catchment areas. Soils data are recoded to illustrate (figure 47) the overall distribution of edible, medicinal and supplemental vegetation patterns on a larger scale in relation to the site locations. Darker values indicate a lower potential for these specific types of

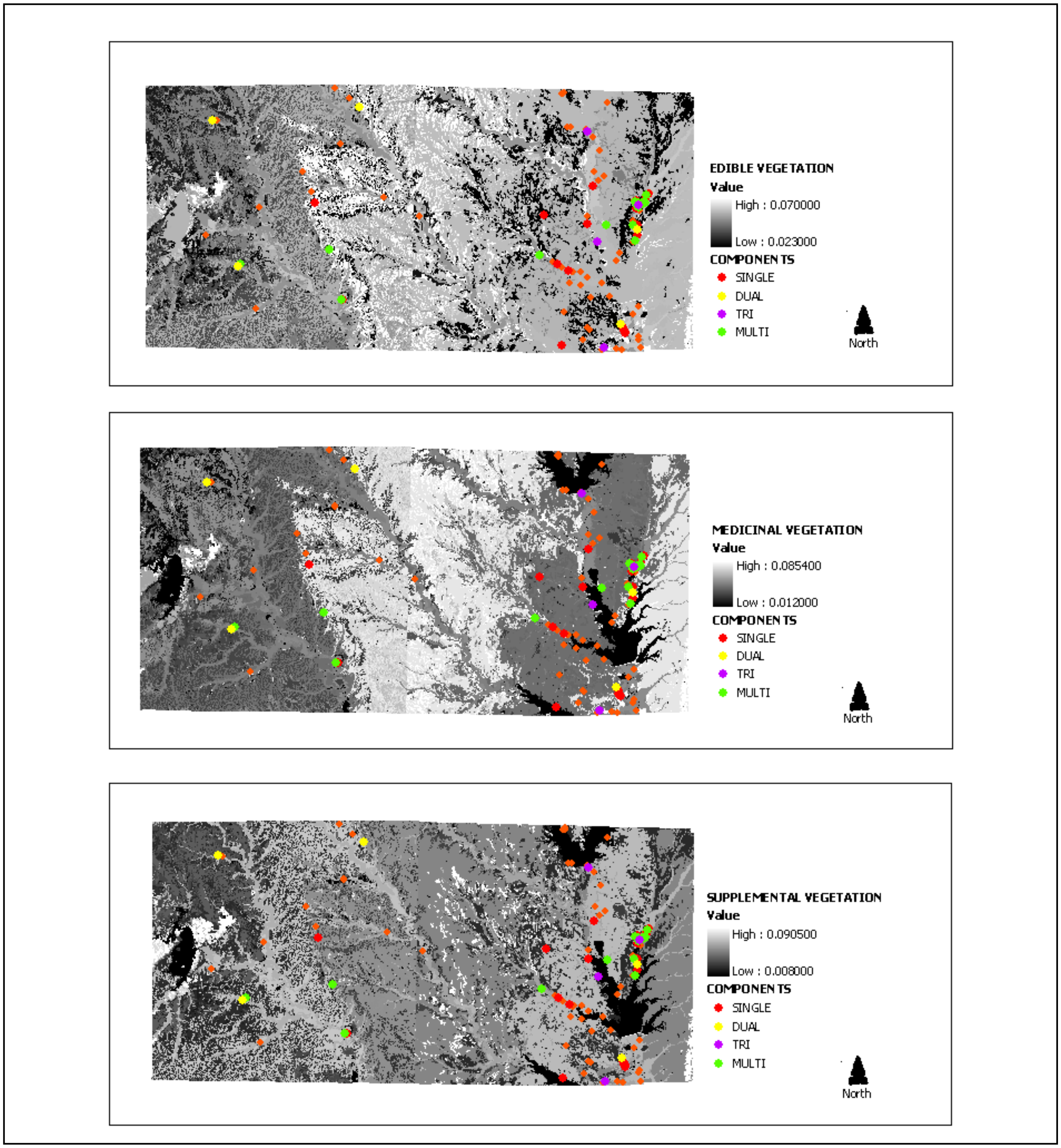

Figure 47. Economic values and prehistoric components.

vegetation whereas the lighter values indicate an abundance of the associated resources. The lower values are weighting the sample due to the lack of soils data where reservoirs now exist. Change through time with respect to these variables is illustrated in the appendix. Overall, there is a fairly similar distribution of each group within the site catchment areas although the abundance varies.

Sites that contain evidence of repeated occupation (figure 48) indicate a strong presence of edible vegetation followed by supplemental and medicinal along the West Fork and the Elm Fork. However, the Elm Fork values reveal a relatively higher edibility factor. With respect to change through time (figure 49) similar patterns occur. During the Middle Archaic and Late Prehistoric I medicinal values rise above supplemental values along the Elm Fork. The East Fork situation is similar except during the Late Prehistoric I era medicinal values notably jump above the supplemental values reaching almost the same level as the edibility values and then gradually decrease. It is likely that these locations provided seasonal resources that were complimented by a variety of edible and medicinal plants paired with woodland resources as reflected by supplemental values. The supplemental value category primarily reflects wood utilization. As such, sites situated in the Cross Timbers are significantly weighted with respect to the supplemental category. The same situation is true for sites located along riparian corridors where woody vegetation tends to aggregate. Fluctuations through time indicate some type of pattern in relation to the correlation between particular economic values and site locations. This could be attributed to climate change, territoriality, seasonality or simply cultural preferences.

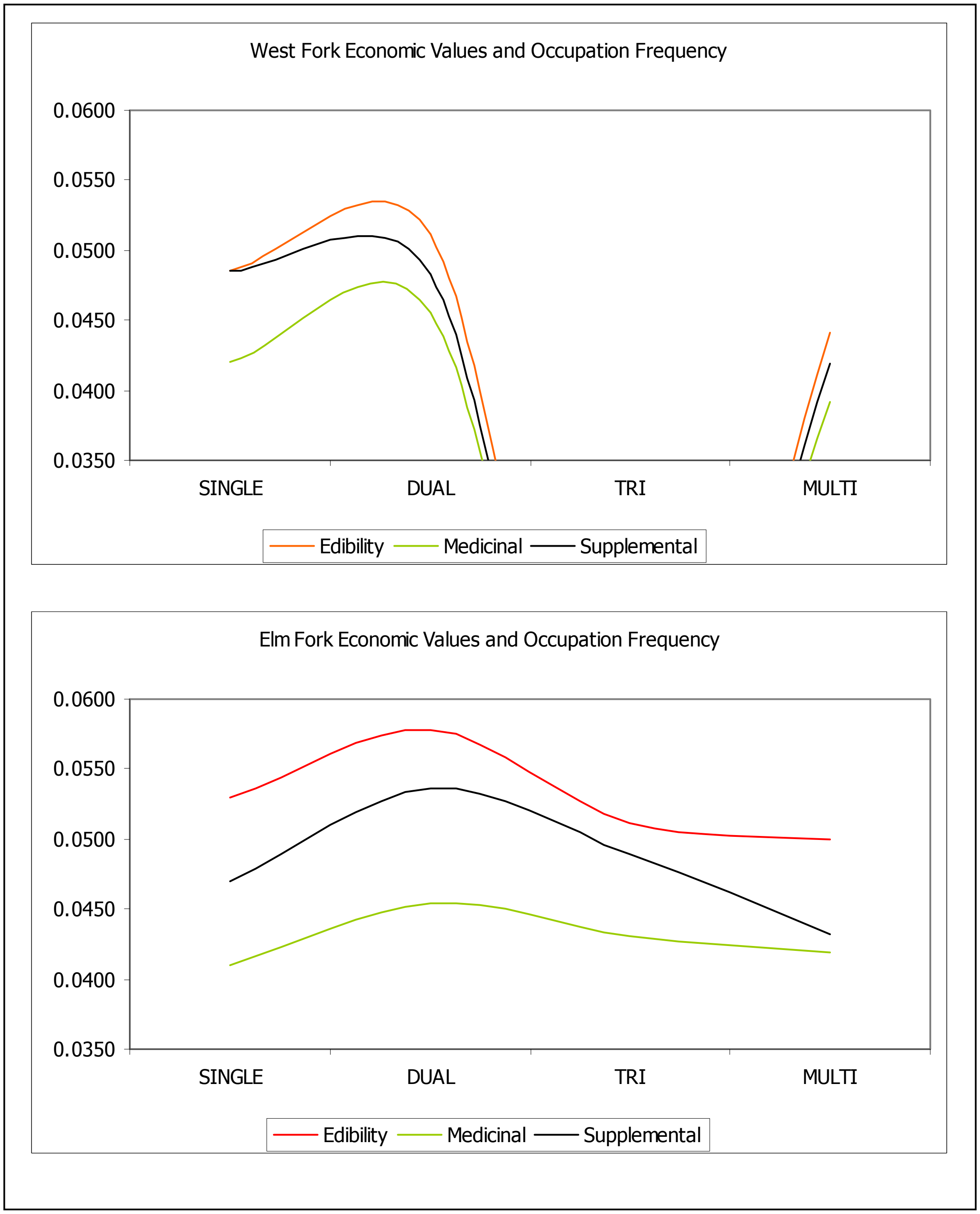

Figure 48. Economic values and occupation frequency.

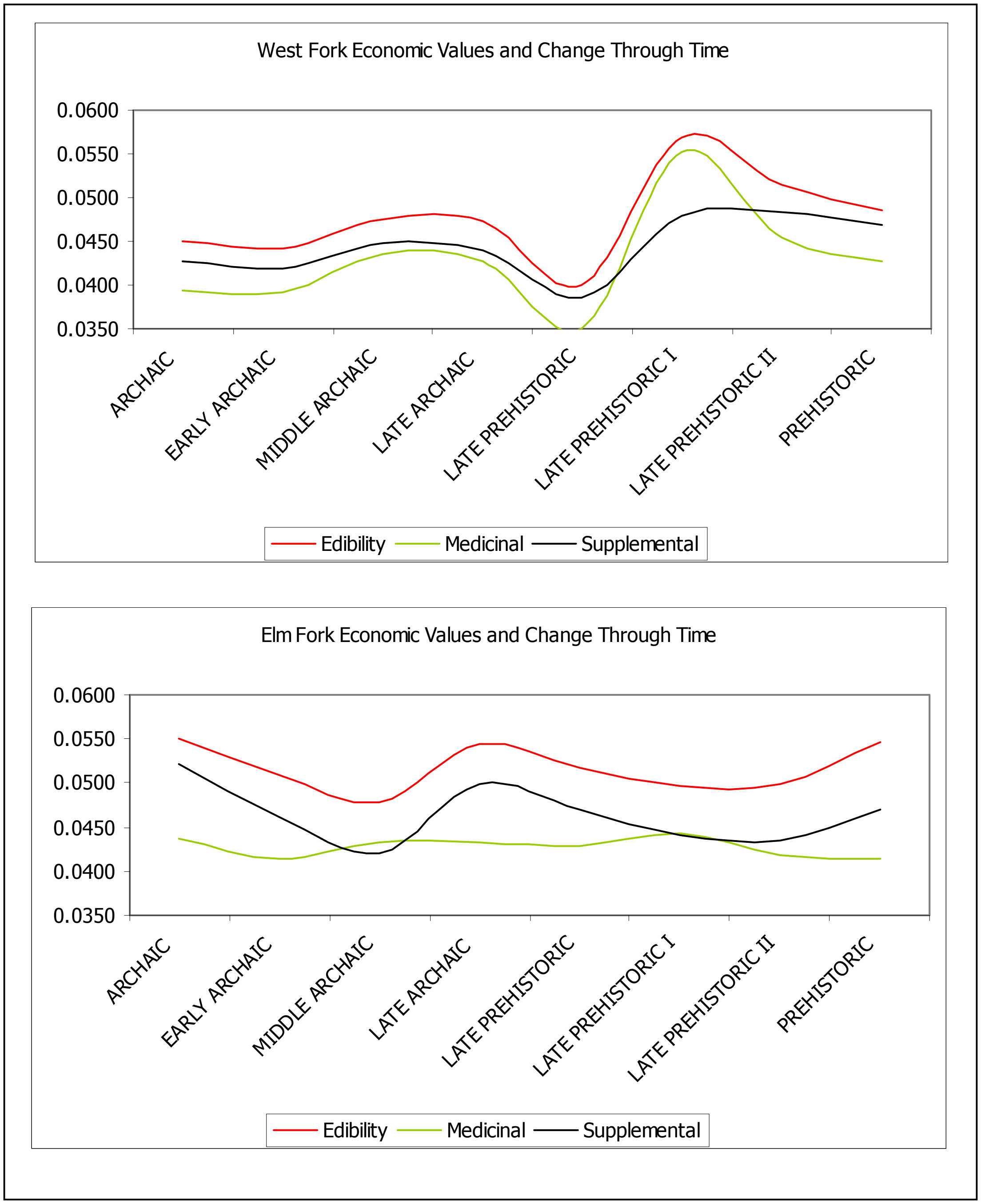

Figure 49. Economic values and time periods.

Mapped distributions of potentials for vegetation types given certain soil combinations indicate relationships between site locations and concentrations of grains and seed crops, grasses and legumes, and wild herbaceous plants (figure 50). This figure illustrates the distribution of soils that have been recoded to represent wild herbaceous plants, grains and seed crops and medicinal grasses/legumes. The darker values indicate a lower potential for these types of vegetation whereas the lighter values indicate an abundance of these resources. Lower values are weighting the sample due to the lack of soils data where reservoirs now exist. Change through time in relation to these variables is illustrated in the appendix.

All of the sites in the study area appear to have a stronger relationship with wild herbaceous plants than any other vegetation group. These types of plants are primarily associated with forested settings. This relationship is not surprising given that prehistoric populations appear to have aggregated in the Cross Timbers and in riparian environments. Grains and seed crops are secondary in relation to change through time yet tertiary in relation to occupation frequency. This is an interesting relationship that may indicate that diagnostic sites are found more often in association with this type of vegetation whereas single occupancy sites (mostly non-diagnostic) are situated in grassier areas. West Fork sites have a strong correlation with Grasses and Legumes given that there are sites situated on the ecotone near prairie settings. This type of vegetation is in the proximity of the Elm Fork sites although it is not concentrated in the site catchment areas. Overall, relationships between the vegetation types remain fairly similar with respect to occupation frequency (figure 51) and time period (figure 52).

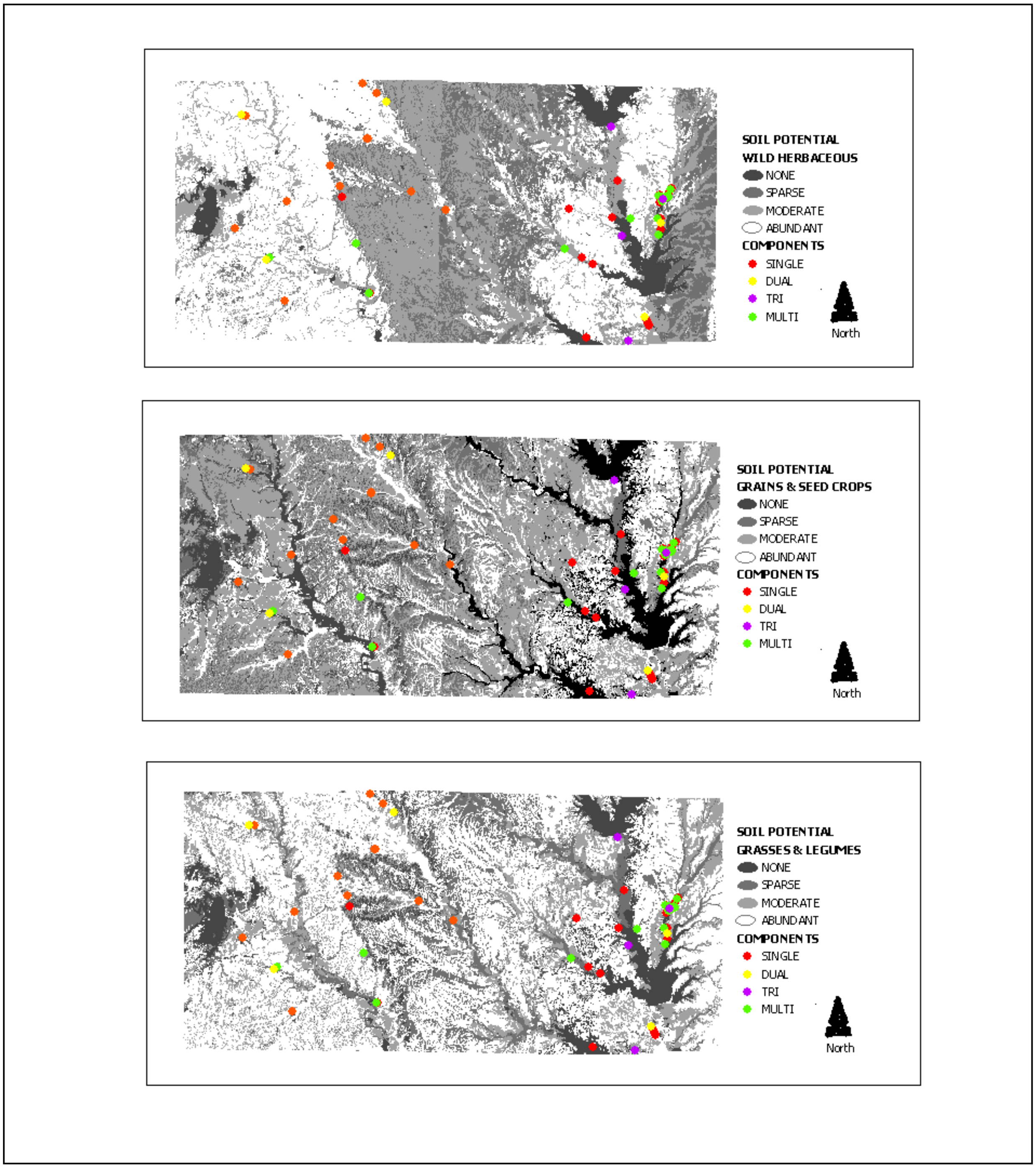

Figure 50. Vegetation potential and prehistoric components.

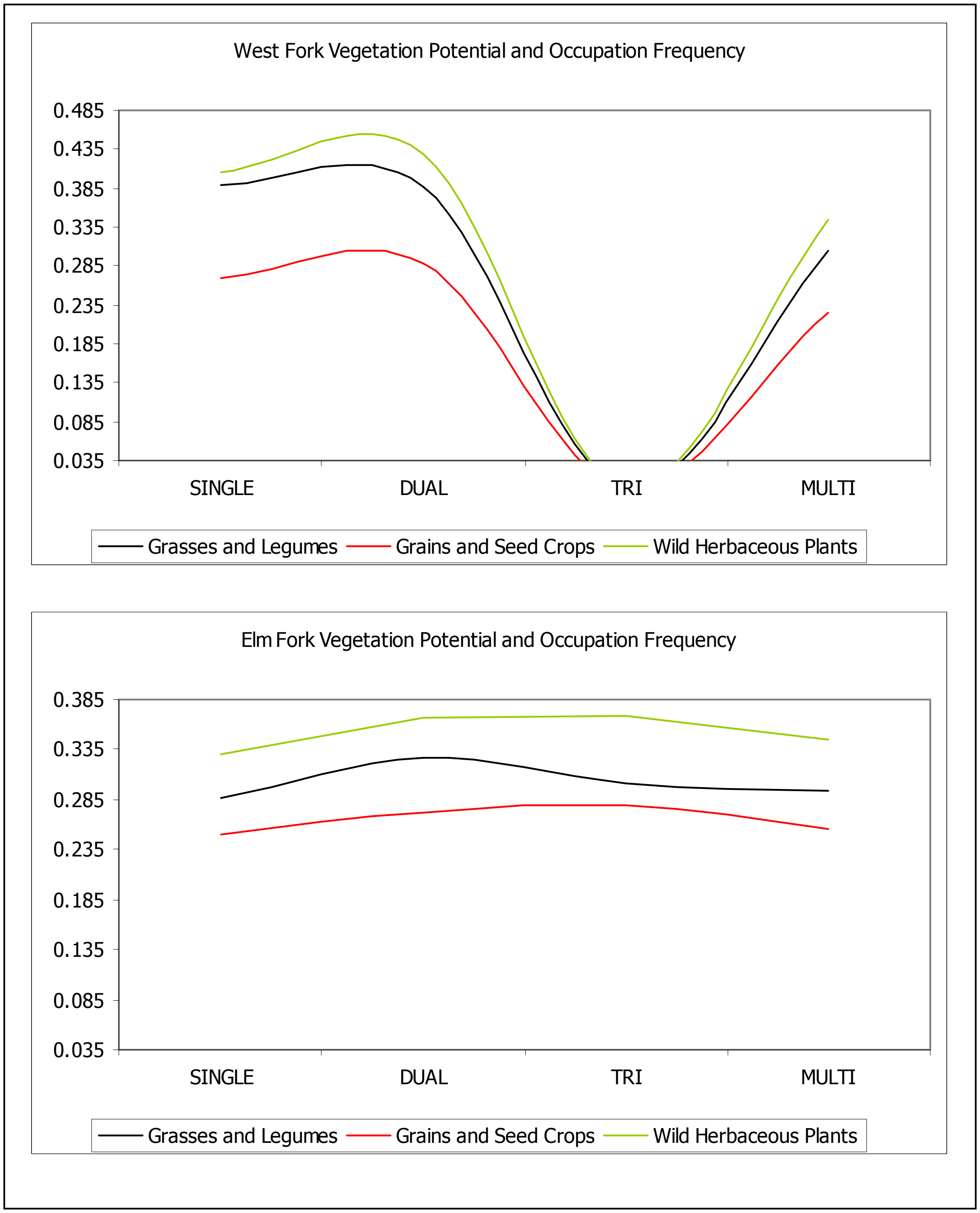

Figure 51. Vegetation potential values and occupation frequency.

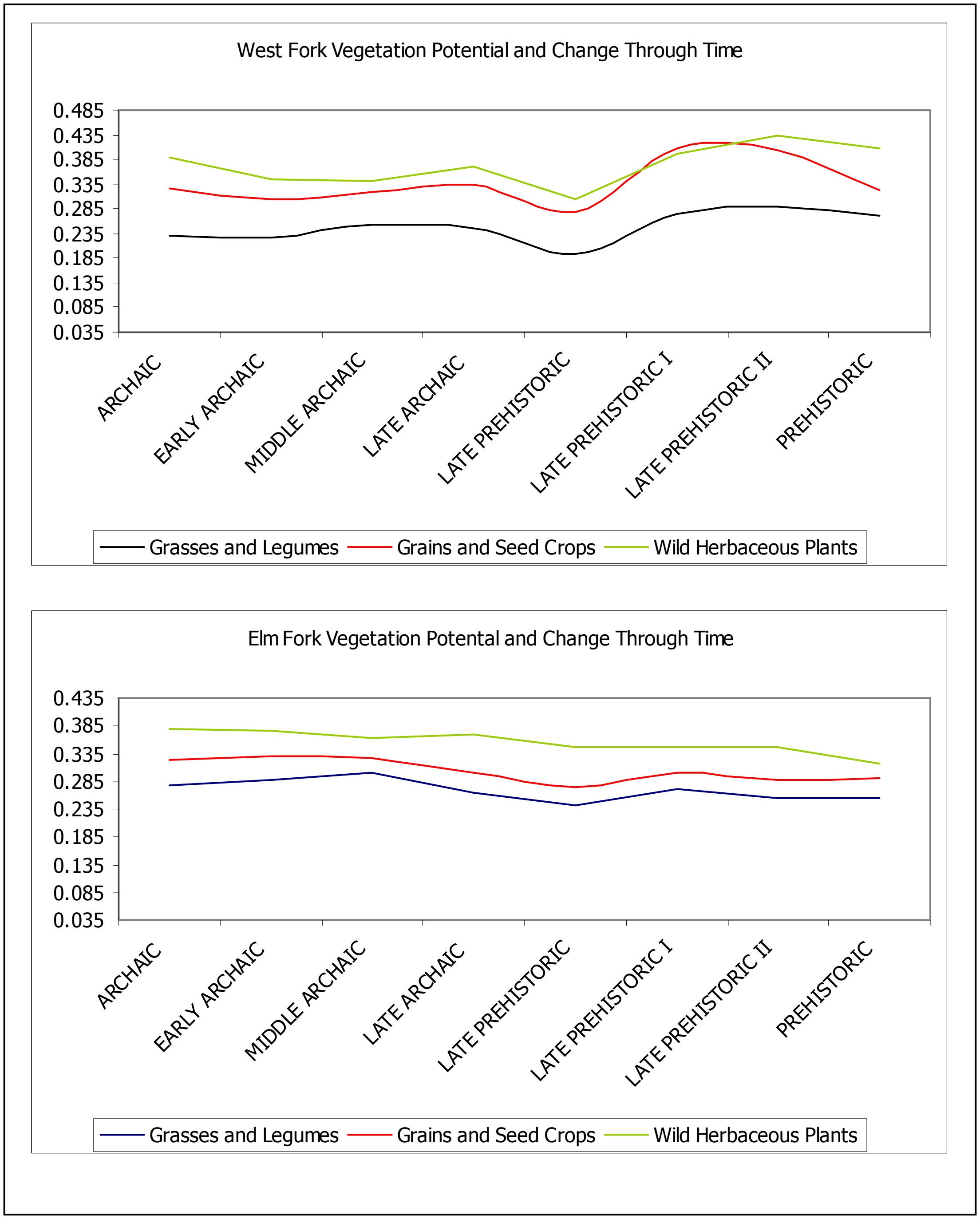

Figure 52. Vegetation potential values and time periods.

Soil potential to provide habitat for certain types of wildlife as estimated by soil survey data provides a view of another facet of potentiality. Mapped values reveal differential distribution that indicates that certain types of wildlife are more likely to be concentrated in particular locations (figure 53). This figure illustrates the distribution of soils that have been recoded to represent relative potential for rangeland, openland and wetland wildlife habitat. The darker values indicate a lower potential for these types of vegetation whereas the lighter values indicate an abundance of these resources. Lower values are weighting the sample due to the lack of soils data where reservoirs now exist. Change through time in relation to potential for wildlife habitats is illustrated in the appendix.

Sites that contain evidence of variable occupation frequency follow similar trends (figure 54). This is probably due to sample size combined with the fact that sites are often clustered along the Elm Fork and have overlapping site catchment areas which influence the outcome. Through time there are fairly consistent correlations between site location and openland, wetland and rangeland wildlife habitat (figure 55). Wetland habitat remains fairly low due to the low concentrations of soils associated with these settings. This is not to say that wetland wildlife was not utilized as much as the other types. In this case soil classification is weighting the sample. Riverine corridors are not factored into the distribution of wetland wildlife. Based on the archaeological faunal data it is known that prehistoric populations, in this region, utilized aquatic resources, regardless of the time period. Given the limited sample it is difficult to know if this is the case with all the sites but the proximity to water resources favorably supports this.

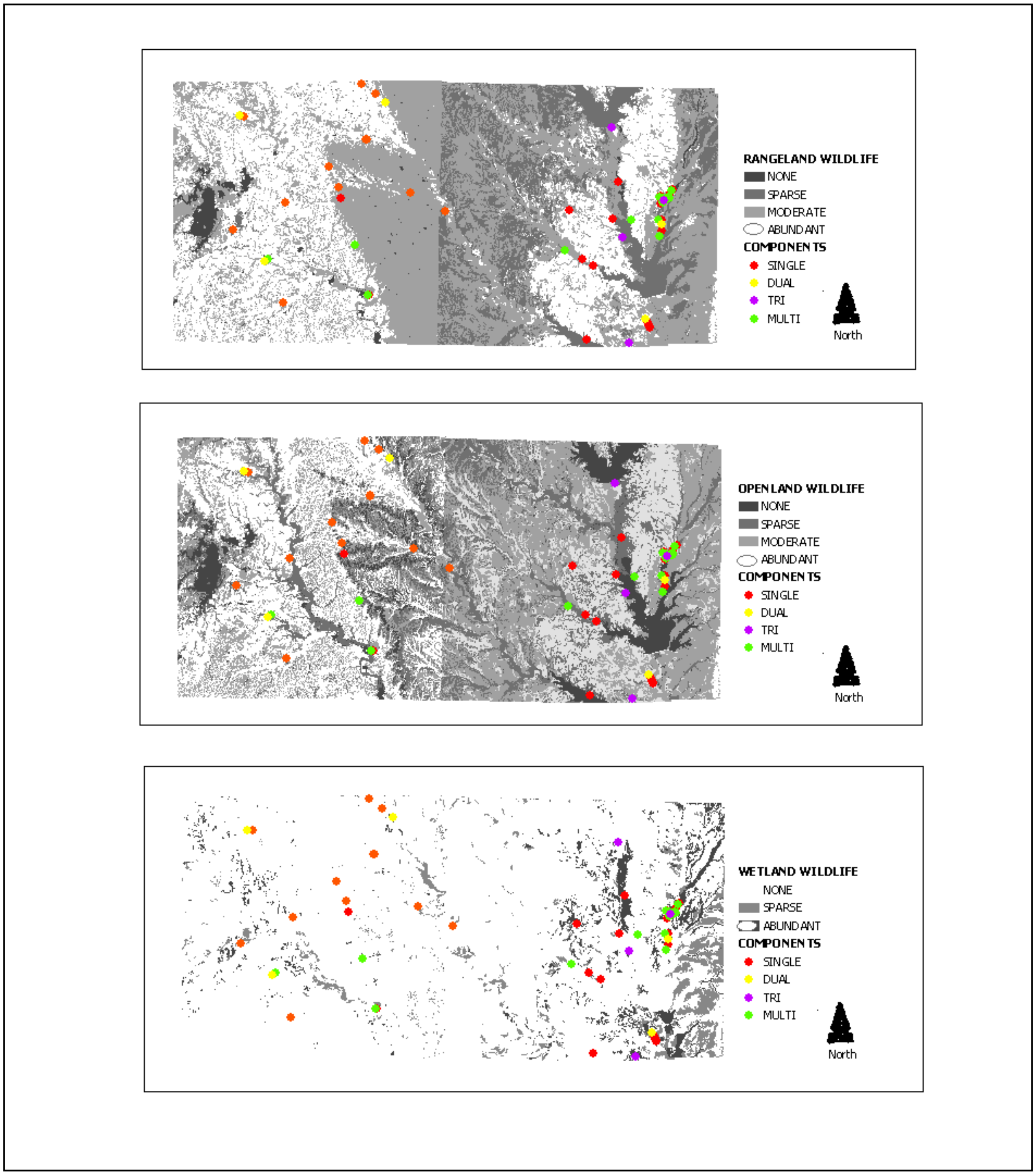

Figure 53. Wildlife potential and prehistoric components.

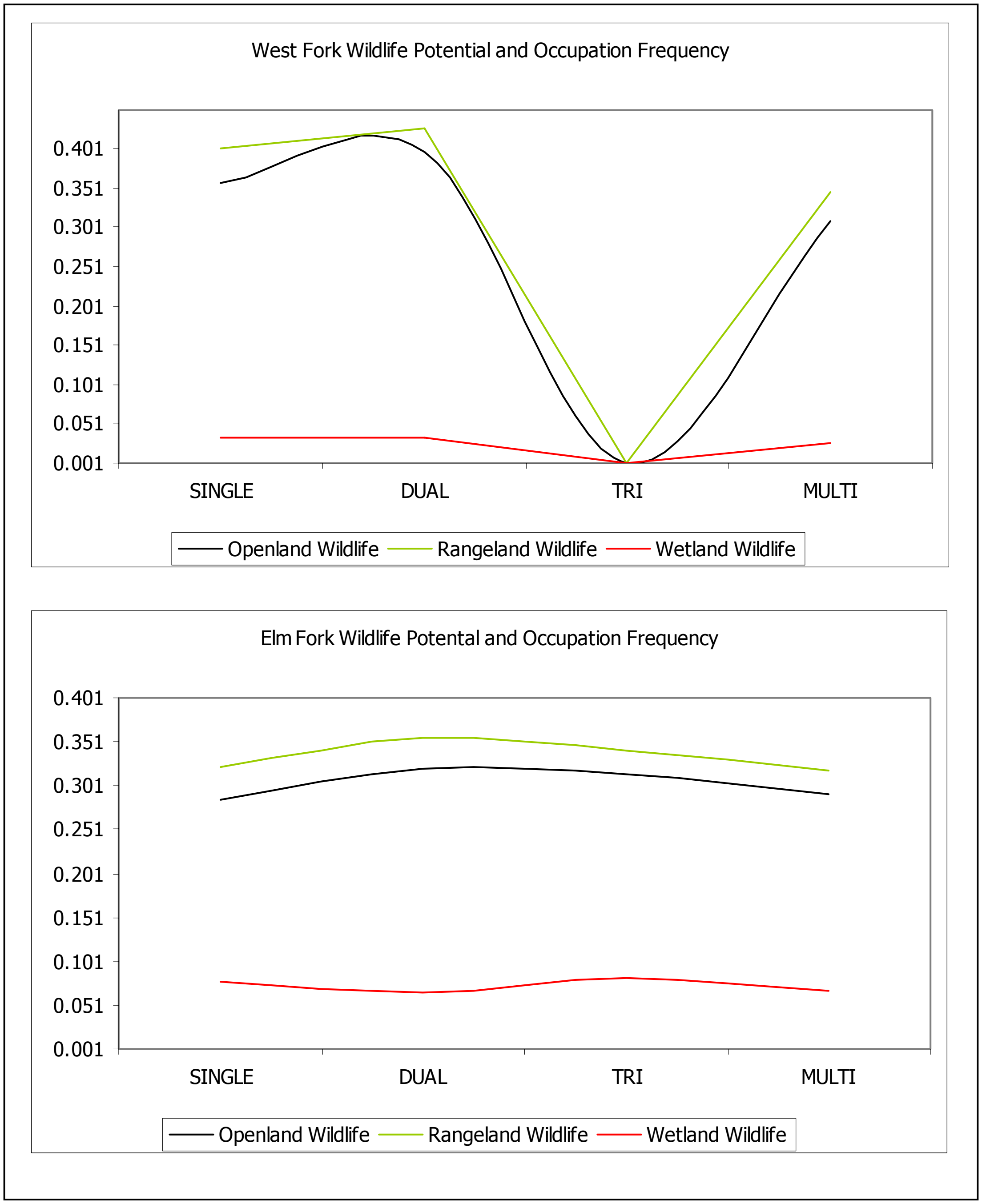

Figure 54. Wildlife potential values and occupation frequency.

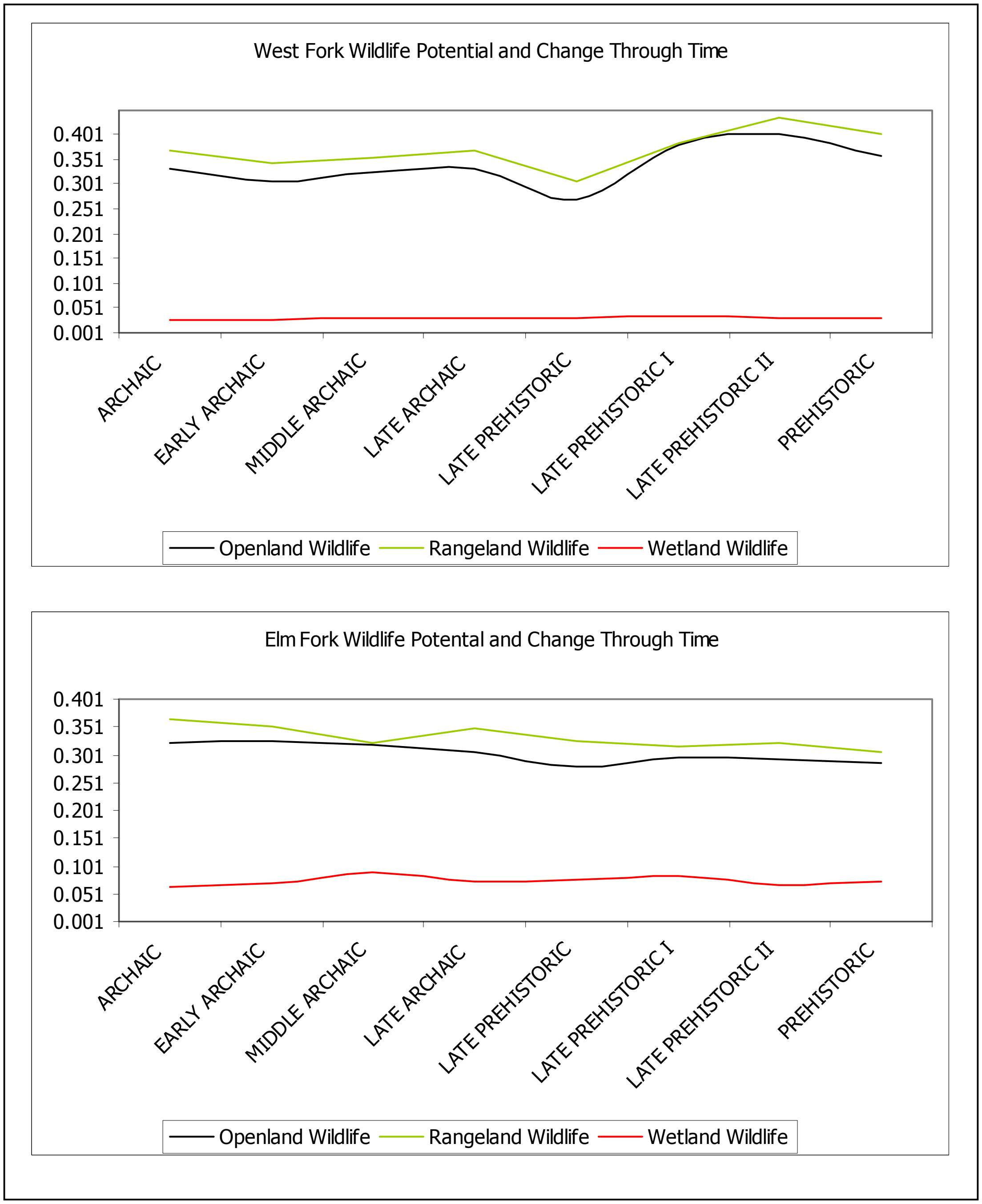

Figure 55. Wildlife potential values and time periods.

Site Catchment Diversity

Sites catchments are measured for relative degrees of diversity based on the proportional presence of soil series contained in the 1km area. Results (figure 39) indicate the largest amount of variability in sites that contain evidence of single occupation. Given the number of sites in this category it is not surprising and in fact anticipated. However, there are considerably less multi-component sites and this group also exhibits increased variability.

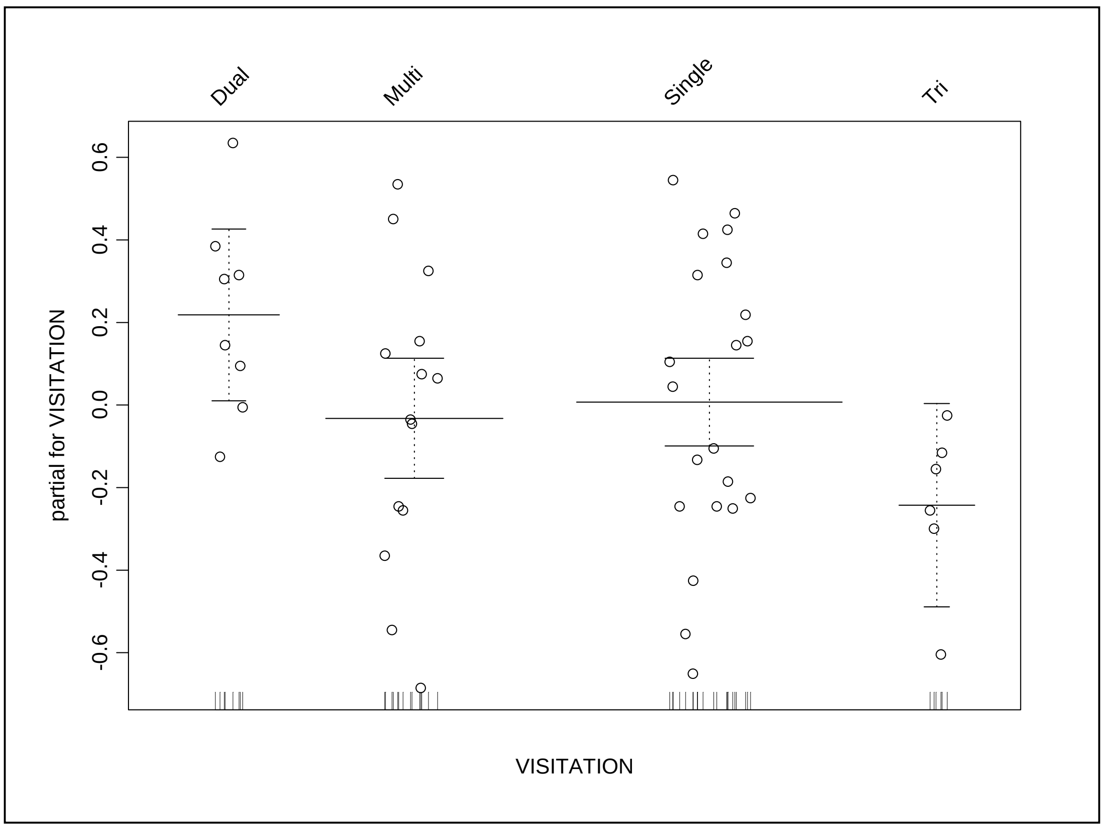

Figure 56. ANOVA comparisons of site catchment diversity and occupation frequency.

With respect to change through time the most significant range of variation occurs with the Late Archaic sites. The results illustrated by the graph (figure 40) indicate that there are expressed changes that occur in relation to site catchment diversity. It is possible that during the Late Archaic populations diversified and enjoyed a greater range of motion. Previous studies have indicated in prior research that patterns of site location indicate a decrease in territorial boundaries during the Late Prehistoric. If these populations were restricted to certain locations under variable climatic conditions there may be relatively less diversity. However, given the character of the region a fair amount of diversity is available within the woodlands, prairies, ecotones and riverine settings such that a certain degree will be continuously present.

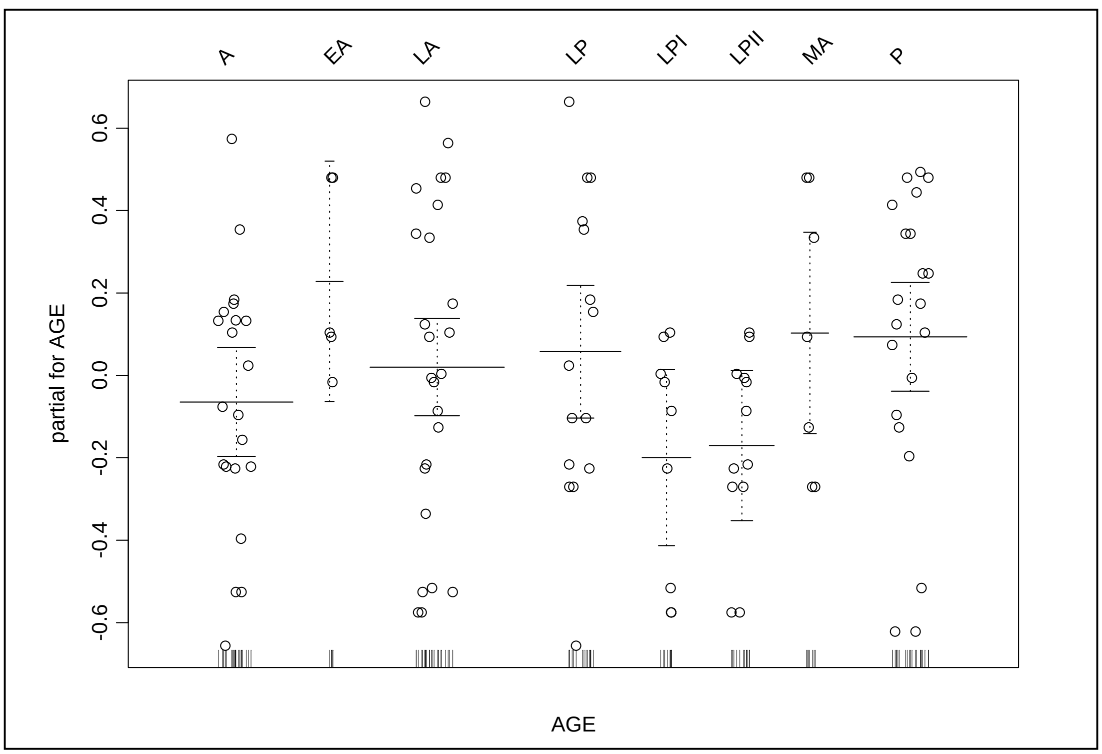

Figure 57. ANOVA comparisons: Site catchment diversity and time periods.

Climatic Interpretations

Climatic conditions are often referred to as explanatory mechanisms for culture change. Recoded soils data based on pollen records reflects relative vegetal abundance given various climatic conditions (figure 55). When these data are mapped correlations

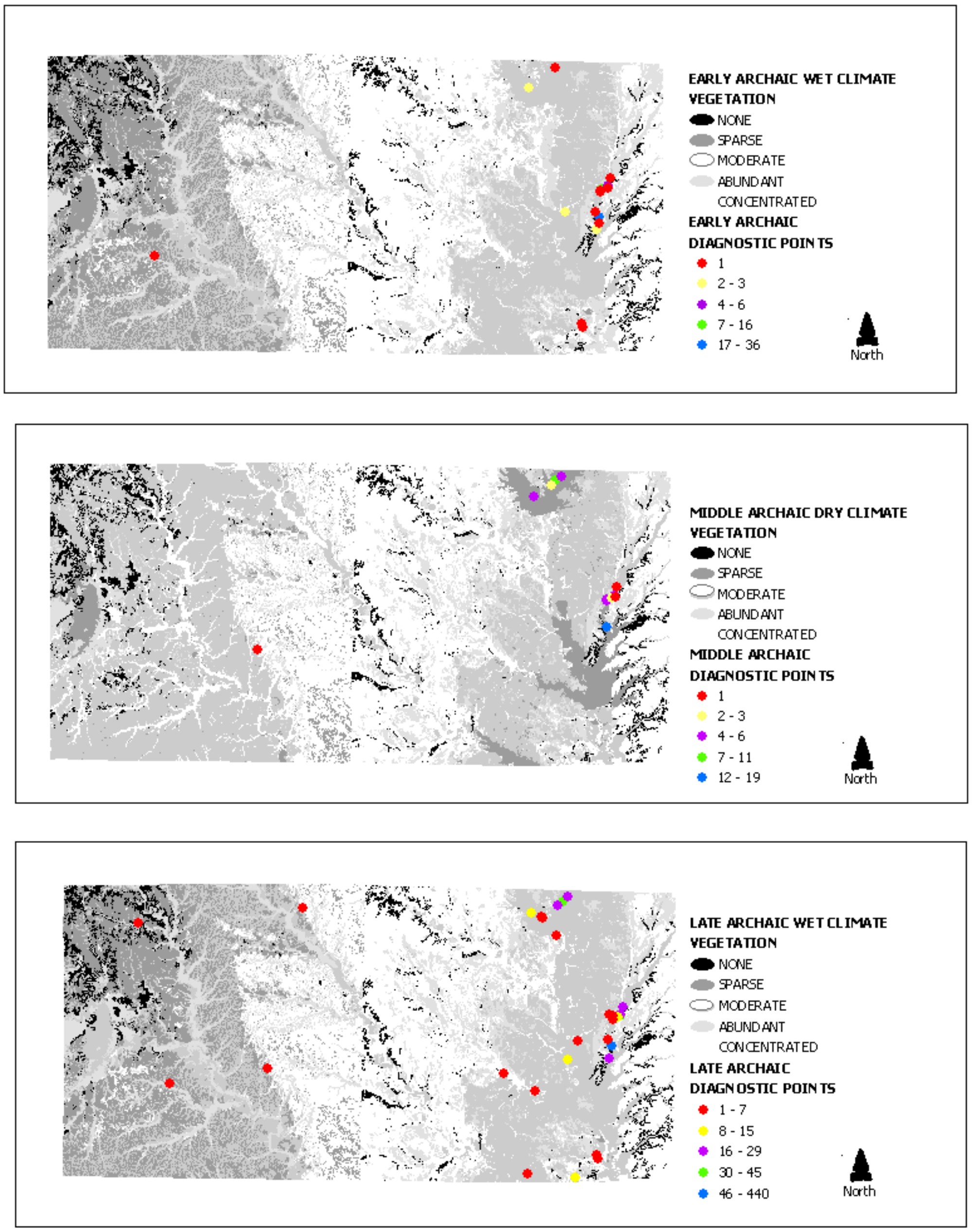

Figure 58a. Distribution of climatically abundant vegetation families.

can be drawn in relation to site distribution as it changes through time (figure 55 and figure 56). The working assumption is that populations would have been drawn to locations that contain abundant opportunities of valuable resources given the appropriate climatic conditions. This is a generalized model that could be calibrated with more detailed data. However, due to time constraints it is generalized for the purpose of illustration. If these patterns are accurate then it is suggested that sites that were selected by prehistoric populations would have provided a fairly stable economic resource base in spite of climatic fluctuations. Even though changes through time are apparent site locations are consistently situated near abundant resources.

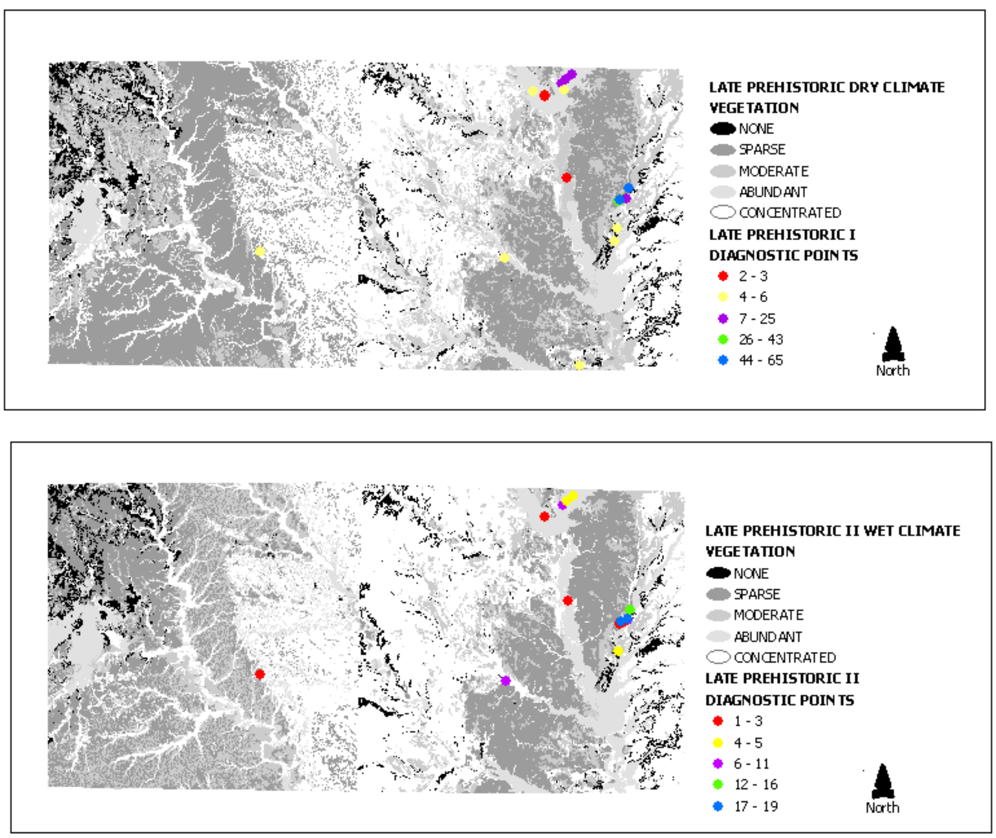

Figure 58b. Distribution of climatically abundant vegetation families.

Site Activities and Density

Prehistoric activities are inferred based on the types of tools recovered from given site locations. When they are viewed in relation to the various characteristics of the site catchments the dynamic inter-relationships between prehistoric activities and the environment within which they were performed can be evaluated. Sites that contain evidence of tool manufacturing activities, food preparation, hunting activities and lithic scatter are predominantly represented in fluvatile and alluvial deposits. In some cases sites contain evidence of all four activities and as such would be considered to be base camps. However, the degree of activity that is occurring in a given area can be cross-checked with the level of occupation density. Correlations indicate at least twelve site locations exhibit intensive occupation in upland and terrace settings that are associated with fluvatile and alluvial deposits. Ephemeral sites are primarily correlated with lithic scatter which are situated in terrace and upland settings situated on fluvatile, alluvial and sandstone deposits along riparian corridors in the Cross Timbers. Activities represented at West Fork sites indicate an increased frequency of hunting during the Archaic and equal distribution of tool manufacture, hunting and food preparation during the Late Prehistoric. Given that prehistoric sites are non-diagnostic sites defined by lithic scatter this activity is pronounced for both the West and Elm Forks during the general Prehistoric. Along the Elm Fork hunting and food preparation are predominant during the Archaic with a similar pattern accompanied by a slight increase in food preparation occurring during the Late Prehistoric. Activities in relation to the variables addressed in this section are summarized by a series of graphs (Figures 59-65).

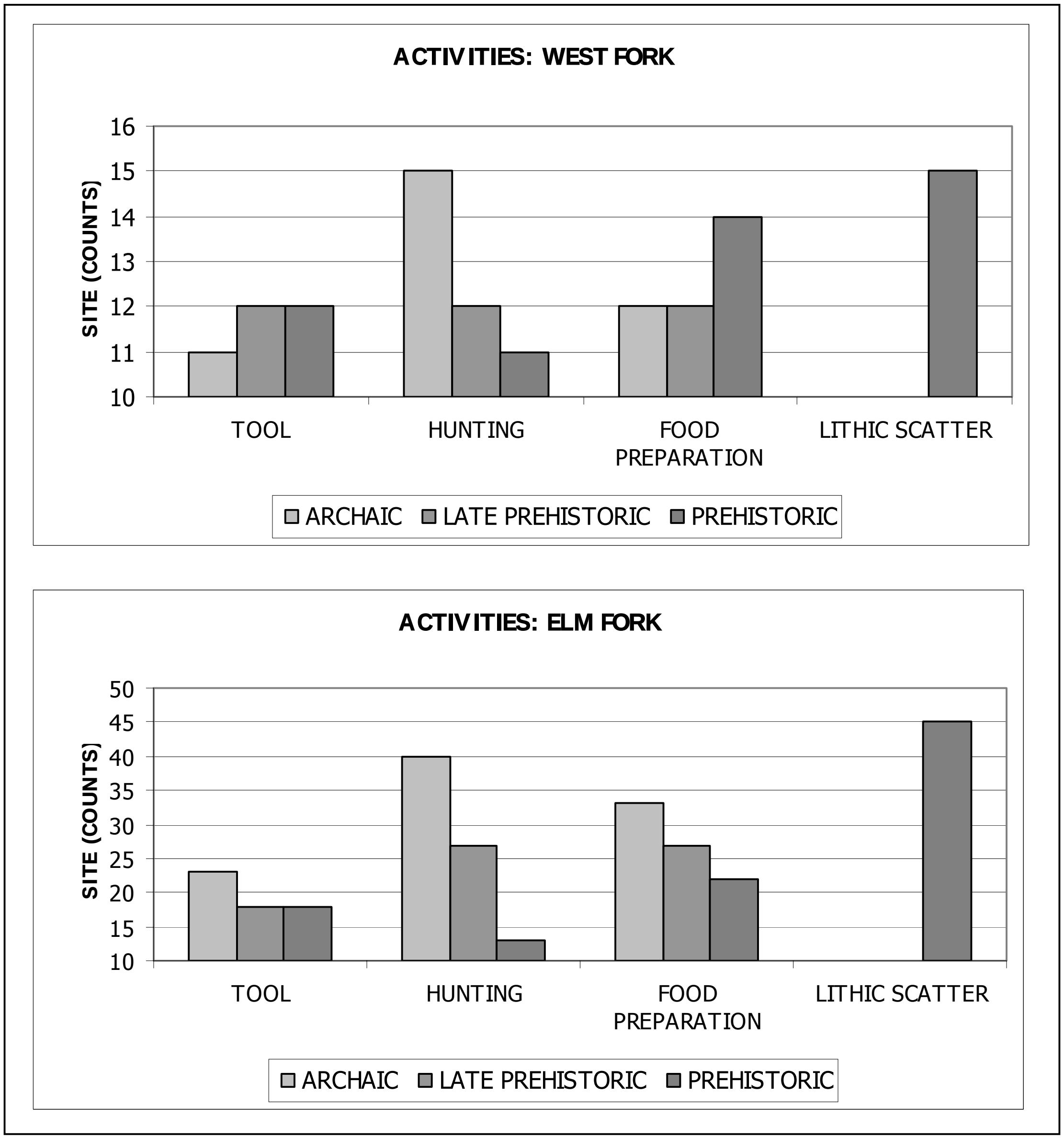

Figure 59. Prehistoric activities and time periods.

Relationships between the number of sites that contain evidence of each particular activity is illustrated (figure 59). This data is biased by the number of surface sites that contain limited evidence combined with the abundant data recovered from excavated sites. It would appear that there is a decrease of activities from the Archaic to the Late Prehistoric and very little lithic scatter during the Archaic along the Elm Fork. This is not particularly the case. Lithic scatter, for example is a category that includes sites that contained non-diagnostic lithic scatter. As a result, this category is composed of non-diagnostic single component prehistoric sites. The same situation is true when occupation frequency (figure 60) is considered. Future research with a better sample would help solve this problem.

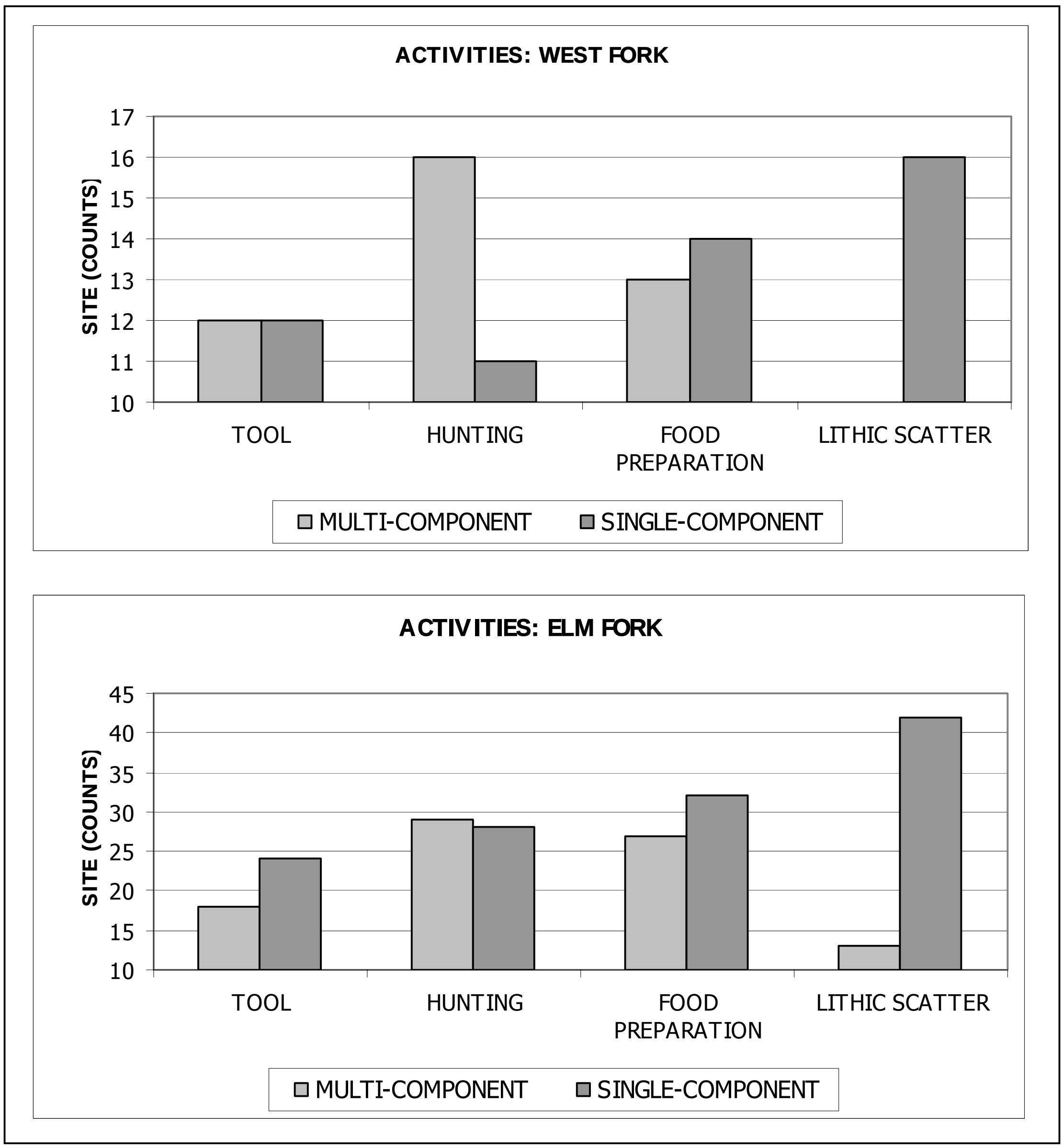

Figure 60. Prehistoric activities and occupation frequency.

Most of the activities (figure 61) are consistently associated with water deposited sediments and sandstone geological settings. Repeated testing indicates a preference for these locations. Shale settings are followed by limestone. A similar pattern emerges with respect to occupation density (figure 61). Many of the referenced site catchments contain both sandstone and water deposited sediments such that overlap should be taken into account.

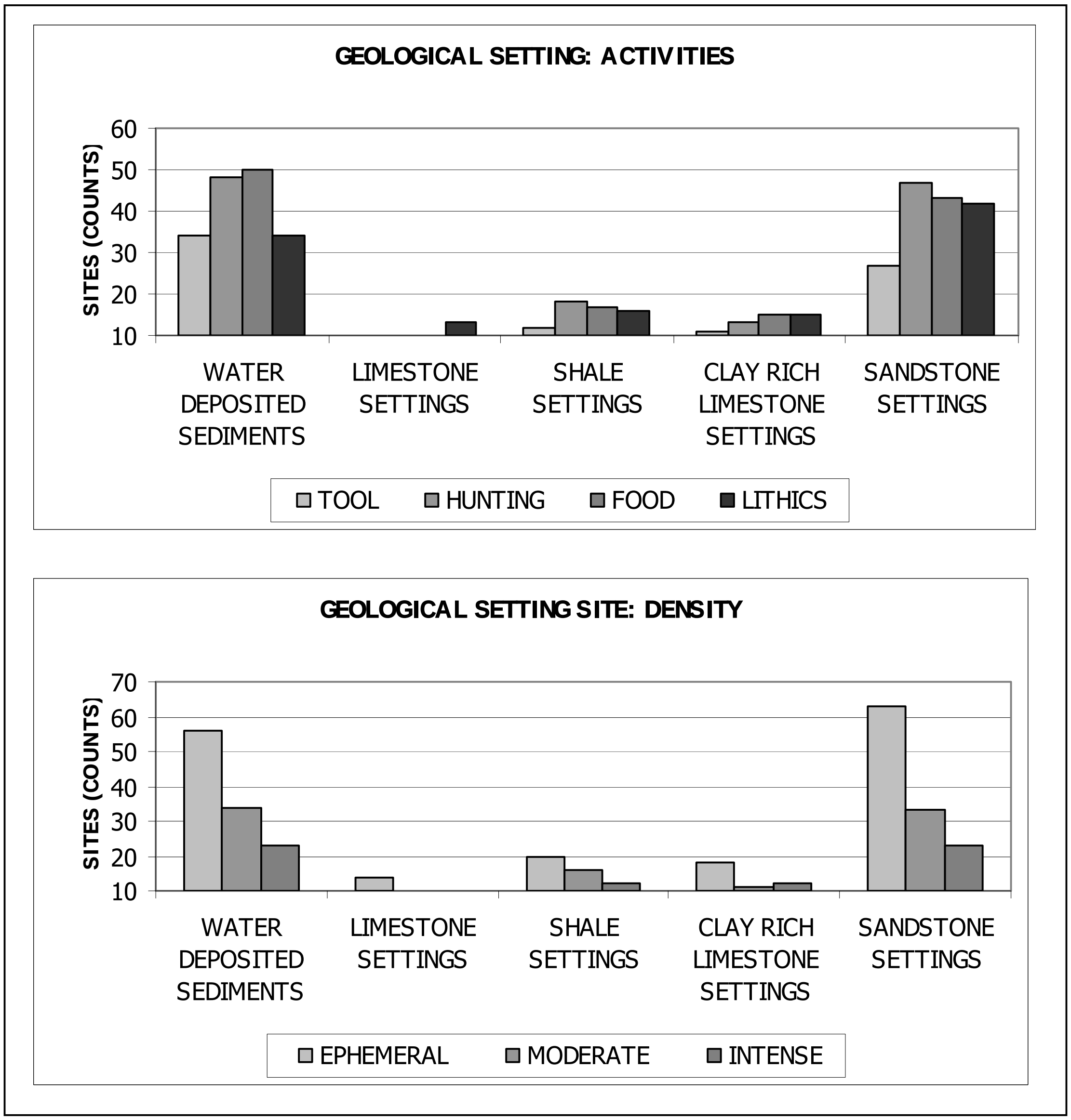

Figure 61. Prehistoric activities, site density and geological settings.

Patterns related to soil settings (figure 62) indicate a fairly equal distribution of soil types within catchments that contain various activities and degrees of intensity. The change between categories appears to be primarily related to the number of sites in each category. The presence of the various soil settings indicates a strong correlation with ecotonal settings.

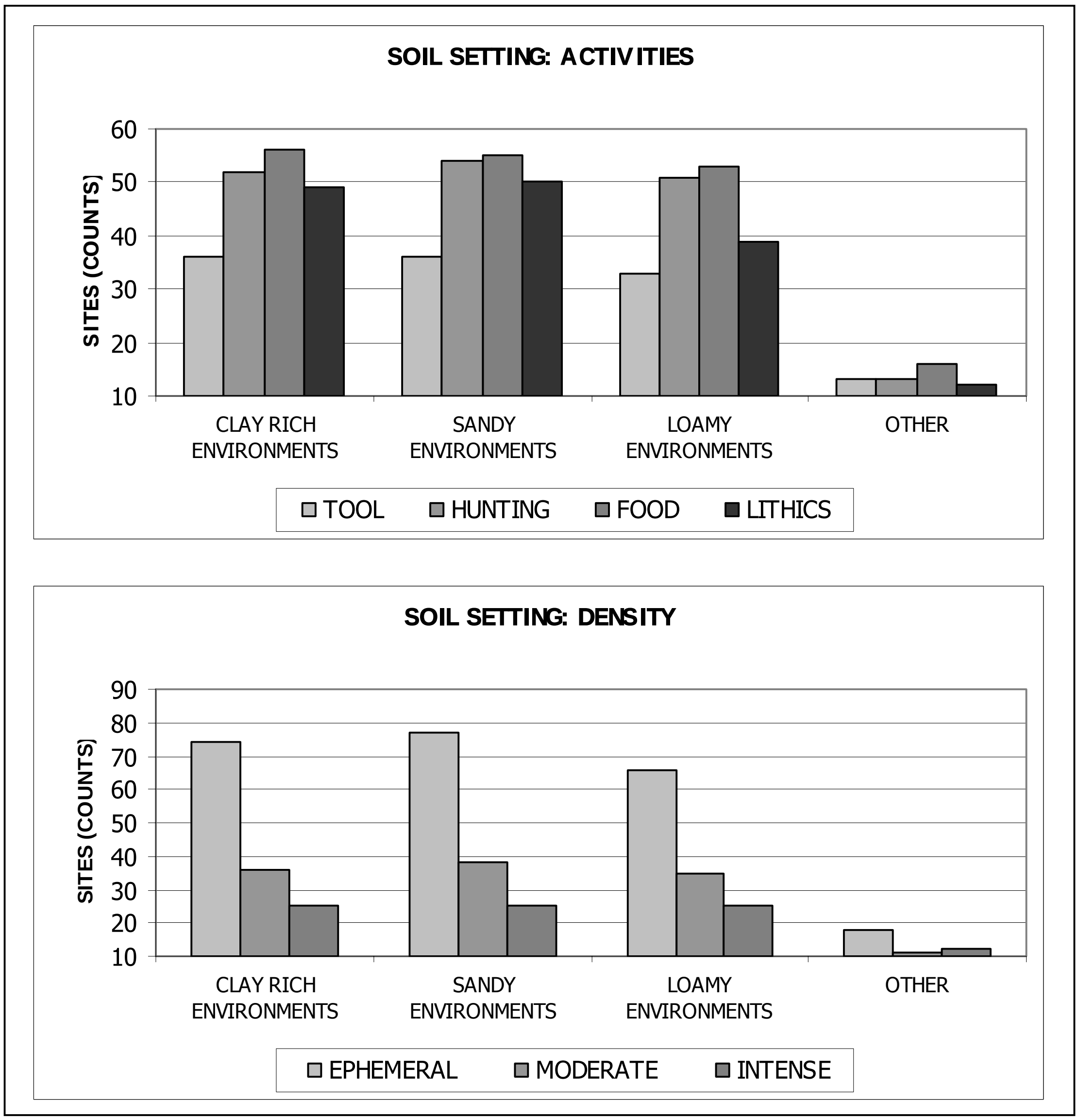

Figure 62. Prehistoric activities, site density and soil settings.

great groups (figure 63) tend to produce similar patterns in relation to activities and site density as did soil settings. The fairly equal distribution appears to be proportionately affected by the number of sites within each category.   In addition, the presence of all three great groups supports ecotonal utilization regardless of site density or activity.

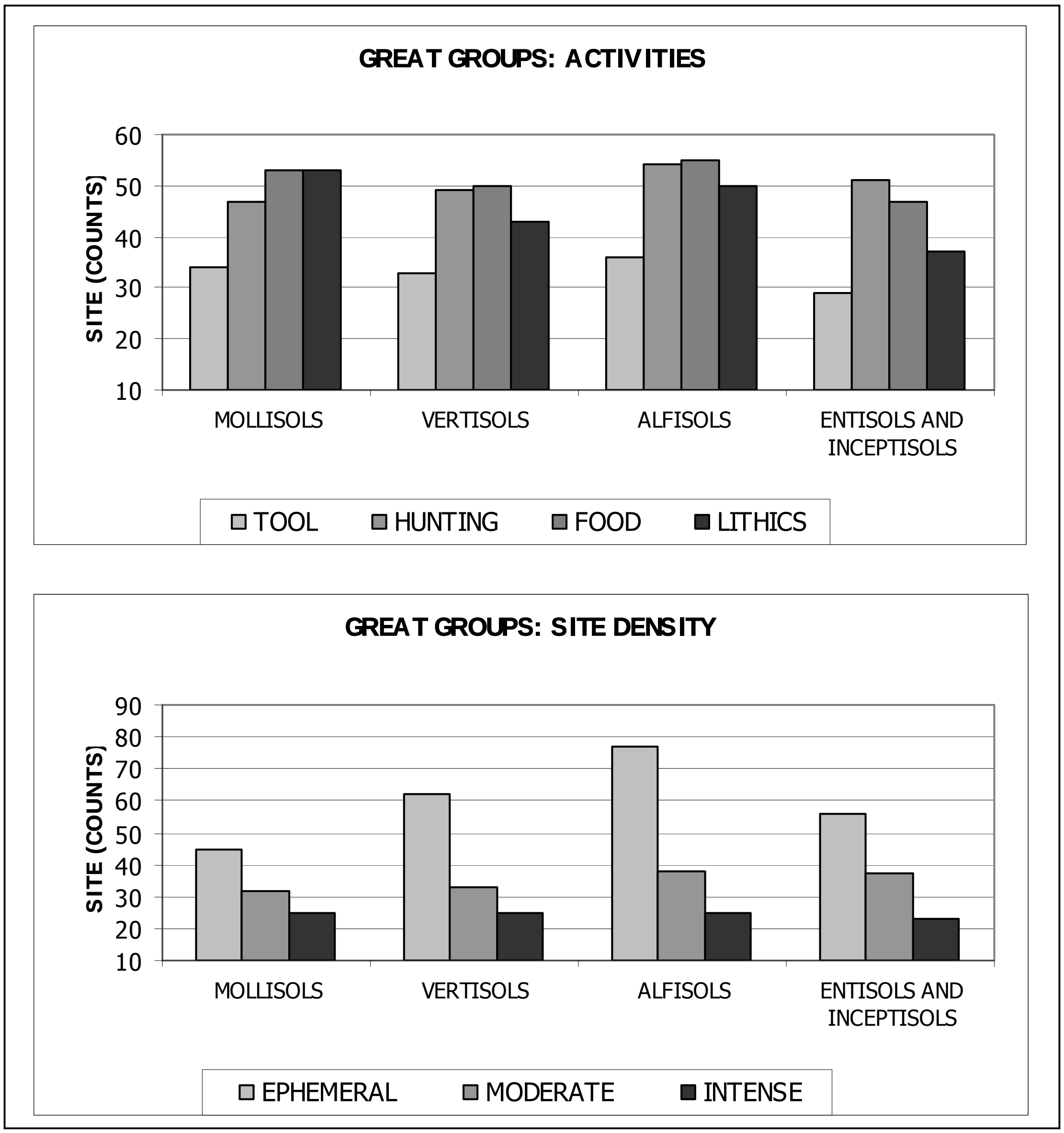

Figure 63. Prehistoric activities, site density and great groups.

Topographic settings (figure 64) in relation to activities and site density indicate a variable landscape surrounding site location. Apparently sites are situated in locations where the catchments include more then one topographic setting. The pattern continues to proportionately change reflecting utilization of a variety of settings regardless of activity or site density.

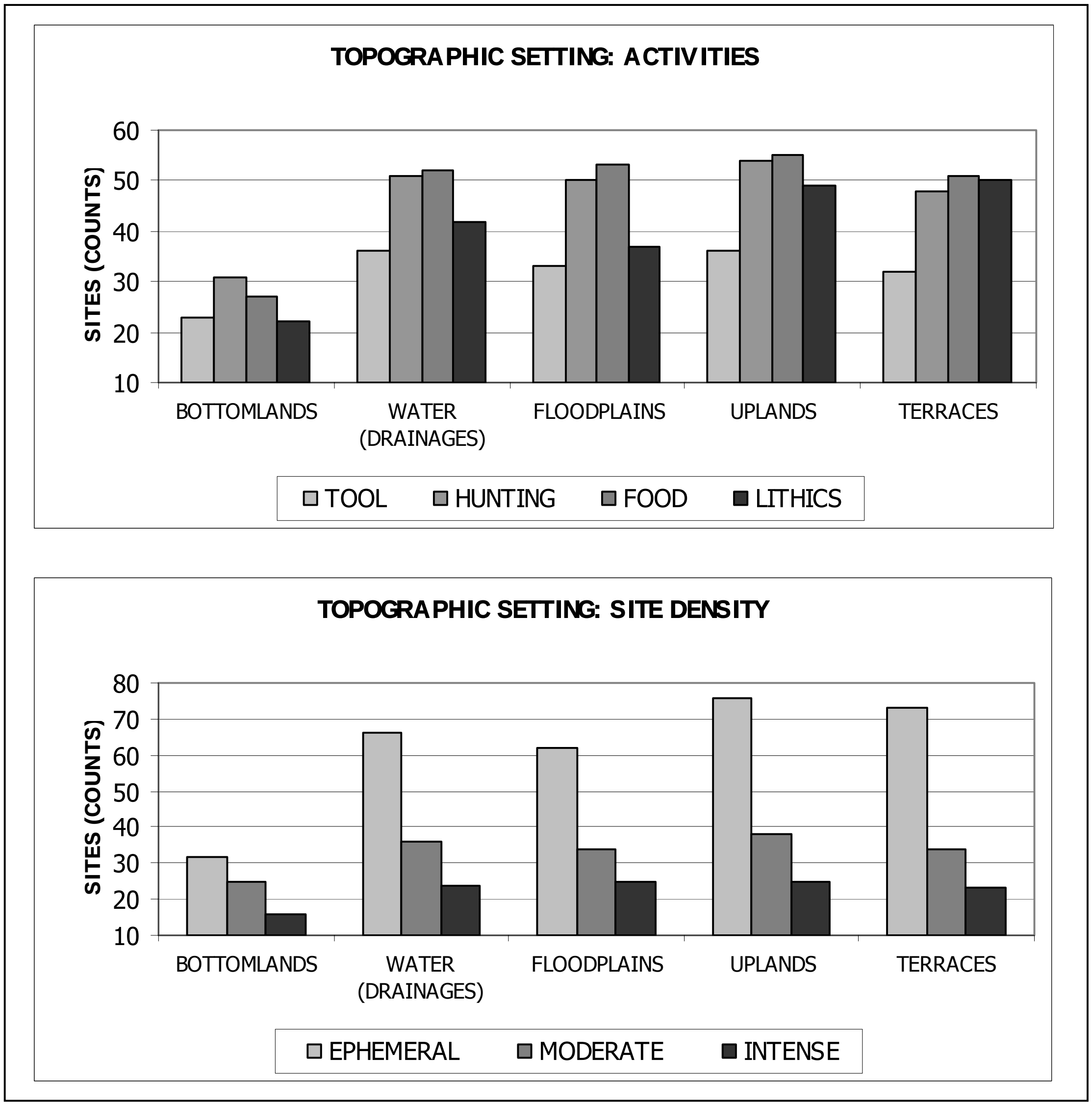

Figure 64. Prehistoric activities, site density and topographic settings.

Given the previous results the ecotonal physiographic setting (figure 65) should have a higher site frequency. However this graph is a little misleading due to the fact that ecotonal settings contain a combination of the other categories. This cannot be avoided due to the site catchment character combined with site distribution. Future research should delineate sites that are completely within prairie or woodland settings. The results would probably remain the same due to the character of the region.

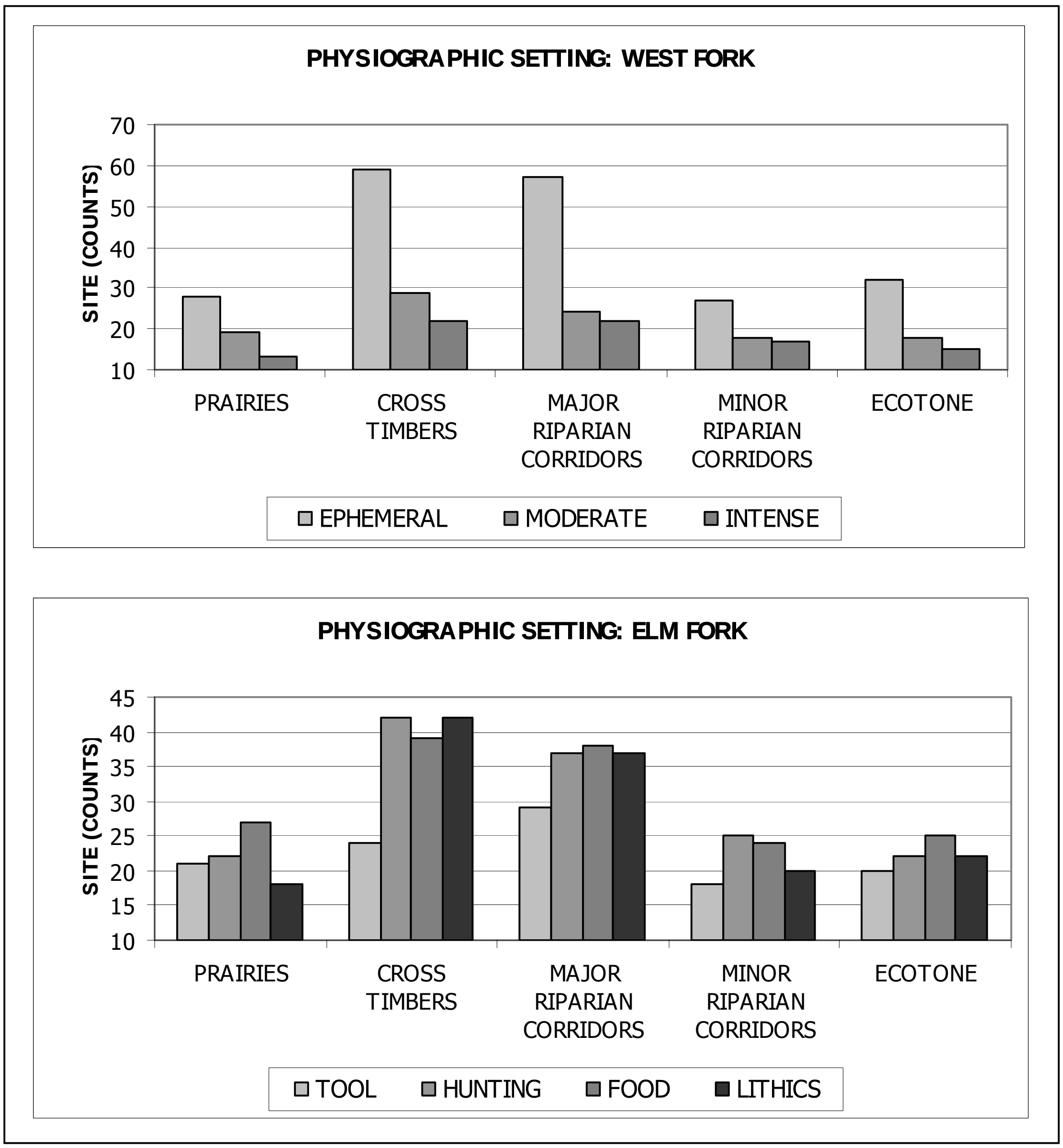

Figure 65. Prehistoric activities, site density and physiographic settings.

Statistical Conclusions

Results yielded from the statistical analysis indicate that differences between site locations through time are predominantly due to chance. Similarly there is no indication of differential selection in relation to occupation frequency. Apparently prehistoric populations in north-central Texas returned to similar site settings that may vary in geographical location but not in economic related content. It is important to note that the statistical results are extremely biased due to the number of sites situated Elm Fork and the lack of sites along the West Fork of the Trinity. The bias is such that a robust statistical comparison is not possible until more sites are uncovered. Furthermore, repeated occupation at sites through time along the Elm Fork heavily weighted temporal considerations and occupation frequency. The raw environmental and economic data indicates differential selection. Maps depict this variability in relation to site catchments. The particular variation between site locations is primarily due to the different soil settings so there is a considerable difference between sites situated on the Elm Fork, East Fork and West Fork of the Trinity.

The statistical results (table 8-table 10) are summarized to illustrate the variables that were depicted and the corresponding results. Although statistical results indicate that there is not a significant difference between site catchments in relation to occupation frequency, density, activities or change through time there are a few cases that do indicate statistically significant differences. Activities and site density indicate statistically significant differences in relation to change through time and occupation frequency. This simply means that site function and density varies through time but

Table 8. Summary of statistical conclusions.

Variable 1	Variable 2	X-Square	df	p-value	Statistical Significance
Great groups	Components	22.1639	33	0.9239	N
Great groups	Time	26.2866	84	1	N
Great groups	C-Time	9.2734	48	1	N
Great groups	Site Density	13.0649	24	0.965	N
Great groups	Site Function	13.4503	36	0.9998	N
Topography	Components	40.1809	45	0.6759	Y
Topography	Time	49.3356	105	1	N
Topography	C-Time	19.1622	60	1	N
Topography	Site Density	19.7875	30	0.922	N
Topography	Site Function	15.5873	45	1	N
Soil Setting	Components	60.4014	60	0.4612	Y
Soil Setting	Time	62.8236	140	1	N
Soil Setting	C-Time	20.3485	80	1	N
Soil Setting	Site Density	26.7694	40	0.9459	N
Soil Setting	Site Function	17.6018	60	1	N
Geology	Components	34.2261	45	0.8789	N
Geology	Time	35.4769	105	1	N
Geology	C-Time	15.3905	60	1	N
Geology	Site Density	15.3535	30	0.9876	N
Geology	Site Function	12.4191	45	1	N
Physiography	Components	21.4053	36	0.9743	N
Physiography	Time	21.7192	84	1	N
Physiography	C-Time	8.007	48	1	N
Physiography	Site Density	9.2363	24	0.997	N
Physiography	Site Function	8.2276	36	1	N
Site Density	Components	58.4496	6	0	Y
Site Density	Time	64.6353	14	0	Y
Site Density	C-Time	2.4361	8	0.9646	N
Site Function	Components	32.2334	9	0.0002	Y
Site Function	Time	41.2895	21	0.0052	Y
Site Function	C-Time	1.9654	12	0.9995	N

Elm Fork and West Fork Combined

not necessarily in relation to site location. Occupation frequency exhibits statistically significant differences in relation to topography and soil setting. This is the only indication of differences between site catchments and given the character of the variables this suggests that there is a pattern operating that can be correlated with site

Table 9. Summary of statistical conclusions.

Variable 1	Variable 2	X-Square	df	p-value	ss
great groups	Sing/Multi (West)	0.5632	3	0.9048	N
great groups	Sing/Multi (Elm)	1.2972	3	0.9775	N
great groups	Sing/Multi (Total)	3.3307	11	0.9856	N
Topography	Sing/Multi (West)	0.6025	4	0.9628	N
Topography	Sing/Multi (Elm)	0.9917	4	0.911	N
Topography	Sing/Multi (Total)	5.8985	14	0.969	N
Soil Setting	Sing/Multi (West)	3.9752	3	0.2642	Y
Soil Setting	Sing/Multi (Elm)	2.547	3	0.4669	Y
Soil Setting	Sing/Multi (Total)	5.7574	20	0.9992	N
Geology	Sing/Multi (West)	0.3855	4	0.9836	N
Geology	Sing/Multi (Elm)	1.0043	4	0.9091	N
Geology	Sing/Multi (Total)	2.985	15	0.9996	N
Physiography	Sing/Multi (West)	0.4115	4	0.9815	N
Physiography	Sing/Multi (Elm)	1.0354	4	0.9044	N
Physiography	Sing/Multi (Total)	2.4332	12	0.9984	N
Site Density	Sing/Multi (West)	4.9184	2	0.0855	Y
Site Density	Sing/Multi (Elm)	17.1127	2	0.0002	Y
Site Density	Sing/Multi (Total)	46.1361	2	0	Y
Site Function	Sing/Multi (West)	2.31	3	0.5106	Y
Site Function	Sing/Multi (Elm)	9.7762	3	0.0206	Y
Site Function	Sing/Multi (Total)	38.7188	3	0	Y

West and Elm Fork Individually Analyzed

reoccupation. Of all of the variables these two are probably the most informative in relation to extending interpretation beyond the physical landscape. Along the Elm Fork of the Trinity there is a statistically significant difference between soil settings with respect to change through time. Essentially, this means that sites were situated in areas that would provide access to specific types of vegetation. In addition, there is a statistically significant difference in site density in relation to soil setting.

Table 10. Summary of statistical conclusions.

Variable 1	Variable 2	X-Square	df	p-value	ss
great groups	A/LP/P (West)	1.4139	6	0.965	N
great groups	A/LP/P (Elm)	1.7195	6	0.9436	N
Topography	A/LP/P (West)	2.209	8	0.9739	N
Topography	A/LP/P (Elm)	1.7437	8	0.9879	N
Soil Setting	A/LP/P (West)	0.257	6	0.9997	N
Soil Setting	A/LP/P (Elm)	4.0219	6	0.6737	Y
Geology	A/LP/P (West)	1.3967	8	0.9943	N
Geology	A/LP/P (Elm)	3.211	8	0.9204	N
Physiography	A/LP/P (West)	1.4773	8	0.9931	N
Physiography	A/LP/P (Elm)	1.0117	8	0.9982	N
Activities	A/LP/P (West)	1.9469	6	0.9245	N
Activities	A/LP/P (Elm)	49.7815	6	0	Y
Activities	Soil Setting	1.9554	9	0.9922	N
Activities	Topography	3.6075	12	0.9895	N
Activities	Geology	4.5979	12	0.9707	N
Activities	Physiography	4.55	12	0.9713	N
Activities	great groups	2.4048	9	0.9833	N
Density	Soil Setting	3.1109	6	0.7948	Y
Density	Topography	3.3872	8	0.9078	N
Density	Geology	4.4548	8	0.8139	N
Density	Physiography	3.658	8	0.8866	N
Density	A/LP/P (West)	5.1097	4	0.2762	Y
Density	A/LP/P (Elm)	67.3799	4	0	Y
Density	great groups	3.6117	6	0.7291	Y

West and Elm Fork Individually Analyzed

This indicates that site density varies according to the particular soil setting. Soil Settings tie directly into the edible, medicinal and supplemental vegetation given that there is an association between the two. The fact that site density and change through time in correlation with soils settings produce statistically significant results is a signal that prehistoric populations were drawn to specific locations related to the environmental setting. Future hypotheses could be formulated to determine what types of plants these cultures were drawn to during their respective time periods.

Topographic location provides valuable information in relation to climatic fluctuations and micro-environmental variation. The statistical significance in this respect indicates that patterns exist between site location and topographic setting. As these settings are evaluated it is possible to form explanations for site location in relation to the climate. As such, this variation is addressed in the final synthesis. Overall, it can be generally inferred that prehistoric populations consistently selected site locations for intensive or ephemeral occupation that vary according to soil setting and topographic setting. These are important clues to discovering the motivation for such choices. Due to the sample bias posed by the numerous sites along the Elm Fork that are in close proximity or indicate reoccupation it is necessary to approach the development of the regional settlement pattern model from a different angle.

One of the benefits of incorporating GIS into SCA is the ability to spatially analyze site locations with overlay analysis. The GIS interface provides a means to observe the intersection of the multiple variables, interpret these patterns into dynamic relationships and observe change through time. In the final synthesis, prehistoric settlement patterns are observed comparatively between the East, West and Elm Forks of the Trinity as they change through time by performing an overlay analysis with a GIS interface. Results from this analysis combined with tabular and descriptive data are synthesized in a regional model of prehistoric settlement pattern behavior in north-central Texas.

CHAPTER 7

NORTH CENTRAL TEXAS SETTLEMENT PATTERN MODEL

The model presented here is designed to address the character of prehistoric adaptation to the environment and landscape of north-central Texas. A variety of factors influence prehistoric decision-making processes. Each of these factors has been evaluated throughout the course of this thesis. In order to make sense of the pieces they must be integrated into a coherent whole and synthesized into a regional settlement model. The primary goal of this research is to formulate theories that would explain why these populations selected certain locations during their respective time periods and why these locations were revisited during later time periods. Examination of the landscape has helped determine the economic value of areas directly associated with archaeological sites. Evaluation of archaeological remains at these sites has delineated functional value of these locations. In this chapter sites are comparatively evaluated and settlement models are developed for each time period within the West Fork, Elm Fork and East Fork. Settlement patterns that emerge from these relationships are then evaluated on a regional scale to develop theories regarding functional site types and adaptations that characterize prehistoric populations. This model can be utilized to formulate future hypotheses concerning relationships between these cultures, how they related to each other, to the animals and to the landscape.

Prehistoric Populations along the West Fork of the Trinity

During the Early Archaic sites, along the West Fork of the Trinity, contain evidence that indicates moderate occupation involving hunting in upland alluvial settings within the Western Cross Timbers. The most intensively occupied site in this portion of the study area (41WS38) is centrally located in relation to the other sites in the West Fork drainage. Intensive occupation at this site is indicated by high artifact density, hearth features, fire cracked rock and faunal remains that have been excavated from midden deposits. A site of this nature is considered to be a semi-sedentary base camp that was probably seasonally occupied. The proximity of this multi-component site to the rolling plains suggests that it was a good location for bands to aggregate and prepare for communal hunting on the plains. Of all the currently known sites in Wise County this site appears to be the most frequently occupied based on the diversity of time-diagnostic projectile points that have been recovered. This site is situated in an economically advantageous position on the floodplain near a minor tributary. It is located in a diverse location within the parameters of the Grand Prairie/Western Cross Timbers ecotone. Economic values associated with this ecotonal locale indicate an equal presence of edible and medicinal vegetation.

All of the sites that were occupied during the Early Archaic in the West Fork drainage are also associated with the Middle Archaic time period. An additional site location is present approximately 30 km to the north in a similar setting. It is located in an ecotonal setting between the Western Cross Timbers and the Grand Prairie on top of the same geological foundation but it is on a terrace near a major tributary (Denton Creek) rather than on a floodplain of a minor tributary. This site is not as intensively occupied but it has an equivalent economic value. Limited food preparation and hunting activities are indicated by the artifacts recovered from this site. However, there is no evidence of tool manufacture. Economic potentials are equally distributed between edible, medicinal and supplemental values. Combined with the frequency of peripheral non-diagnostic prehistoric sites it is suggested that the Howard site was a base camp and 41WS7 was an ephemeral hunting camp.

Late Archaic patterns reveal continued site reoccupation of the Middle Archaic sites with one new site established approximately 30 km to the west and a couple more about 10km south of 41WS38. Site 41WS43 is situated in a terrace setting on top of Antlers sandstone near the ecotone that connects the Western Cross Timbers to the Rolling Plains. The site is ephemeral containing evidence of hunting activities suggested by projectile points. However, the economic resources offered by the riparian and ecotonal settings are fairly substantial such that it is likely that it served as a hunting camp. The overall pattern during this time period suggests a certain level of sedentism combined with the development of exploratory hunting camps in relation to the southern sites. Late Archaic sites in the West Fork Study area are less numerous with relatively lower wildlife and economic values than the previous time periods. The two base camps are situated near the Grand Prairie/Western Cross Timbers ecotone whereas the ephemeral hunting camps are in the interior of the Cross Timbers approximately 5km from the Rolling Plains. This configuration suggests a western movement from the base camps toward the rolling plains where large game could be hunted. A westward shift of site locations is the most obvious between the Middle and Late Archaic throughout the region. It is less noticeable in the West Fork region due to the paucity of Middle and Late Archaic sites but when viewed in relation to the West

Fork this shift is more apparent. Presence of diagnostic points and darts at these western sites combined with repeated occupation suggests either a migratory route or a satellite hunting camp. Supporting evidence for a migratory route is provided by an ephemeral prehistoric site containing non-diagnostic lithic scatter approximately 10 km west of the nearest diagnostic site and well within the rolling plains. In addition, although archaeological sites discovered at Lake Bridgeport, 3 km west of this site, have not been reported to TARL, a multitude of evidence, housed at the University of North Texas, awaits diagnosis. Sites in Wise County that are in the process of analysis could add a greater breadth and meaning to this settlement model. Based on the current settlement model it is expected that sites are located directly west of the study area and that archaeological evidence reflects cultural affinities to other sites in the region.

Late Prehistoric sites in Wise County are few in number and exhibit opposite patterns of the previous Late Archaic time period. One could hypothesize based on the settlement patterns that emerged during this study that population density decreased along with territorial parameters. During the first phase of the late prehistoric there is only one site in the West Fork study area that contains evidence associated directly with this time period designation. Only three sites are associated with the second phase of the Late Prehistoric and two with the general Late Prehistoric. All of these sites are occurrences of reoccupation of sites related to previous time periods. As such, it is difficult to draw any certain conclusions about late Prehistoric populations in the West Fork study area. However, it would suffice to say that these populations appear to be retreating from the westward movement indicated during the Late Archaic.

Twelve prehistoric sites in Wise County are not associated with any given time period due to the lack of time-diagnostic artifacts at these locations. However, the presence of lithic scatter, tools and a variety of other materials that indicate prehistoric human activity accumulate more meaning when combined with the character of the landscape. All of these sites with the exception of the southernmost location are associated with significantly high potential for openland and rangeland wildlife. In addition edibility medicinal and supplemental values are significantly high at most of these locations. They are also widely distributed across the landscape unlike the clustered patterns that emerge in both the Elm Fork and East Fork areas. Given that the relative distance from 41WS38 ranges between 10km and 30km a return to base camp within a one day time frame is not likely. If they are related it is likely they were satellite camps related to specialized activity or migratory camps that facilitated movement toward the rolling plains to hunt bison and other large game.

Prehistoric populations were widely dispersed in the West Fork portion of the study area (figure 43). These camps appear to be strategically situated in order to optimize procurement efforts. Future hypotheses based on this model and corresponding methodology could predict locations based on the character of the landscape. Discovery and analysis of additional sites is necessary to further enhance knowledge concerning prehistoric settlement patterns in the region.

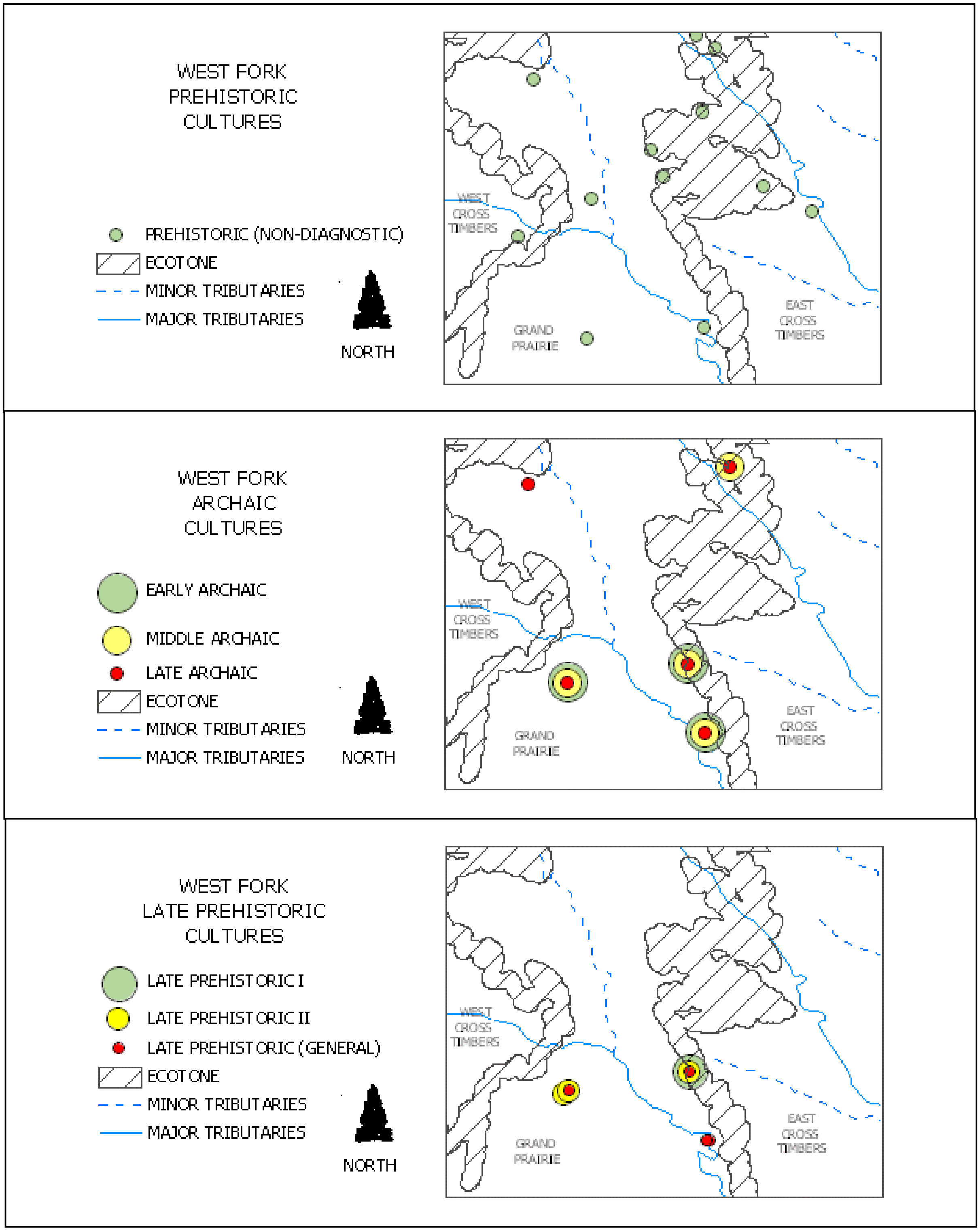

Figure 66. Prehistoric populations along the West Fork of the Trinity.

Prehistoric Populations along the Elm Fork of the Trinity

Archaeological research has been performed extensively along the Elm Fork of the Trinity (figure 44). As such, this research is heavily weighted by the increased number of sites in this portion of the study area. However, it is worth noting that this area provided a desirable habitat for prehistoric adaptations given the bottomland resources, mast crop, access to permanent major water resources, ecotonal settings and the overall diversity of the landscape.

Along the Elm Fork of the Trinity 11 of the 19 Early Archaic sites are aggregated in a fairly central location along Little Elm Creek. Situated along the northern portion of the Elm Fork near the Little Elm Creek branch these sites are either on the Woodbine sandstone formation or on fluvatile terrace deposits. All of the sites in this area are on the interior of the ecotone between the Western Cross Timbers and the Blackland Prairie. A high overall economic value indicates a wide range of opportunities including immediate access to mast crops. Intensity of occupation suggests that Early Archaic populations recognized this and aggregated in this location. Settlement patterns during the Early Archaic reveal aggregation in "base camp" locations with hunting, gathering and/or migratory camps located within 10km to the west and lithic manufacturing camps 20 km to the south. A wide range of mobility is indicated during this time period. Gathering activities are complimented in the immediate vicinity of the sites and the topographic setting is particularly advantageous during the wetter climatic episodes that occurred during the Early Archaic. All of these factors indicate strategic site selection.

A small aggregate of Early Archaic sites are equally spaced with approximately 1 km separating them from one another. Collectively these sites form a westward facing arch that appears to be protecting the confluence of the Elm Fork and Little Elm Creek from Eastern invaders. These sites also follow the curvature of Running Branch Creek providing immediate access to riparian resources. The strategic geographical location of these sites is echoed by their functional presence that alternates between ephemeral "outposts" and large base camps. These outposts could either signify an off-site hunting and/or gathering event or sites protecting from northern or eastern encroachments. On the other hand it is possible that rather than protecting the confluence to the west these populations were simply following the river system northward with scouts inspecting the territory upstream. North of these sites near the confluence of Little Elm Creek a group of sites is situated in a heavily forested environment in riparian environments. Of all of the sites in the region this group has the highest frequency of reoccupation and density of artifacts.

There is an interesting inverse relationship between economic value and projectile point frequency. Two sites in particular in the periphery of the Elm Fork illustrate this relationship. For example, 41DN62 contains the largest number of artifacts yet a very low economic value. Conversely, 41DN48 has the lowest number of artifacts and the highest overall economic value. The wildlife factor is weighting this value although it also the highest supplemental value and a fairly high edibility value. Hunting activities are suggested by a combination of factors. The paucity of remains and the fact that it only contains evidence of single occupation combined with the fact that all of the elements necessary for the hunt including the appropriate habitat for rangeland wildlife are present support a hunting situation. In addition a more intensively occupied site (41DN31) is 1.5 km to the southwest that contains lithic debris, midden soil, fire cracked rock and various other artifacts that suggests a relatively large scale gathering covering approximately 10 acres. These factors collectively support an Early Archaic gathering associated with a hunting event and camp near the confluence of Clear Creek and the Elm Fork of the Trinity. Sherds and celts provide evidence of one other occupation at site 41DN31 during the Late Prehistoric. Given the size and location of the site it is very likely that Late Prehistoric people scavenged the site. There are three reasons why this is thought to be the case. First, the contemporaneous occupation of the two sites during the Early Archaic combined with the character and proximity of the sites necessary for fulfillment of the conditions that typically facilitated a communal hunt. Second, the fact that besides 41DN31 the closest Archaic sites are 7 km away suggests that this scenario is likely. Third, the paucity of Late Prehistoric artifacts combined with the size of the site and density of site content suggests that 41DN31 was scavenged for artifacts. The closest Late Prehistoric site is 1.4 km away on the west side of the Trinity. This site (41DN2) situated on a terrace contains Perdiz, Bonham and Fresno points, as well as, 20 ceramic sherds. It would be interesting to compare the sherds from the two sites to evaluate possible similarities. Given the tendency for territorial tribal conflict, especially during the Late Prehistoric, it is likely that discovering a previously occupied site stimulated an increased level of defensiveness. Therefore the selection of the site on a terrace with a river barrier between the two sites appears to be a logical choice of location. This situation is a very good example of how sites acquire meaning when viewed with respect to occupation frequency and chronology in relation to other sites in the region.

A clustering of Early Archaic sites situated along the southern portion of Elm Fork are correlated with fluvatile terrace deposits on the Blackland Prairie side of the Eastern Cross Timbers ecotonal boundary. 41DN251 and 41DN252 contain Early Archaic projectile points. These sites, situated in the Blackland Prairie near the confluence of Denton Creek and the Elm Fork of the Trinity, are less than a kilometer from each other. Both sites contain evidence of tool manufacture including cores, preforms, debitage and diagnostic projectile points. Less than a kilometer to the south there are three Archaic sites that contain non-diagnostic dart points, cores, debitage, preforms, retouched pieces and fire cracked rock. These five sites are within a 1 kilometer radius of each other. The closest economic resource is supplemental bottomland hardwoods that would have provided fuel for the fire to heat treat lithic materials, provide warmth and cook with. Situated on fluvatile terrace deposits within 2 km of a major tributary these sites had access to the riparian food resources and protection from any contemporaneous cultures traversing the River corridor. This cluster of sites appears to be associated with preparation for the hunt or territorial warfare. A small number of individuals present at this site are indicated by the moderate density of artifacts. More than likely it was a band that was in the process of lithic manufacture while collecting raw materials that were apparently available in the terrace settings of this portion of the study area. Notably, they are the only Early Archaic sites along the Elm Fork that are located in the Blackland Prairie proper. Once an occupation has been established at a site it becomes difficult to discern which occupation had the strongest presence. However, in situations such as this, the frequency of sites in proximity to one another suggests that a significant amount of activity involving tool manufacture was conducted in this area during the Early Archaic. The paucity of Late Archaic and late prehistoric artifacts suggests that repeated visitation during later time periods was likely associated with recycling of tools and raw materials. While this is not the case in all situations it appears to be in the northern and southern satellite sites where economic values associated with the landscape are relatively low within the site catchment. However, both site clusters are situated near the Elm Fork of the Trinity and small patches of edible vegetation. Medicinal and supplemental vegetation are also accessible although not immediately present at the site. One of the sites contains a single Early Archaic component with light scatter whereas the other site is dual-component and contains substantial evidence of tool manufacture. Given that the sites are less then 1 km from each other and contain similar diagnostic projectiles it is likely that there was cultural interaction between these site locations or that a scavenging event occurred at a later time. The site that contains considerably more lithic debitage contains evidence of occupation during both the Early and Late Archaic.

During the Middle Archaic a cluster of sites are focused along Little Elm Creek in site locations that were pre-established as base camps during the Early Archaic sites. Besides this cluster there is only one other site located about 5 km south which is also a case of reoccupation. Situated near the ecotone between the Eastern Cross Timbers and the Blackland Prairie on fluvatile terrace deposits this site primarily contains evidence of hunting activities that are expressed by a high density of projectile points. However, the abundance and variety of projectile points indicates some type of tool manufacture and the presence of cooking pits indicates food preparation. Bison remains have also been recovered from the site in the form of scapula hoes. Given that this site was occupied during the Early, Middle and Late Archaic time period it is difficult to discern which archaeological remains can be attributed to each particular time period. The main source of differentiation between the time periods is found in the diagnostic points that are associated with stratified sites in peripheral locales.

During the Late Archaic the Elm Fork site location is once again re-occupied yet to a much greater degree then previously. Site numbers in areas of reoccupation increase substantially during the Late Archaic. Pre-established sites to the south and southwest are also reoccupied. However, during this time period a number of new sites appear in south, southwest, west and northwest locations. There also appears to be a trend of movement to the west. For the most part new sites appear in small aggregates. Choice locations appear to be fluvatile terrace deposits situated in sandstone settings. All of the new site developments develop in these locations in or near ecotonal settings. Newly developed sites indicate a notable shift from the Blackland Prairie/Eastern Cross Timbers ecotone westward to the Grand Prairie/Eastern Cross Timbers ecotone. The only exception is the southernmost sites situated approximately 5km south of the camps that were established during the Early Archaic with new peripheral site locations indicating occupation during the Late Archaic. Activities at these sites appear to be centered on hunting and tool manufacture. 41DN68 and 41DN36 are the exceptions to the overall pattern that is suggested by Late Archaic sites. These sites are situated within the Eastern Cross Timbers in upland settings and on fluvatile terrace deposits. While the overall economic values associated with these sites are fairly low the edibility values are relatively high. Moving from east to west they are approximately 7 km from the nearest site indicating that these sites were probably migratory camps. Given the substantial increase of sites along the Elm Fork of the Trinity there appears to be a significant population growth during this time period paired with a westward expansion.

Settlement patterns along the Elm Fork of the Trinity with respect to the diagnostic sites containing Late Prehistoric remains are difficult to discern based on site reoccupation. During the Late Prehistoric I time period site distribution returns to the eastern edge of the Eastern Cross Timbers where an ecotone forms with the Blackland Prairie. Terrace and upland settings in these locations continue to be utilized. During the Late Prehistoric II time period identical settings are occupied. More information is available from the distribution of sites that do not contain diagnostic projectiles but contain untyped arrows and/or ceramics. These sites reveal a continued relationship with the Grand Prairie/Eastern Cross Timbers eco-tonal boundary and fluvatile terrace deposits. The ephemeral character of the sites combined with the variety and abundance of valuable economic resources suggests a correlation with gathering activities. During the Late Prehistoric populations appear to be growing yet retreating to previously occupied sites and aggregating into smaller territorial eco-niches.

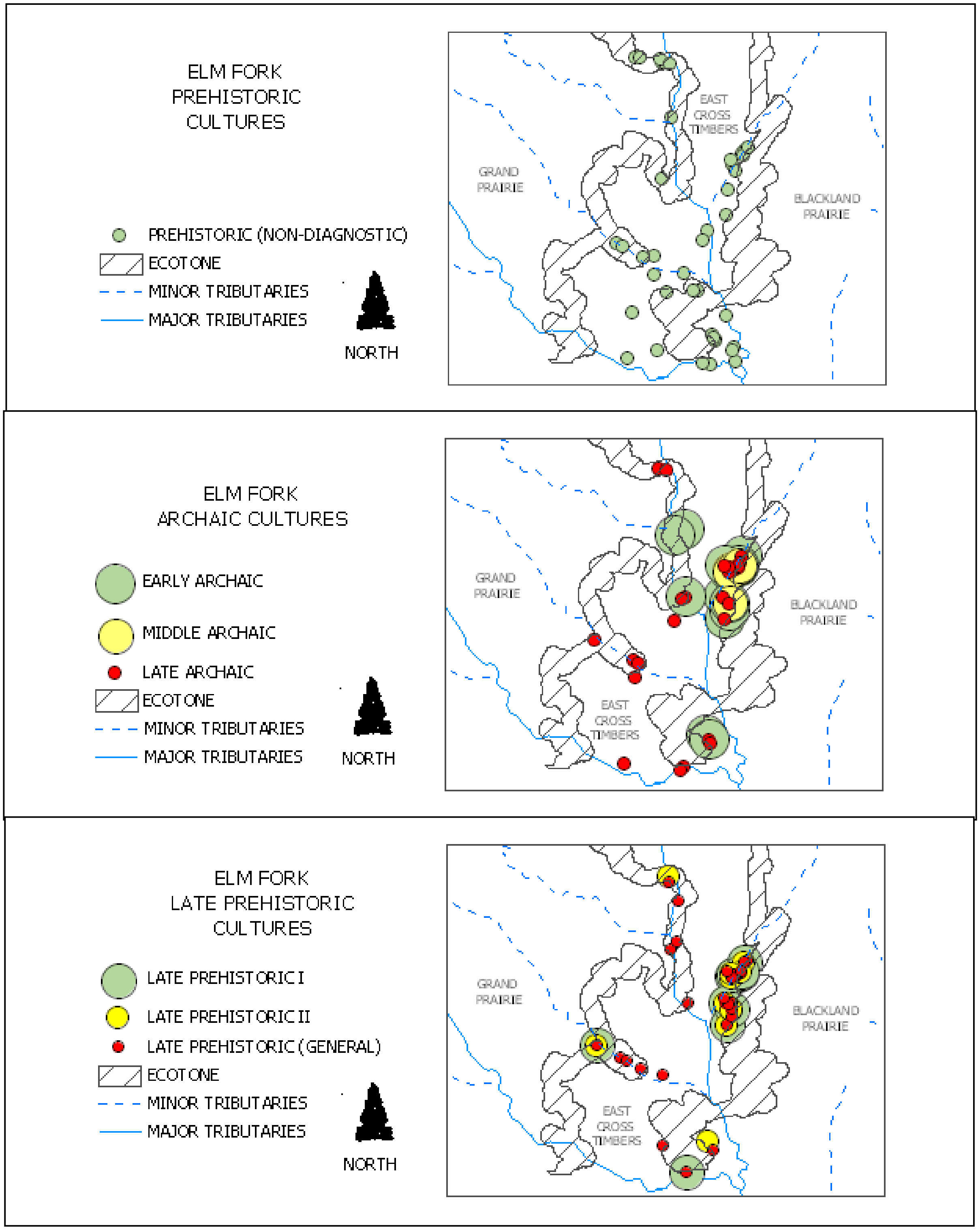

Figure 67. Prehistoric populations along the Elm Fork of the Trinity.

Prehistoric Populations along the East Fork of the Trinity

Extensive archaeological research has been conducted in the East Fork portion of the study area (figure 45) which contains sites that are particularly unique in character. Given the current state of digital data available for Collin County it was not possible to evaluate the economic values. Geological information, great groups and topographic settings are evaluated with respect to site selection. However, the variation is limited based on the general uniformity of the landscape. All of the sites along the East Fork are located in the center of the Blackland Prairie. Clay-rich soil characteristic of this area involve a lot of shrink-swell activity that makes it very difficult for soils to develop. As a result, besides the predominant tall grass prairie vegetation the main vegetal resources of food, medicine and supplemental products are contained in the riparian environments. Site distribution follows this pattern fairly closely.

Very little is known about the Archaic time period. Reportedly only a few sites were occupied during the Early Archaic. These sites were locations that were later selected for the construction of Wylie Focus Pits. Whether of not the Wylie Focus Pit originated during the Early Archaic is unknown but by the Middle Archaic the sites that would contain these characteristic ceremonial "pits" all provide evidence of prehistoric activity. Late Archaic populations do not establish new sites but reoccupy sites established during the Early Archaic. Perhaps these populations had a wider dispersal across the landscape but were discovered in these locations due to the extensive excavations that were conducted due to the presence of the Wylie Focus Pits that were presumably not established until the Late Prehistoric.

While some sites suggest occupation during the Archaic time period the bulk of archaeological remains such as the unusual "Wylie Focus Pit" depressions associated with hearth features, lithic manufacture, evidence of violent deaths, burials and possible ceremonial activity does not emerge until the late Prehistoric. This activity probably corresponds with the increase of population and territoriality that would have put prehistoric populations in a defensive stance. Supportive evidence for an increase in populations during the Late Prehistoric is substantiated by the addition of 17 diagnostic sites along the East Fork of the Trinity and 19 non-diagnostic sites scattered along the minor tributaries to the east. In relation to the current settlement model significant patterns emerge from site distribution in the East Fork portion of the study area. These patterns relate to the centrally based camps that are equally spaced from each other (8km-10km) across the landscape and then surrounded by clusters of subsidiary sites that may or may not contain diagnostic material. Whether these sites were hunting camps, gathering camps, migratory camps or lithic manufacturing camps remains to be seen. Further research would shed light on the character of these subsidiary sites that would either support or refute the current settlement model.

The overall character of the base camp sites, artifacts and number of burials suggests that these sites were inhabited by completely different cultures than those who inhabited the Elm Fork or West Fork. In addition, the causes of death indicate conflict and likely conflict of territorial origin. What is difficult to discern is the direction that the conflict is coming from. Given the character of the sites it seems that Eastern populations were moving westward where they met with extreme resistance.

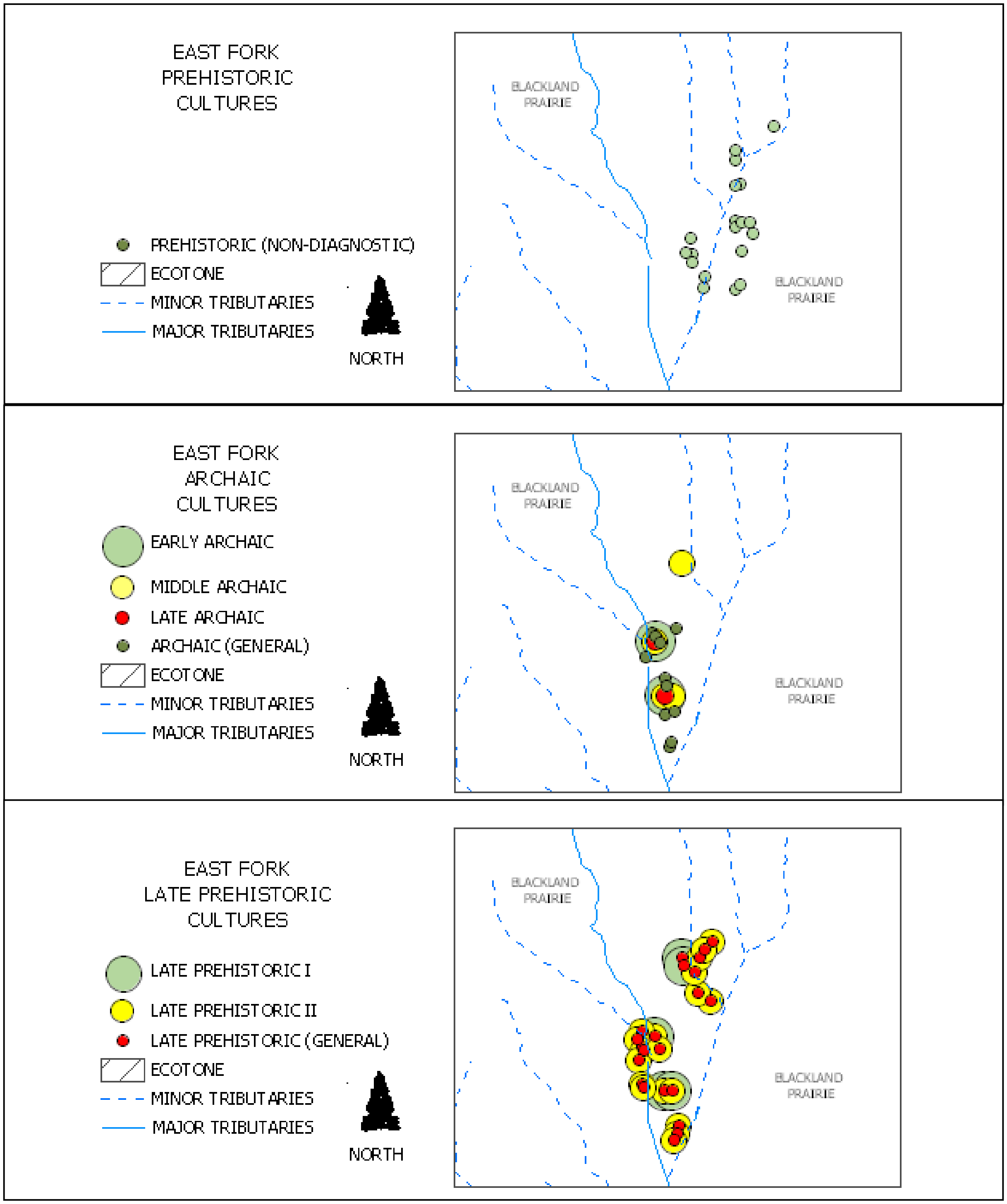

Figure 68. Prehistoric populations along the East Fork of the Trinity.

Functional Site Types in North-Central Texas

Regardless of time period there are common characteristics and functional differences between sites that prompt the development site types. Five types of sites are formulated as a result of this research and serve as the core for the current model of prehistoric settlement patterns. These site types are referred to as base camps, hunting camps, gathering camps, lithic manufacture camps and migratory camps.

Base camps should contain evidence of extended or multi-component occupation and be situated in strategic locations that provide increased environmental diversity with access to optimal economic resources to maximize the gathering contribution of women and children. These sites should contain higher artifact densities and lithic manufacture as it is not economic to transport large amounts of lithic materials during the hunt. Tool manufacturing debris, food preparation artifacts, and food storage containers are associated with base camps. Abundance of projectiles indicates work stations at base camps.

Hunting camps are sites that contain evidence of ephemeral single visitation are situated in strategic locations where hunting would be optimized. In particular, these sites are associated with areas that have a higher potential for wildlife resources. As such, these sites provide access to economic resources that may be more specialized in terms of value relative to sites that contain evidence of higher density occupation. Sites with low artifact density may have been utilized as food-processing stations where the hunted animal was prepared for transport and dull or excess flakes discarded on site. At these site locations there may also be evidence of tool maintenance, a logical by-product required for the process of preparation. Moderate artifact diversities indicate hunting camps depending on the character and abundance of the remains.

Gathering camps are sites that contain evidence of ephemeral or repeated occupation combined with a low artifact density. This site type acquires meaning in relation to the relative economic value. It is expected that at these particular sites there is a high economic value for edible, medicinal, supplemental resources or a combination therein. In order to be categorized as a camp the site location must have access to a water source.

Lithic manufacture camps are sites that contain artifacts that are primarily and directly associated with lithic manufacture. In addition, these sites if there are to be seen as specialized activity sites will be located near areas that would provide immediate access to lithic raw materials. It is also expected that such sites will contain heat-treated or fire cracked rocks and in a location that has access to wood bearing resources. While edible vegetation would be of secondary importance water must be accessible within a reasonable distance from the site.

Migratory camps are ephemeral sites that contain similar archaeological evidence to food procurement camps. This site type takes on meaning in association with other sites that are similar in character and indicate a directional movement toward a territory that would provide an economic resource that is seasonally available. In addition, these sites will demonstrate a geographical or archaeological relationship with specific base camps. While these sites are not expected to be associated with high economic values they are expected to be situated in a location that has access to a water resource.

Prehistoric Adaptations

Prehistoric adaptations in north-central Texas vary according to the relative geographical and ecological setting. Similarities and differences between the relative settlement patterns have emerged during the course of this research. Factors such as geology, soils, physiographic setting, topographic setting, climate, economic resource base and population density influence the range of necessary adaptations.

Early and Middle Archaic cultures in north-central Texas set the stage and established the foundations for future adaptations in this region. This is mainly due to the natural circumstances they had to adapt to, as the landscape responded to the changing conditions, during the transition from late glacial to post glacial climates. Essentially, humans had to adjust to the establishment of extensive forests that accompanied this transition. As such, it is expected that sites would be situated near bottomland resources. This appears to be the case, particularly during the Early Archaic, based on a combination of the faunal remains and geographic distribution of sites. Faunal remains and the geographic distribution of sites also indicate that these low density populations enjoyed a fairly wide range of mobility. However, sites associated with the Early and Middle Archaic tend to aggregate in characteristic locations, with a few exceptions, which can be explained by specific cultural adaptations. Lynott (1977) observes a shift from open-land big game hunting to bottomland riverine hunting and gathering during the Early and Middle Archaic. According to faunal evidence, topographic and physiographic settings this appears to be the case. McCormick et al. (1975) correlate Archaic seasonal camps with ecotonal settings and secondary activity-specific sites spread out across the landscape strategically. It has been observed during the course of this research that sites are primarily situated in ecotonal settings with few exceptions. These exceptions find logical explanations by correlating the site contents with the character of the landscape. For example, the correlation of lithic manufacturing stations in association with geological settings, that would provide raw materials, is a common situation.

On a regional scale something happened between the Middle and Late Archaic that prompted a large scale westward expansion. The reason why a migration is hypothesized is due to the character of the newly established. Sites that were considered to be a part of this westward expansion were single occupation ephemeral sites situated between 10-20 km from the "base camp" sites. The direction toward the Plains is a probable migration route given that populations are known to have migrated to the Plains during certain time periods to hunt bison. It is also known that trade with the Plains Indians and New Mexico Pueblos occurred. Although, it is possible that populations were expanding their site distribution away from the more desirable riverine basins due to population increase, there is no evidence that indicates that they were moving their base camps. Given the dry climatic conditions of the previous time period and the wetter climate experienced by Late Archaic cultures it is likely that the population increased and that they were expanding their hunting territory. There is clearly an increase in the number of sites between the time periods which does suggest an increase in population. Lynott (1977) observes an increase in population and decrease in territoriality. Site distribution and frequency combined with the climate patterns supports this. The wetter conditions provided more abundant resources so it is not likely that they migrated out of the region. It is possible that they were returning to the region after the Middle Archaic drought. The paucity of sites in the region during the Middle Archaic suggests that populations were responding to drought conditions by migrating to other locales so it is highly likely that they would have returned to their previously established base camps when conditions permitted. The character of the newly established sites is ephemeral and suggests hunting activities by the presence of diagnostic point types. The complexity introduced by these sites is their distance from any peripheral base camps and the appearance of all of these sites to the west of the majority of established base camps. This is a question that can only be answered by future research and the discovery of additional base camps.

Typically the initial pattern established by Archaic cultures involves a centrally located semi-sedentary base camp surrounded by ephemeral camps that facilitated hunting, gathering, migration or lithic manufacture. Besides the functional site types, that appear to be re-established through time, regional behavior is discernible by the geographical distribution of sites. Archaic cultures have a much wider range of occupation then late prehistoric cultures. This is a phenomenon that requires more research with respect to environmental and cultural resources. There is more than one reason. Perhaps it is more straightforward for the late prehistoric but for the Archaic it is not just a question of territoriality. It is a question that has to do with why Archaic cultures chose to be highly mobile when they could have subsisted just as other cultures did during other time periods under the same environmental conditions.

Late prehistoric cultures in north-central Texas walked upon common ground and the knowledge passed down from their ancestors. These populations were drawn back to the same locations that were utilized by the Archaic cultures. Base camps were re-established and hunting/gathering camps were either revisited or re-established in similar environments where economic values facilitated such activity. Lithic manufacturing stations probably were established in locations where raw materials were available naturally or where previous occupants left workable lithic debris behind. Tools were likely recycled, replicated or refashioned. Cumulative knowledge concerning the proper use of medicinal, edible and supplemental vegetation probably opened doors to greater variety. However, paired with the knowledge passed on from previous generations, population growth and pressure created new problems. Climatic conditions would have influenced the success of the harvest of a seasonal plant or the migratory patterns of animals that provided sustenance for these populations. During the second phase of the Late Prehistoric the effects of drought conditions reappear along with the utilization of bottomland resources, decrease in aquatic resources and increase in the variety of fauna utilized during this time period. Soil character and degree of development certainly provided variable opportunities as late prehistoric populations turned to horticulture. In some cases the physiographic setting provided more opportunities and in others restrictions or barriers. Topographic settings appear to respond to climatic conditions and more pronounced territorial issues.

Regardless of territorialism, late prehistoric cultures still found ways to situate themselves in their "preferred" locations for extended amounts of time. If they were out of their "comfort zone" it does not appear that they were for very long. Even though the population certainly increased, late prehistoric populations tend to occupy sites that were previously occupied by the Archaic, with a tremendous decrease in territorial range. However, it should be noted that there are many unknowns with the number of "non-diagnostic" prehistoric sites present in the region. This pattern is probably more related to the character of the research conducted in the region than it is a real reflection of the behavior of late prehistoric cultures.

Regardless of the time period or climatic conditions prehistoric preferences in relation to site selection appear to be fairly consistent through time. As Bousmann and Verrett (1973) suggested fluviatile terraces often function to accommodate base camps. Also, as McCormick et al. (1975) pointed out, specialized activity locations are often in locations that are amenable to the activity. Several investigators emphasize the importance of ecotonal settings. Ecotones are predominantly selected to provide access to food and shelter. The importance of ecotonal settings is supported by the archaeological faunal evidence and the placement of the sites on the landscapes. Riparian environments and sites situated with reasonable access to water is often combined with the benefits provided by the ecotonal setting.

During the course of this research interesting patterns and fascinating questions have emerged. Interestingly, it is evident that through time based camps were re-established and ephemeral camps distributed either in the near proximity of these base camps or in a wider scattered dispersal around the heart of the base camp sites. In these cases reoccupation of ephemeral sites appears to be based more on random chance then on some type of learned pattern. Reoccupation can be better explained with the addition of an interpretable landscape expanding the range of possibilities that in combination with the material remains could help explain site selection. This ecological approach needs to be expanded and refined with additional environmental data collection and evaluation. Future research designed to address regional questions such as reoccupation and variable dispersal is the only way that these patterns will come to light.

A pattern of rhythmic dispersal and return appears to be the central organizational mechanism underneath prehistoric human behavioral choices in north-central Texas. Only future research can determine why this pattern exists and if indeed history repeats itself through a natural process, some sort of implicit instinct, that revolves around the need to sustain human life. As a result, one must ask oneself if what happened in the past becomes a part of our inherited inherent knowledge that is utilized to survive in the present. This is a question that I think archaeological research was initially designed to answer but unless all of the parts of the whole are organized, preserved, shared and understood this question will remain unanswered. With the knowledge provided by the current regional settlement model and the accompanying methodology it is possible to conduct future research to test a number of hypotheses that question site function, distribution and large scale regional events such as the Middle to Late Archaic westward expansion. These more specific hypotheses can provide clues that when viewed collectively will eventually lead to answers for the larger more abstract questions that science continually seeks to answer.

CHAPTER 8

DISCUSSION AND FUTURE RECOMMENDATIONS

Throughout the course of this research ecological, geographical and archaeological methods have been evaluated, cultural histories reviewed and a new innovative research methodology formulated to facilitate future research and enhance interpretations of prehistoric behavior in north-central Texas. In order to build a regional settlement model SCA has been conducted to extract and interpret environmental information to shed light on the character of archaeological sites in combination with previously excavated remains. Geographic Information System (GIS) software has served as a useful tool for illustrating, comparing, organizing, storing and explaining observations on a regional scale.

Archaeologists concerned with the dynamics of prehistoric behavior must take into consideration the dynamics of the ecological system. Given the evidence available for north-central Texas the best one can hope for on a regional scale is to develop an understanding of the dynamics of the micro-environments around site locations, correlate this information to the material remains, relate it to the larger network of sites and draw inferences by comparison. Framing the archaeological remains in an ecological context, addressing a series of research questions based on ecological and archaeological data and analyzing spatial patterning to formulate a regional model is the basis of the proposed methodology. The methodology can be refined, reshaped and extended to fit the particular character of the region where it is employed. What is of primary importance is that basic conditions are met to fulfill multiple research efforts.

Essentially, what this means is that site catchment analysis (SCA) and all that this phrase implies should be incorporated into archaeological methodology.

Essentially, learning is the basis of a particular manifestation of cultural behavior. In order to understand the mechanism of cultural selection, the process by which new behaviors are taught, learned and retained should be investigated. For example, it must be taken into consideration that food procurement techniques were much more dependent upon geographical location during prehistoric times than they are today and as such learning would have been as intricately intertwined with spatial location. The dynamic character of this cultural process makes it very difficult to discern in the archaeological record but the environment provides clues that can help understand the larger picture. In addition, a deeper understanding of the resources available to ancient populations has shed light on necessary decisions associated with that specific type of environment. For example, many medicinal plants are highly toxic and potentially lethal if not prepared in an appropriate manner. Therefore, a medicinal environment requires a certain degree of knowledge of what plants to choose and how to prepare these plants. Another instance of learning relates to cultural affinities related to style which could either be due to trading goods or exchanging knowledge. On the other hand, it is often the case that flint-knappers discovers a particular tool type and based on their knowledge of tool manufacture replicate the item without outside instruction. As such, it is very difficult to ascertain the basis of cultural affinity and to what extent it is a result of primary or secondary case of information diffusion. In this case examination of the artifacts in isolation could result in the possibility of either case. However, it is possible to establish theories when other variables are factored into the equation. Other artifacts, faunal remains, palynological remains and possibly structural remains all provide clues that shed light on cultural patterns. If a solid correlation is established between two particular sites it is possible to look for processes and reciprocity.

In addition to the complexity of social systems the complexity of ecosystems poses a problem in and of itself in terms of obtaining a database that is powerful enough to reconstruct past systemic interactions between humans and their landscape. Vayda and Rappaport (1968: 495-496) caution against the application of an ecological approach by emphasizing its limitations (cited in Geier, 1974: 47). Regardless of the limitations that accompany any scientific inquiry into the past it is beneficial to begin constructing databases that include consideration of the components of the ecosystem and their potentiality to exist in the past. Although the task may seem insurmountable it is a worthwhile venture that provides a more comprehensive view of the potentiality of past cultural systems. It is true, as Vayda and Rappaport (1968) point out, that most statements of socio-environmental interaction are hypotheses only. However, this is the case with any other inference that archaeologists make about the past. The archaeological record presents "knowns" and "unknowns." It is what we do with the "knowns" that will determine the depth and breadth of our learning experience.

Future Recommendations

Destruction of archaeological sites by agriculture, urban expansion, highway construction, reservoir development projects and a variety of other federal, state, and locally funded construction projects is a continual phenomenon. Mitigation of this problem has been attempted by the passing of legislation such as the National Environmental Policy Act of 1969. The inclusion of cultural resources as a significant part of environmental impact assessments has provided archaeologists with the opportunity to become involved in research and planning of land development to a certain degree. Legislation protecting archaeological resources has produced massive data collection in the archaeological community. Coupled with the lack of communication between state and local agencies this situation has led to increased fragmentation in the archaeological record.

Archaeology as a discipline has only been academically active for a little over 50 years. As a relatively young discipline, experimentation with research methodology and excavation techniques is still in progress. In general, archaeology has come a long way since the antiquarian days of collecting and early pre-conceived anthropological notions of aboriginal cultures. Inter-disciplinary studies have contributed a wealth of information to help explain prehistoric behaviors. Cultural ecology, ethnography and ethnobotany, to name a few, have provided a deeper understanding and appreciation for the necessary intellect required for survival during prehistoric times.

> We no longer think of the pre-ceramic plant-collectors as a ragged and scruffy bands of nomads; instead they appear as a practiced and ingenious team of lay botanists who know how to wring the most out of a superficially bleak environment (Flannery, 1968:67).

A plethora of archaeological methods have been innovated since the inception of archaeology as an academic discipline. These methods have provided focused efforts and increased efficiency in terms of time management while contributing pertinent and valuable information to the archaeological record. However, the associated data and information becomes lost in the shuffle along with the exclusion of data from the site context that could provide important data for other investigations. As a result, many scientific inquiries become redundant procedures and comparability is limited to the research methodology under which the initial excavations were conducted. Archaeologists have been so focused on the particulars that the larger picture is either obscured or over-generalized. While attempting to establish a regional model much time has been consumed by re-entry of data and information. In addition, there is a significant amount of data exclusion due to the unavailability of resource information. It is very difficult for growth to occur in isolation. Archaeology should be a cumulative discipline that is organized and accessible. Regardless of the situation in the archaeological community land development continues and site reports accumulate in inaccessible locations. What is lacking in this system of piecemeal cultural resource management efforts is a standardized methodology to guide local archaeological societies, academic institutions, archaeological consultants and consulting firms. While these entities are due creative process, there needs to be an established set of minimum requirements in place for data collection and reporting, in order for excavation efforts to benefit future research and facilitate comparability. In addition, there needs to be a mechanism in place to centralize and organize these data for future investigations. Growth in technology over the past five years has provided the means to make this happen. GIS technology provides the perfect organizing mechanism that is well suited to the character of archaeological data. The ultimate goal is the creation and maintenance of centralized regional databases, delineated by physiographic boundaries, that links the archaeological data to spatial location and interpretive information. The construction of a database of this nature can facilitate a variety of archaeological, statistical and spatial analyses. With this in mind, the current research was designed to create a proto-type of a regional archaeological database that was incorporated into a GIS interface and linked to an interpretive environmental database. SCA was the established research methodology selected to create a model of prehistoric settlement patterns in north-central Texas. The design is such that multiple analyses could be performed and various research methodologies employed. At this point in time there is a necessity to organize the data that has been collected so that it can be accessed and synthesized for cumulative analyses. In order to fulfill these goals a mechanism must be in place to organize our prior knowledge so that it can be used analytically. Otherwise we will continue to piece together a past that is biased by the available data that has been collected to fulfill particular research methodologies and the record will remain as fragmented in reports as it is in the ground. There is assuredly data that is irretrievable. However, simply organizing what we already have and establishing standards for future data collection is a step in the right direction. Future excavations should include analyses beyond the archaeological remains including active field surveys and excavation of environmental information.

1. Systematic excavation of the site with particular attention to the recovery of economic data
2. Identification of floral and faunal species, and soil character, recovered from cultural deposits
3. Delineation and description of the microenvironmental habitat of each species

4. Field survey of the environment in the region of the site including topographic features, available resources, and cultural limitations of access within a 1-2 km radius of the site location. This would require extensive field survey, test units to collect natural pollen and micro-faunal samples with stratigraphic time- depth, soil samples and vegetation samples of the modern natural environment.

5. Delineation of concentric temporal contours around the site representing travel times from the site to facilitate interpretation and field strategy

6. Description of technological aspects of the culture represented at the site, with particular reference to patterns of subsistence and settlement based on the assemblage character.

7. Identification of the number and proportion of the resources found in the deposit which could have been obtained from each of the several zones as defined by the temporal contours

8. Determining the zone (site territory) which can account for procurement of the respective resources.

During the Stone Age, Bronze Age, Iron Age, Medieval, Renaissance and the Industrial age in the Old World, archaeological evidence suggests that hunter-gatherers in north-central Texas enjoyed the comforts of a landscape structured only by plants, animals, and other humans. For over twelve thousand years people lived in this region and the only traces of their existence are in the archaeological record, as artifacts, features, and concentrations of other types of archaeological materials. Without these records, from our perspective, in time and space, they did not exist. The challenge, then, is to record the existence of these prehistoric populations with as much detail as possible so that we can learn from the behavior of our ancestors to create a better future. We live in an Information age where data surpasses our current ability to deal with it adequately but we can begin fashioning and structuring databases for the archaeological record with integrated systems that will archive this information for future generations.

APPENDIX

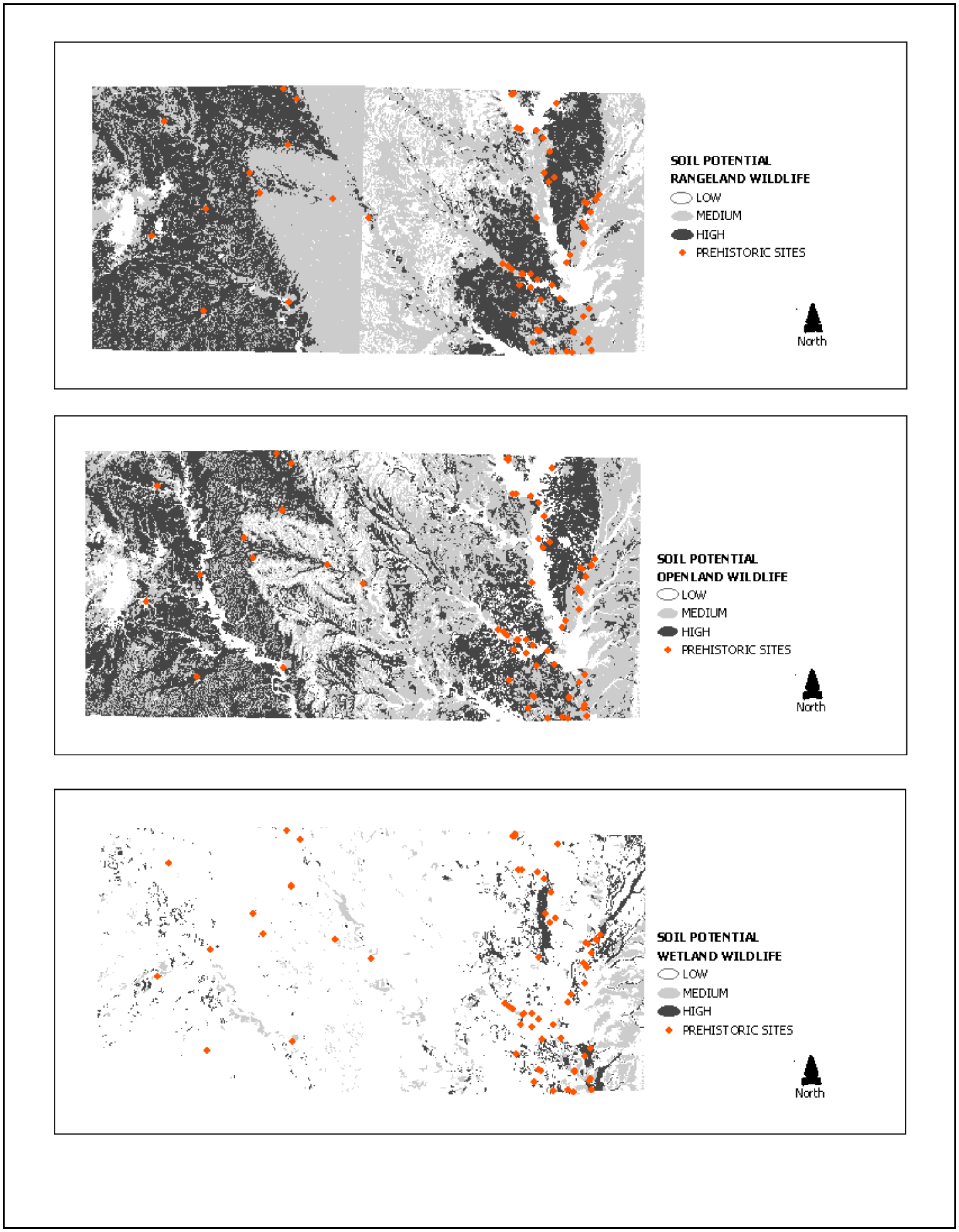

Figure A1. Wildlife potentials and prehistoric sites.

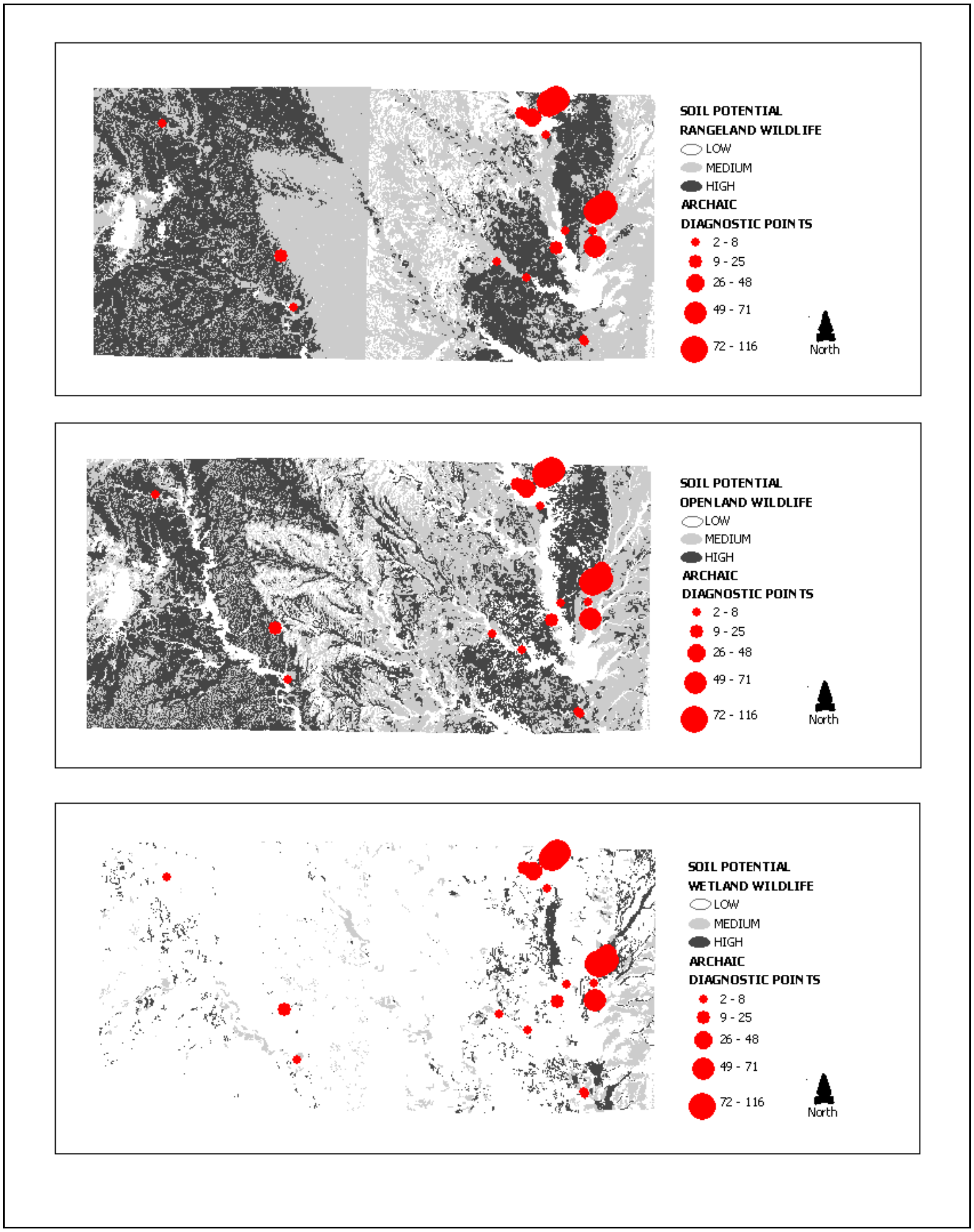

Figure A2. Wildlife potentials and Archaic projectile points.

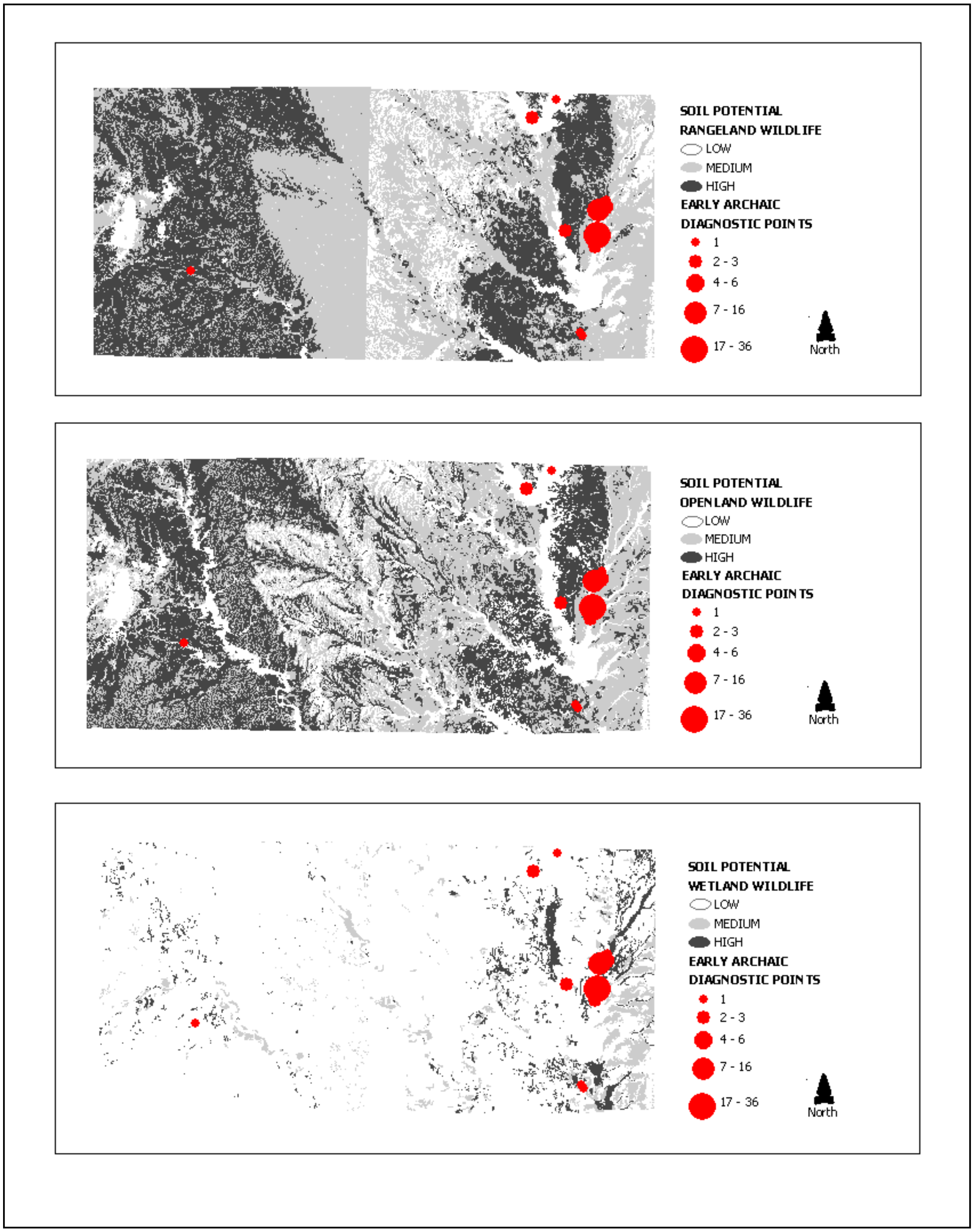

Figure A3. Wildlife potentials and Early Archaic projectile points.

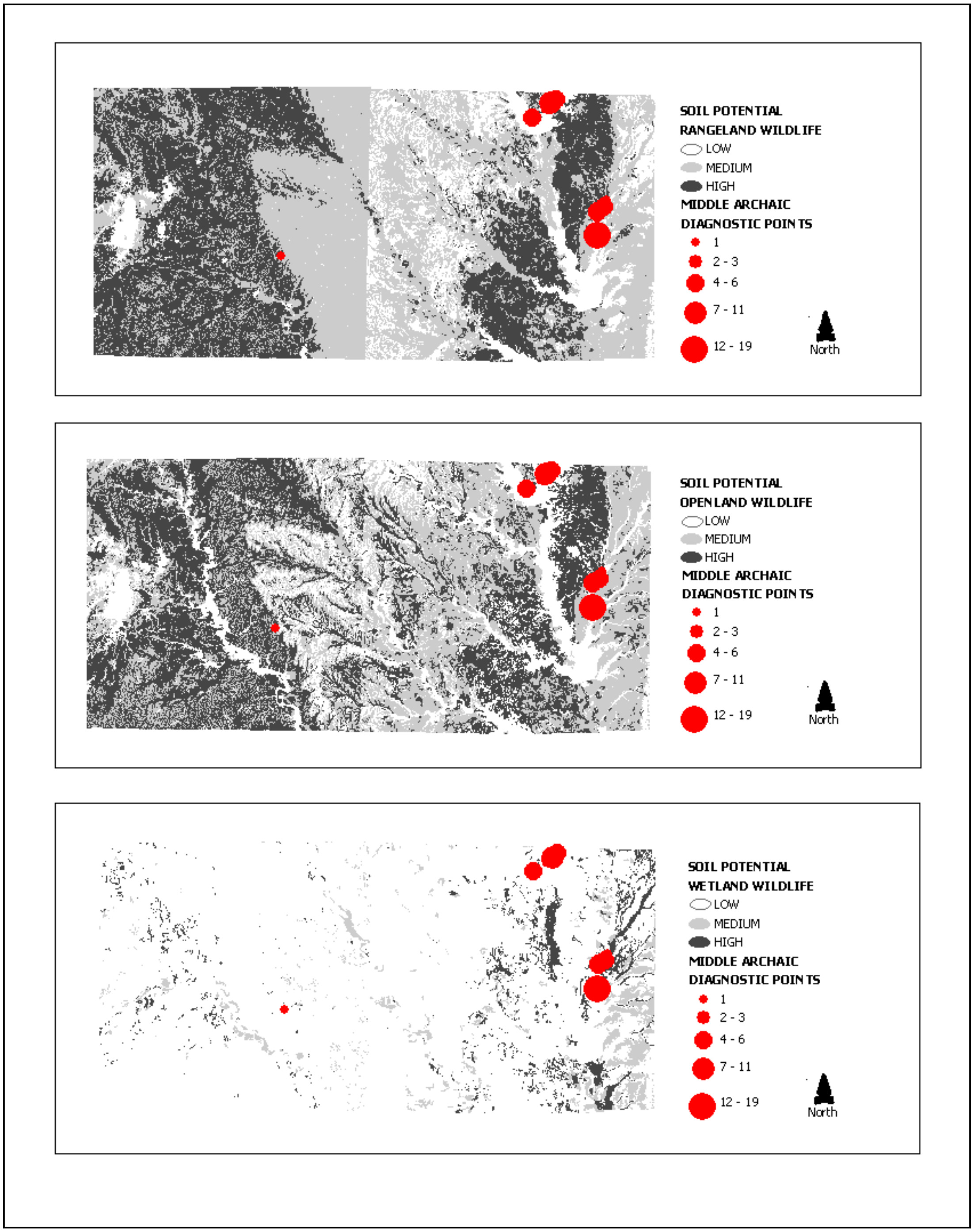

Figure A4. Wildlife potentials and Middle Archaic projectile points.

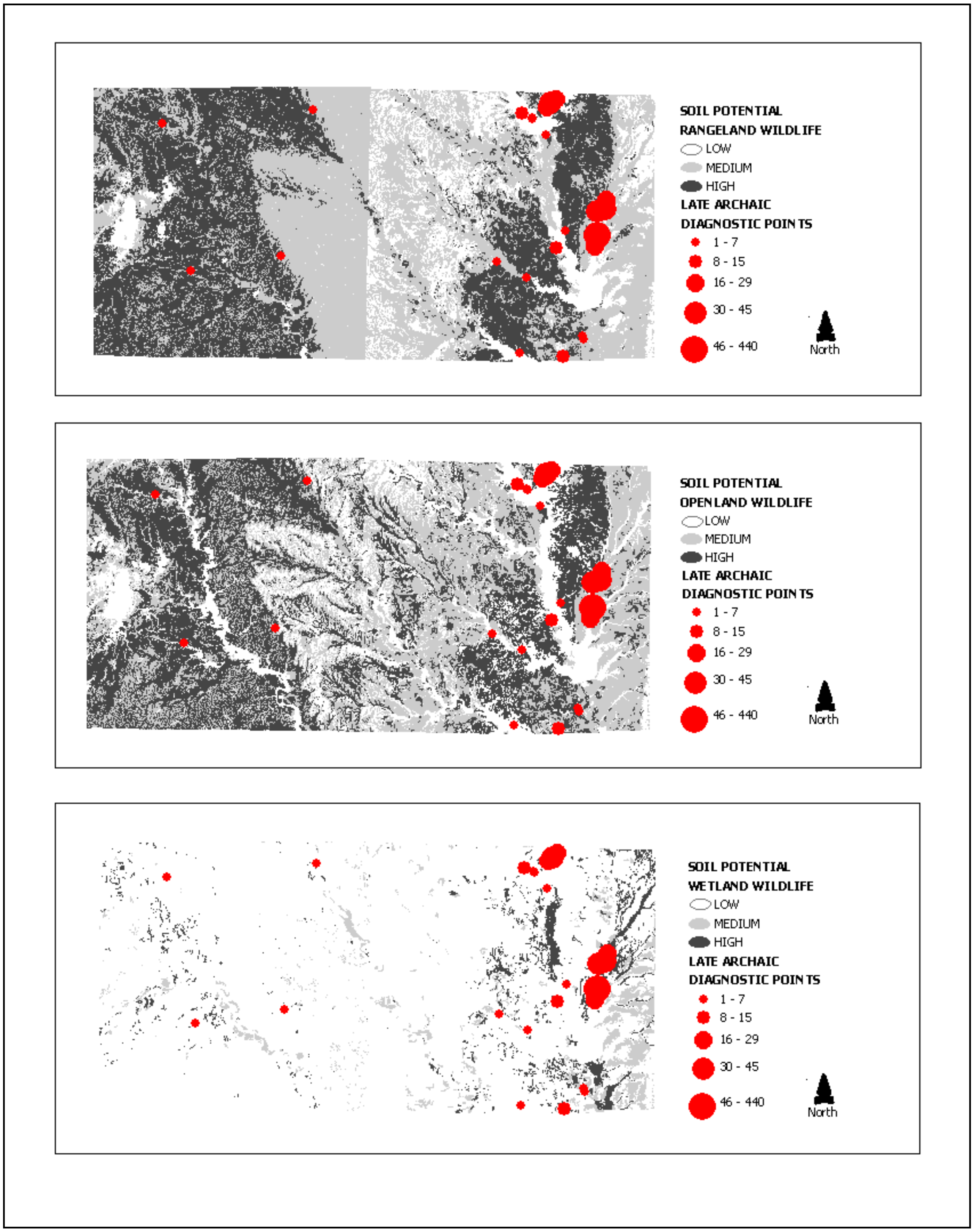

Figure A5. Wildlife potentials and Late Archaic projectile points.

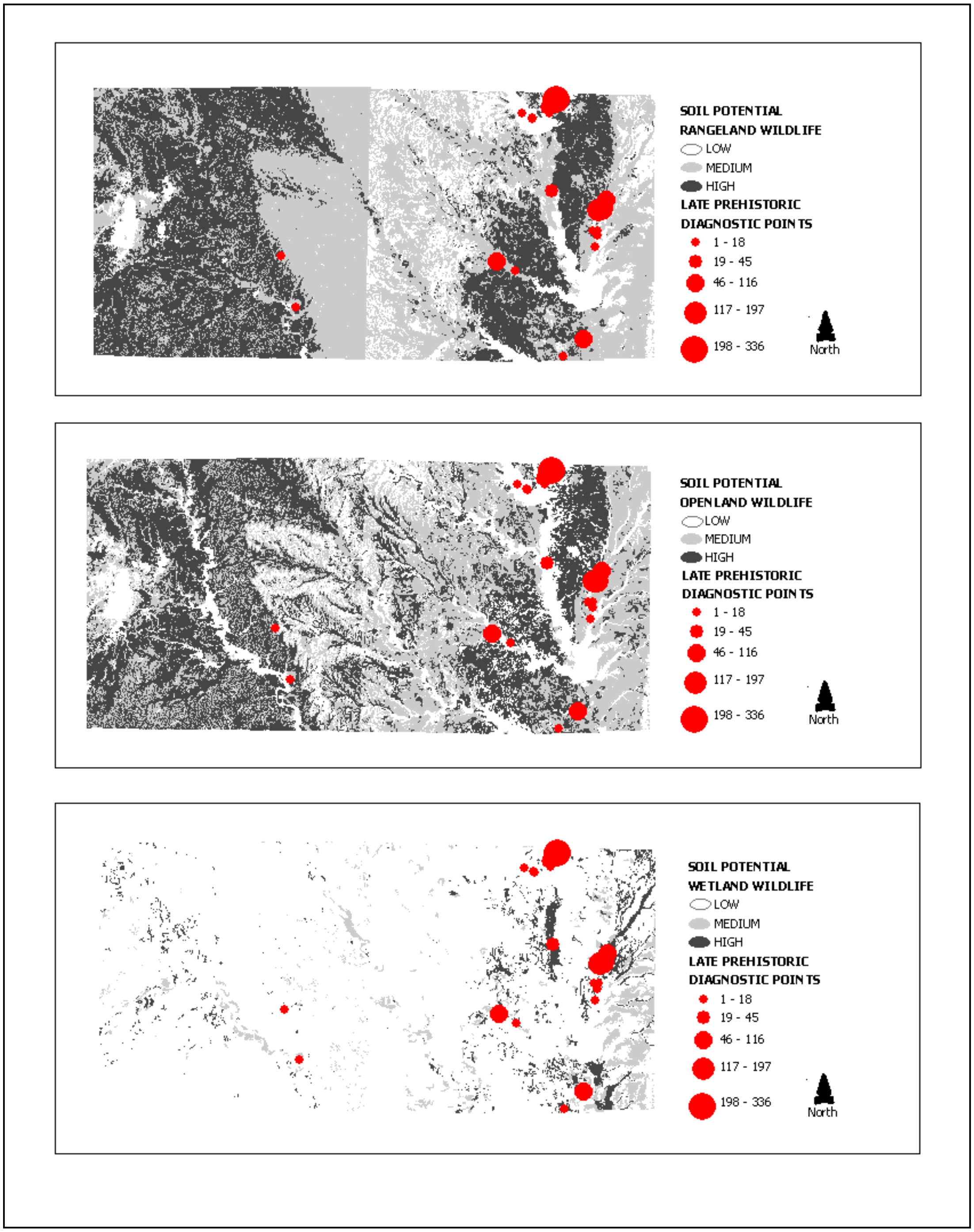

Figure A6. Wildlife potentials and Late Prehistoric projectile points.

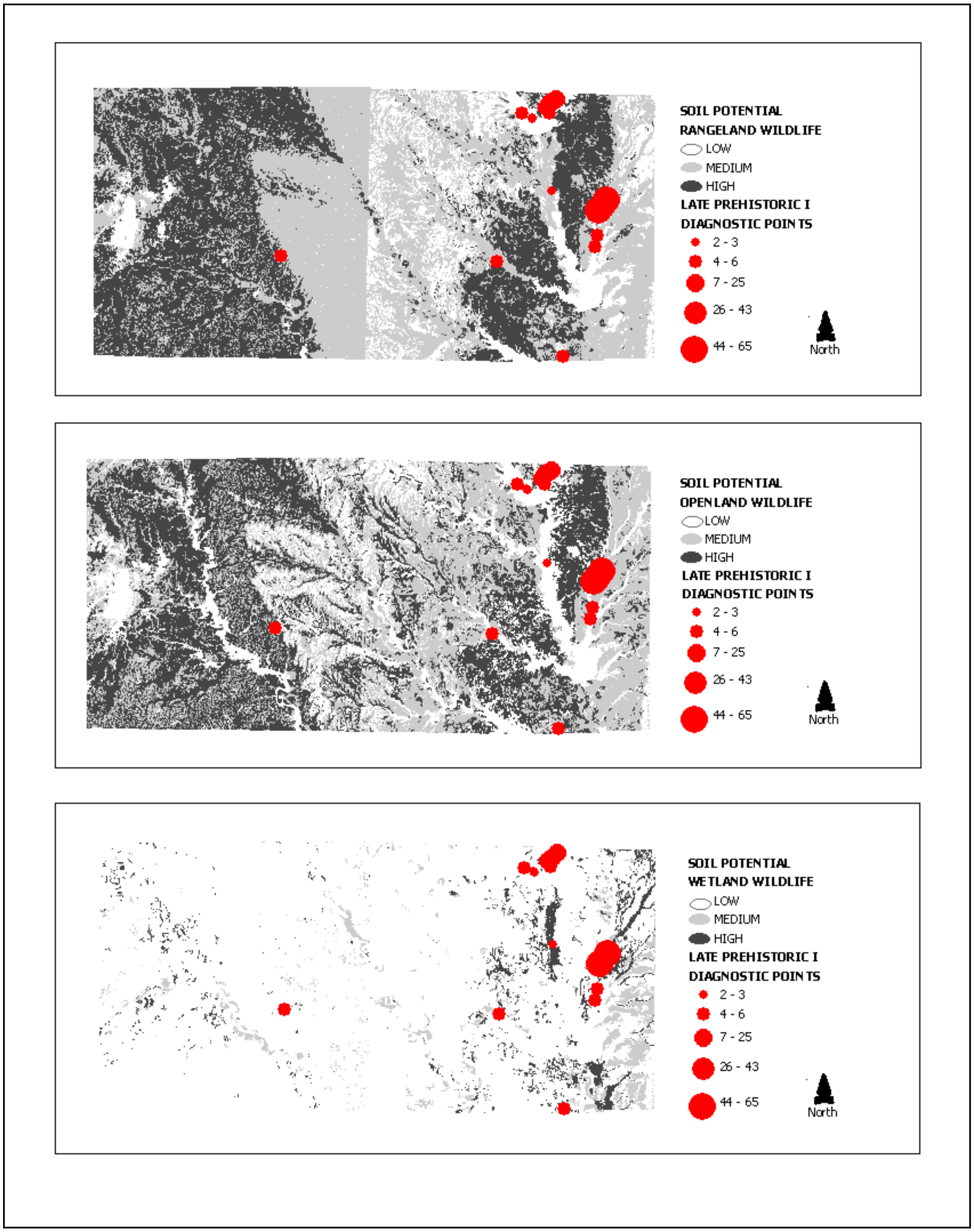

Figure A7. Wildlife potentials and Late Prehistoric I projectile points.

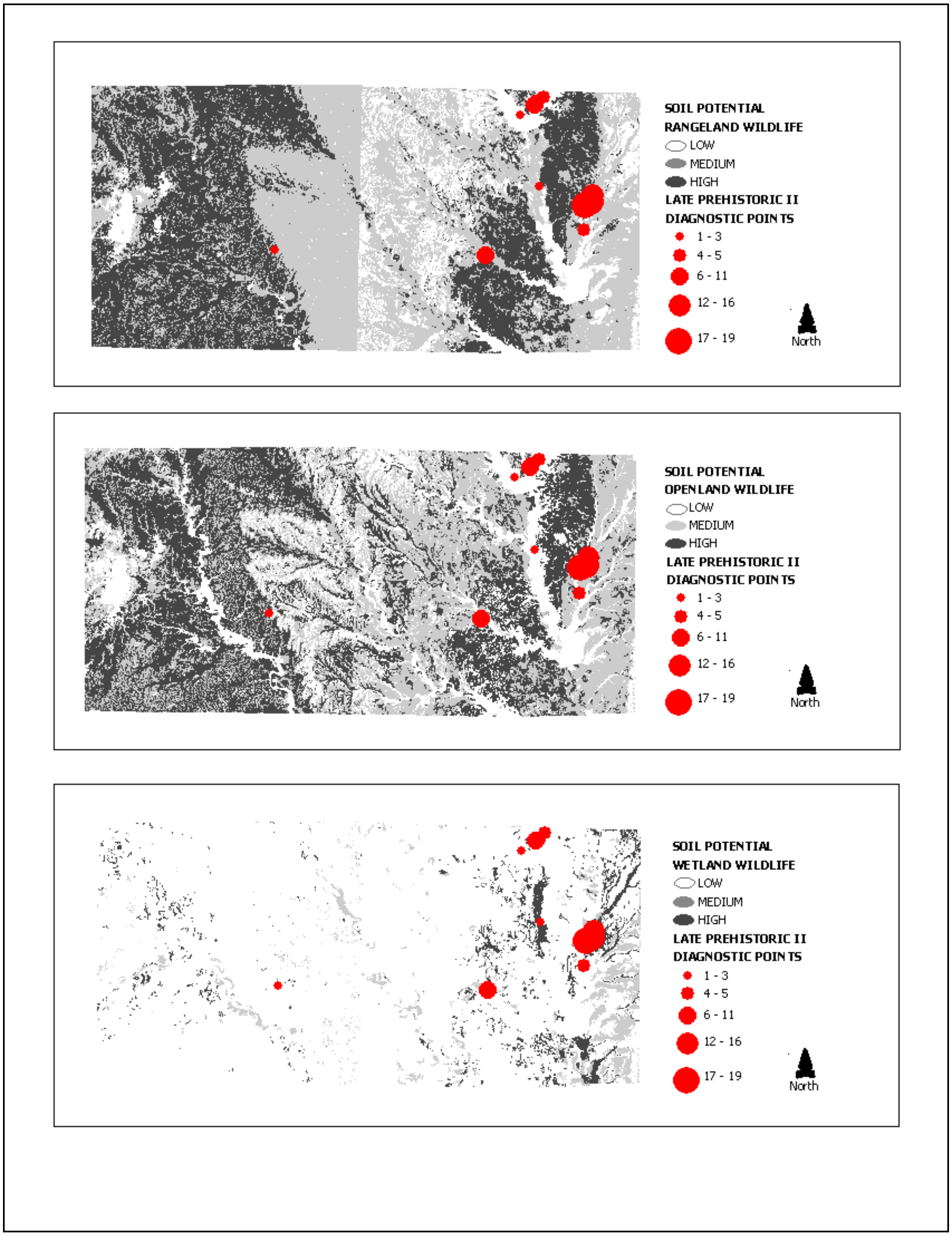

Figure A8. Wildlife potentials and Late Prehistoric II projectile points.

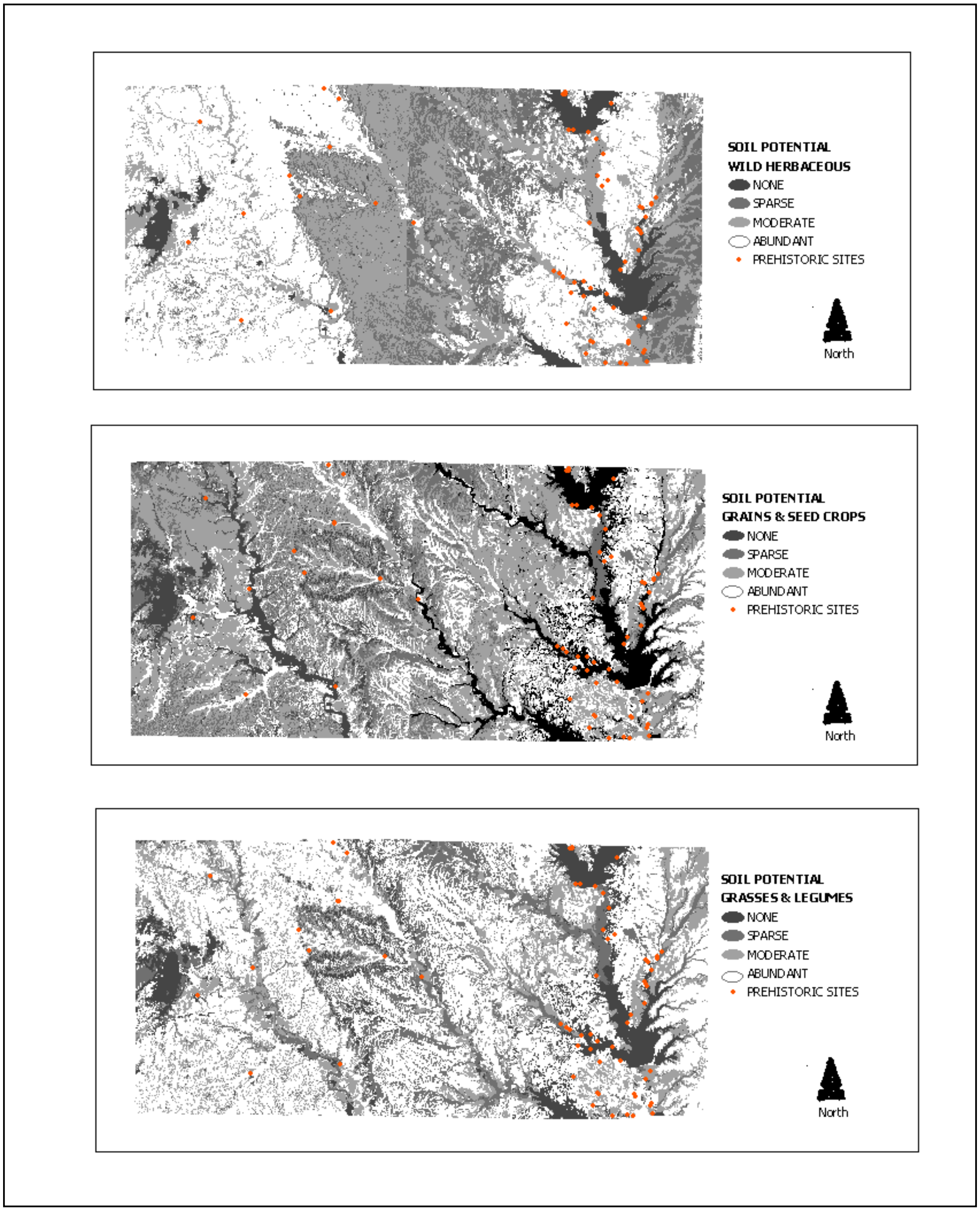

Figure A9. Vegetation potentials and prehistoric sites.

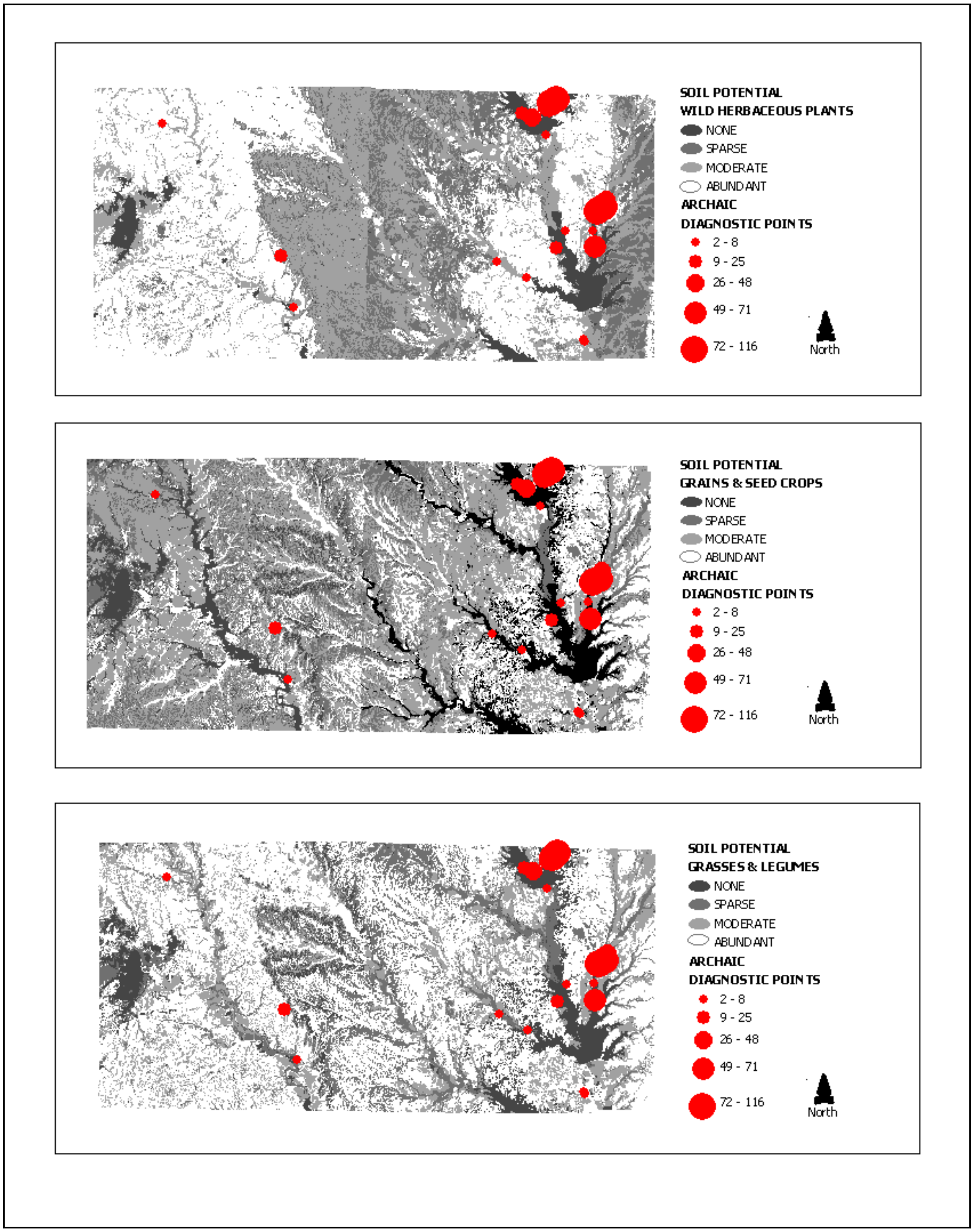

Figure A10. Vegetation potentials and Archaic projectile points.

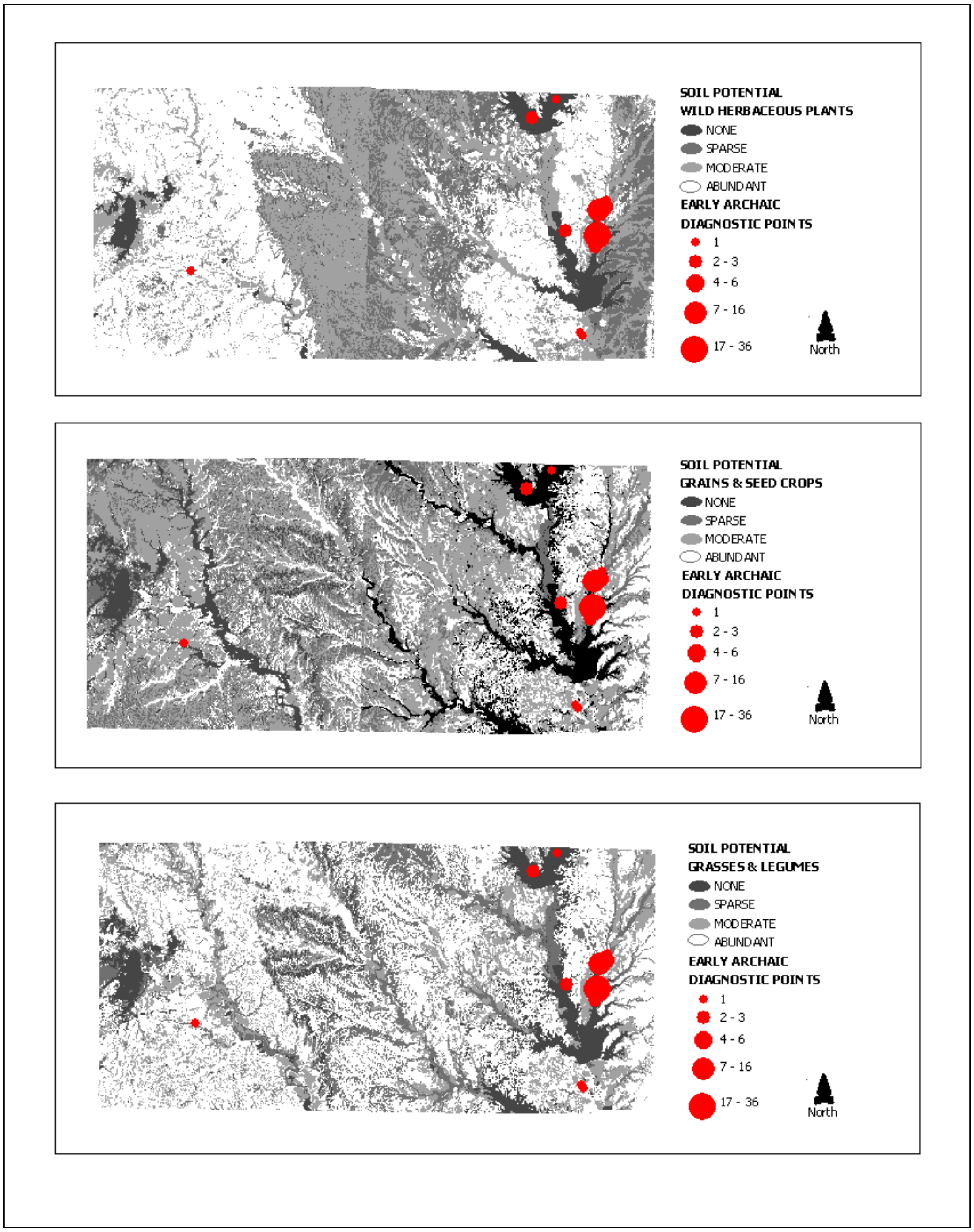

Figure A11. Vegetation potentials and Early Archaic projectile points.

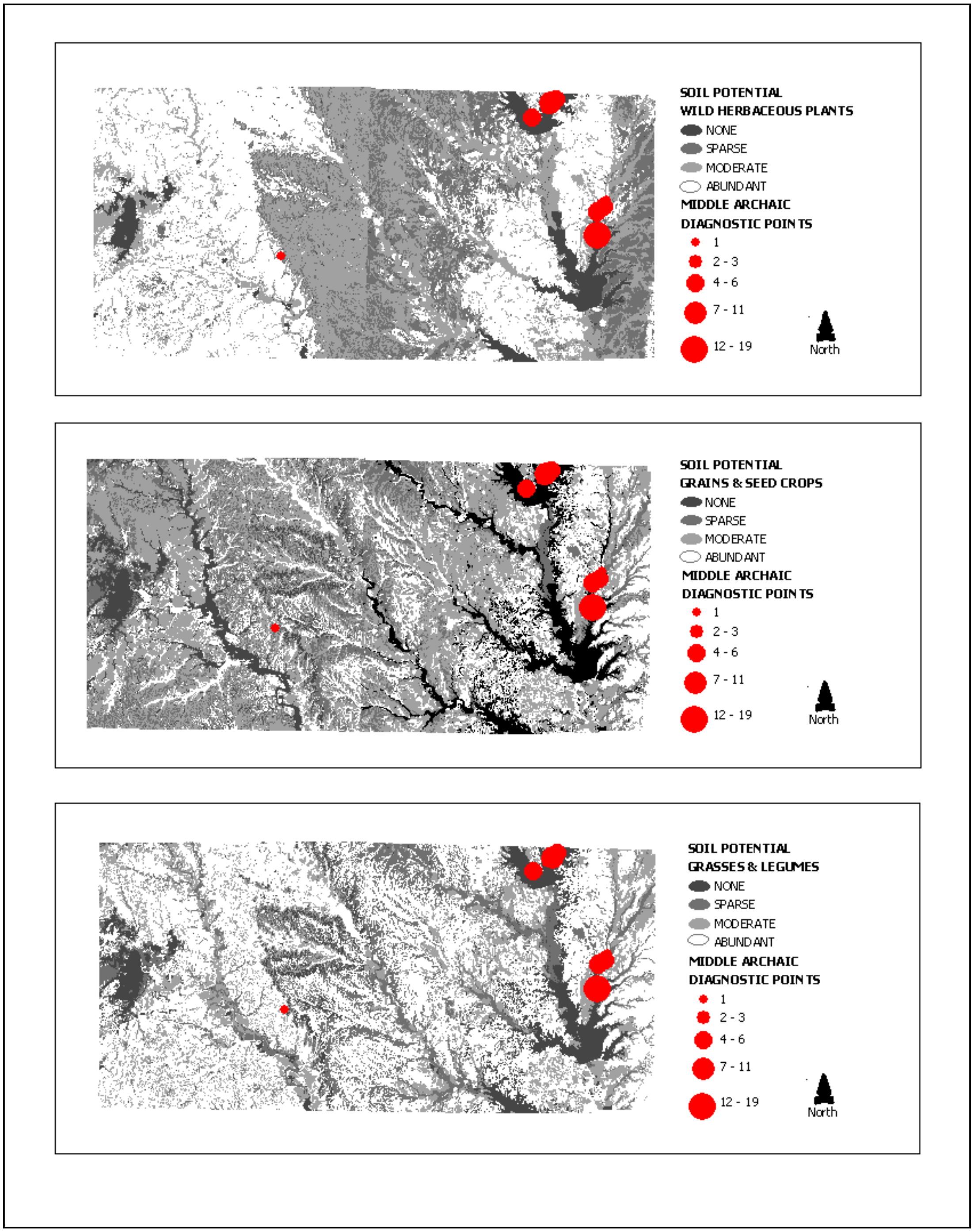

Figure A12. Vegetation potentials and Middle Archaic projectile points.

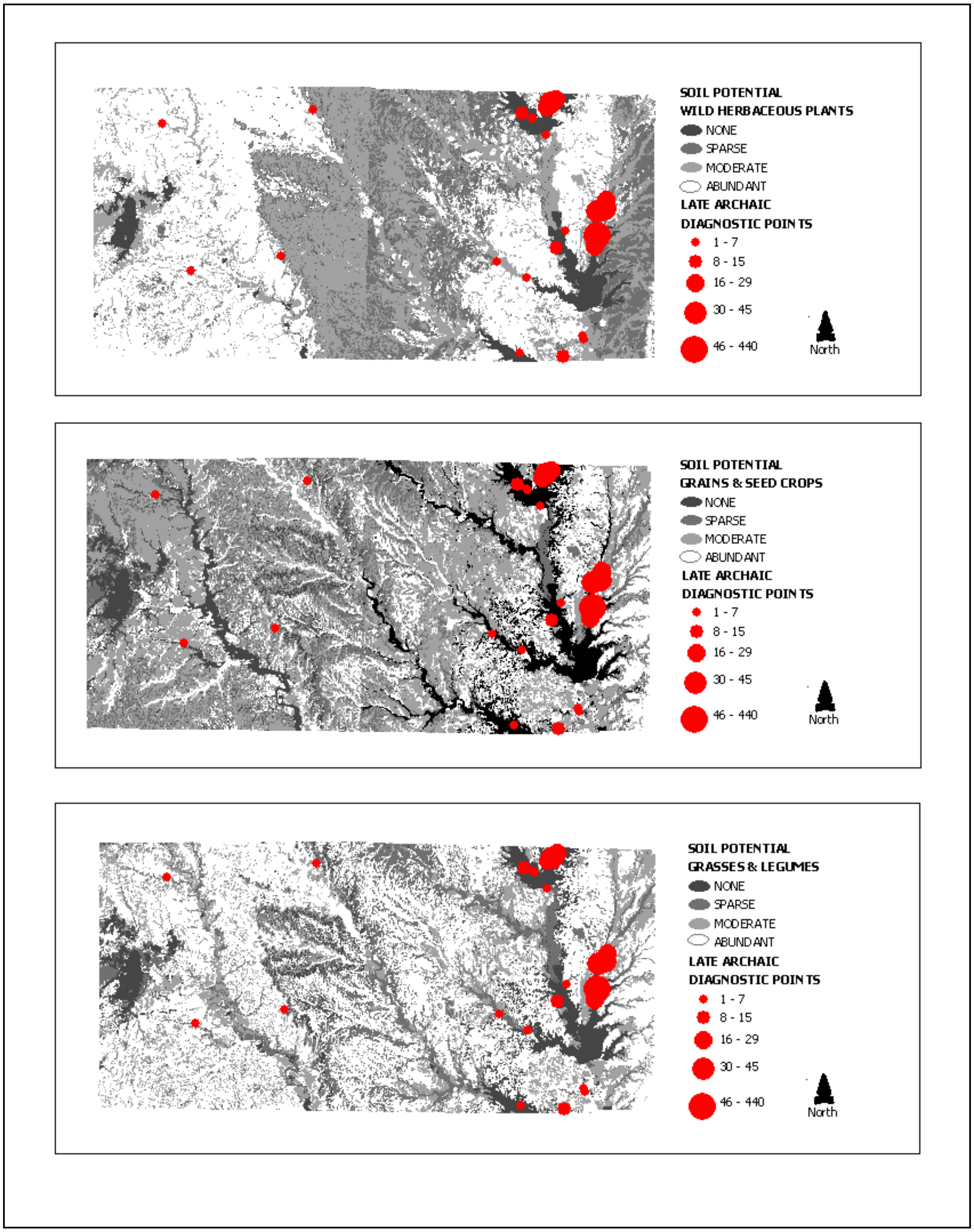

Figure A13. Vegetation potentials and Late Archaic projectile points.

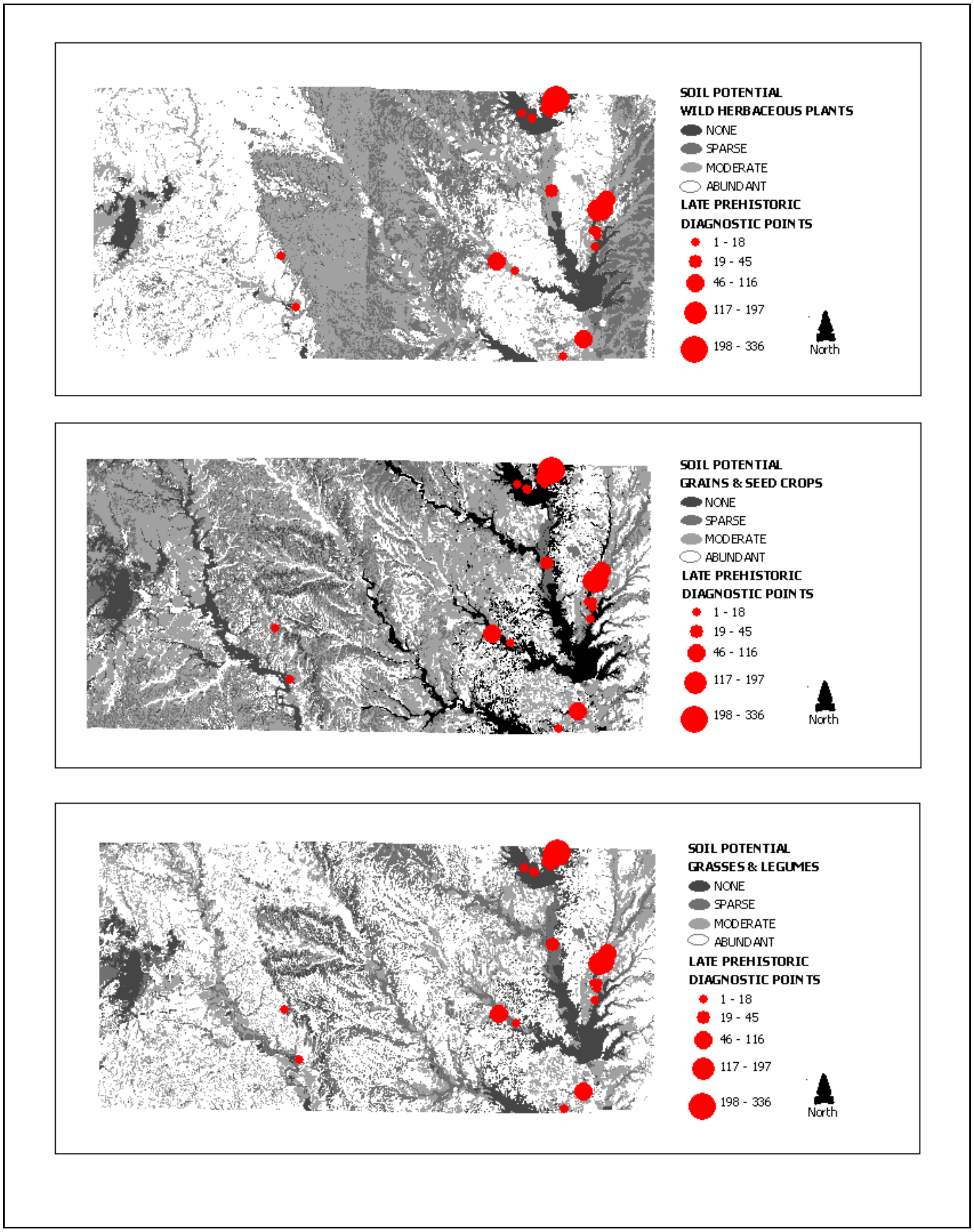

Figure A14. Vegetation potentials and Late Prehistoric projectile points.

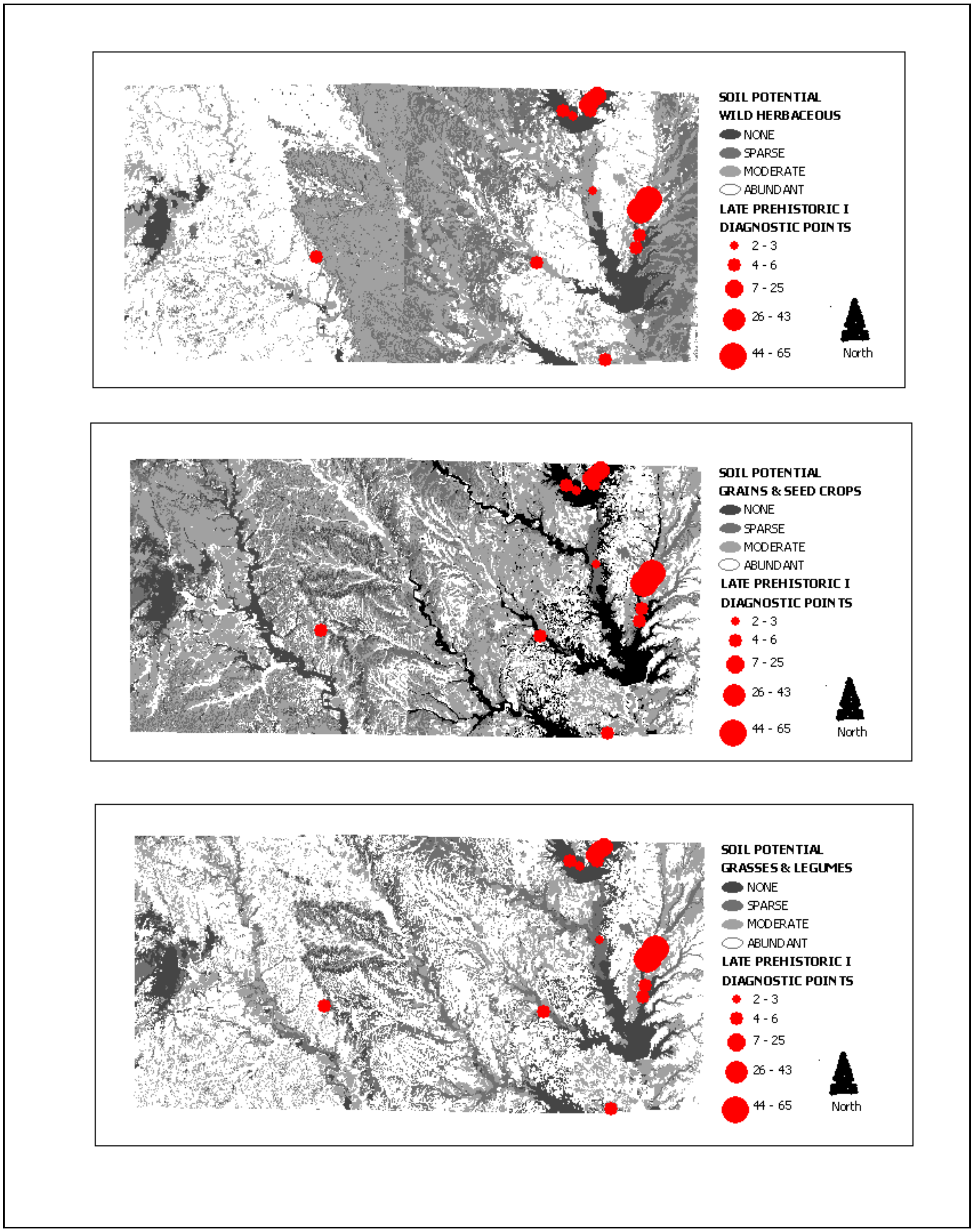

Figure A15. Vegetation potentials and Late Prehistoric I projectile points.

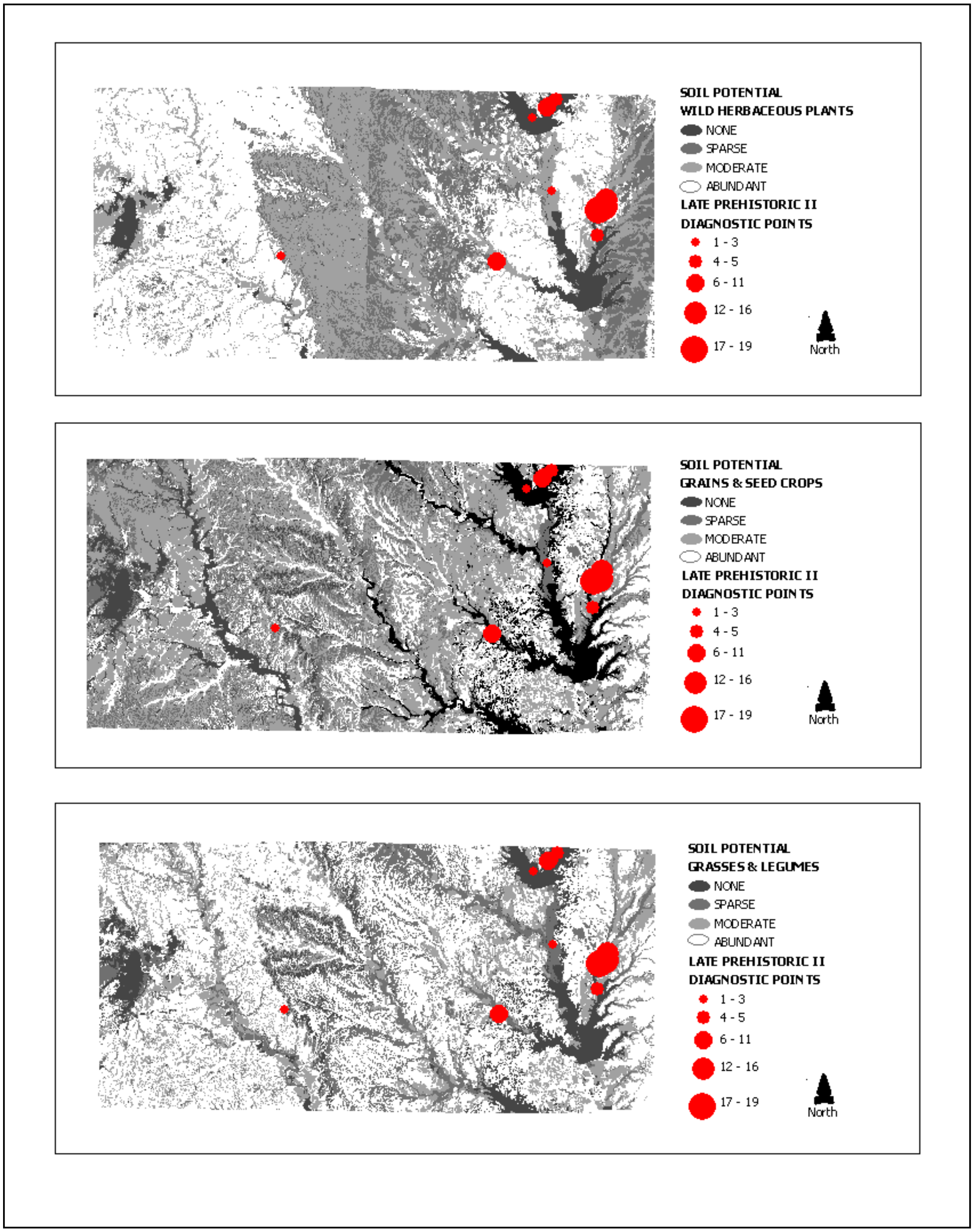

Figure A16. Vegetation potentials and Late Prehistoric II projectile points.

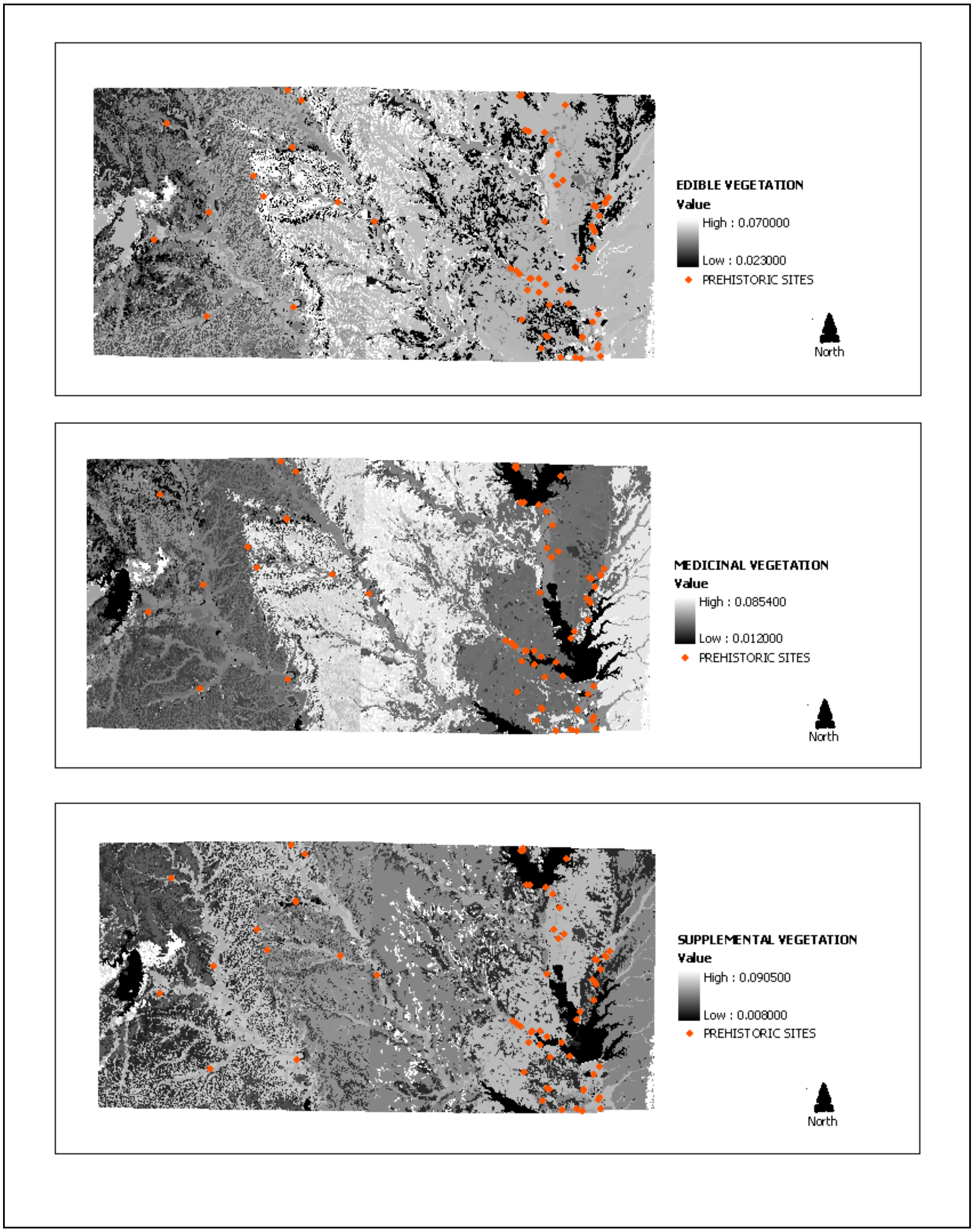

Figure A17. Economic potentials and prehistoric sites.

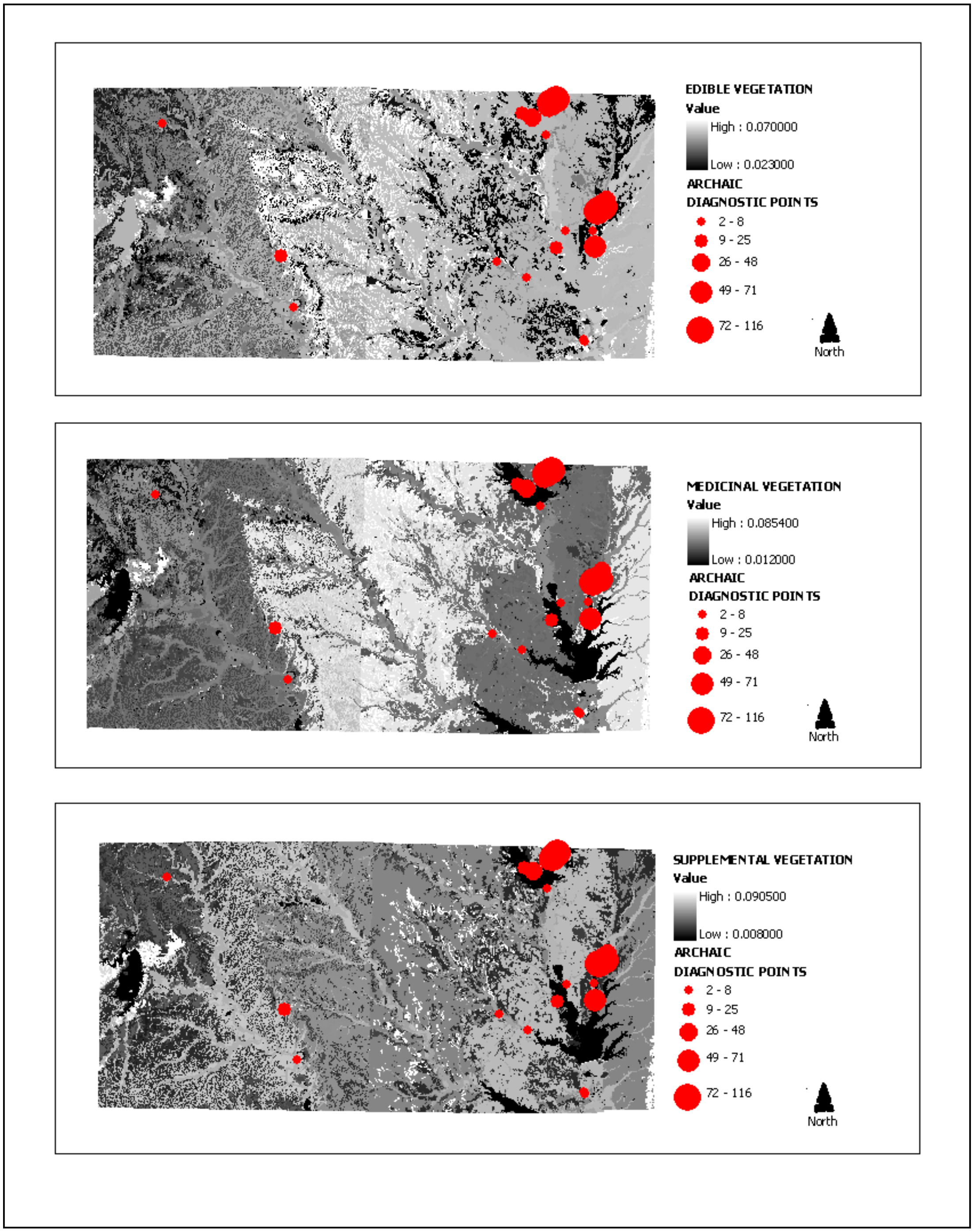

Figure A18. Economic potentials and Archaic projectile points.

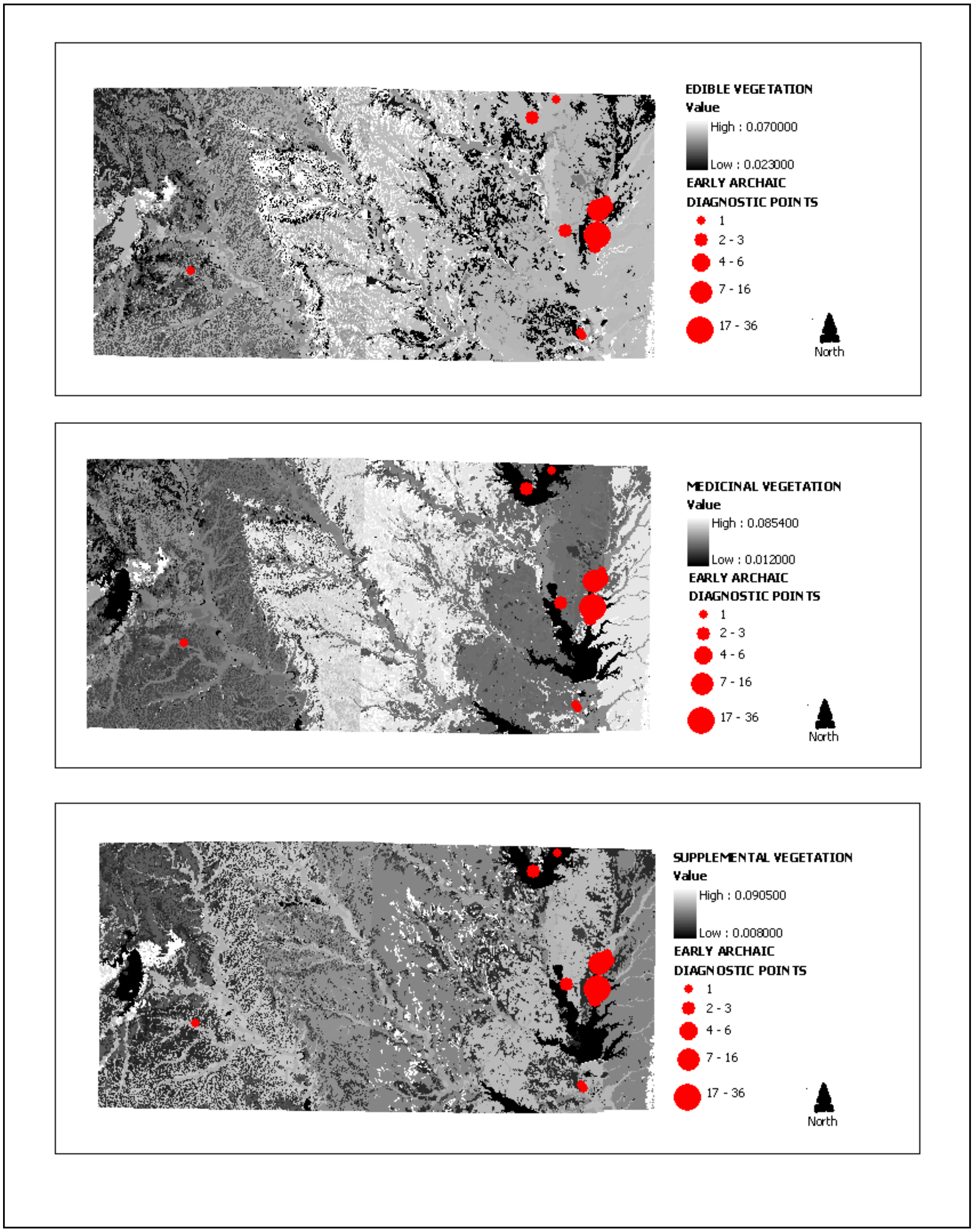

Figure A19. Economic potential and Early Archaic projectile points.

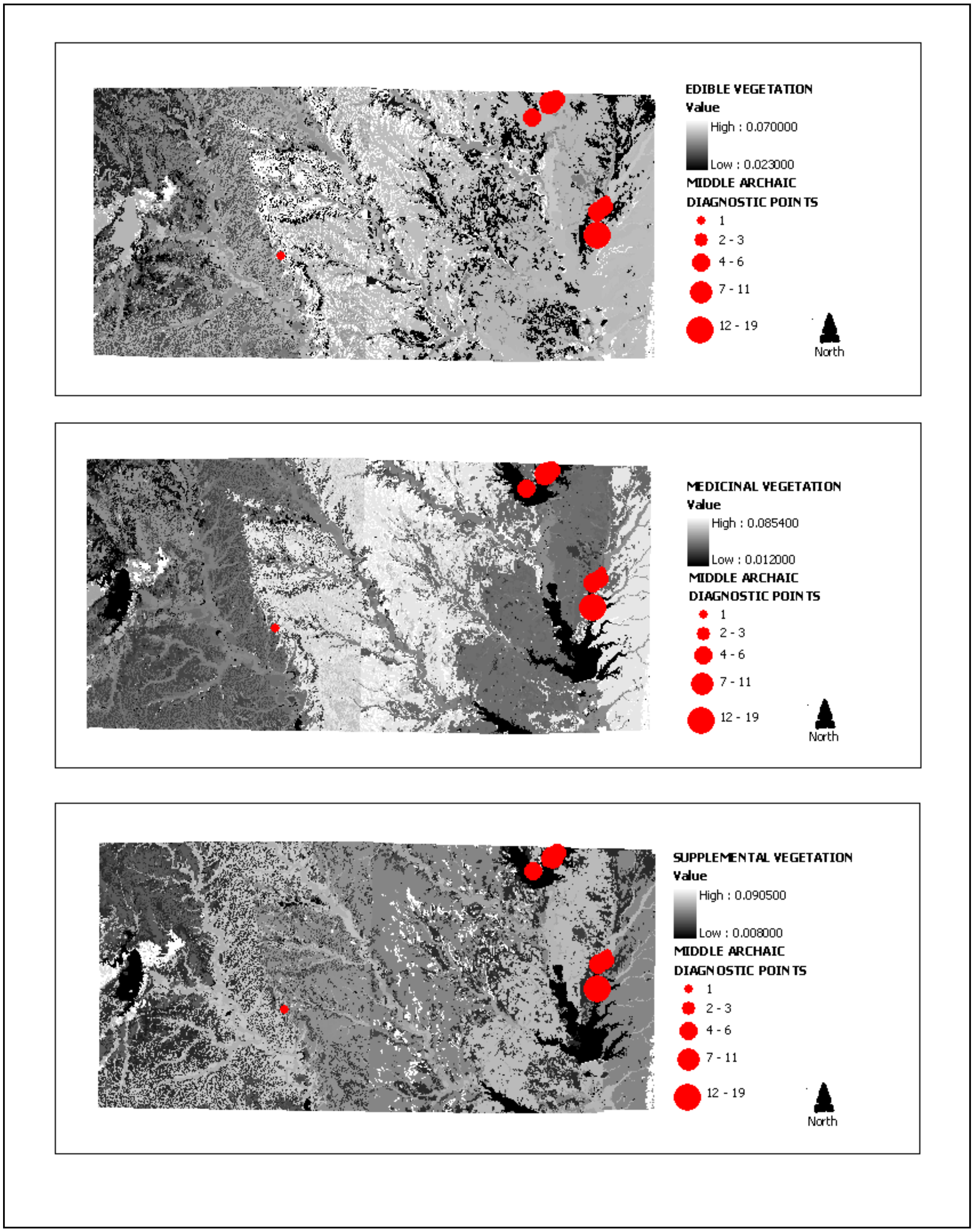

Figure A20. Economic potentials and Middle Archaic projectile points.

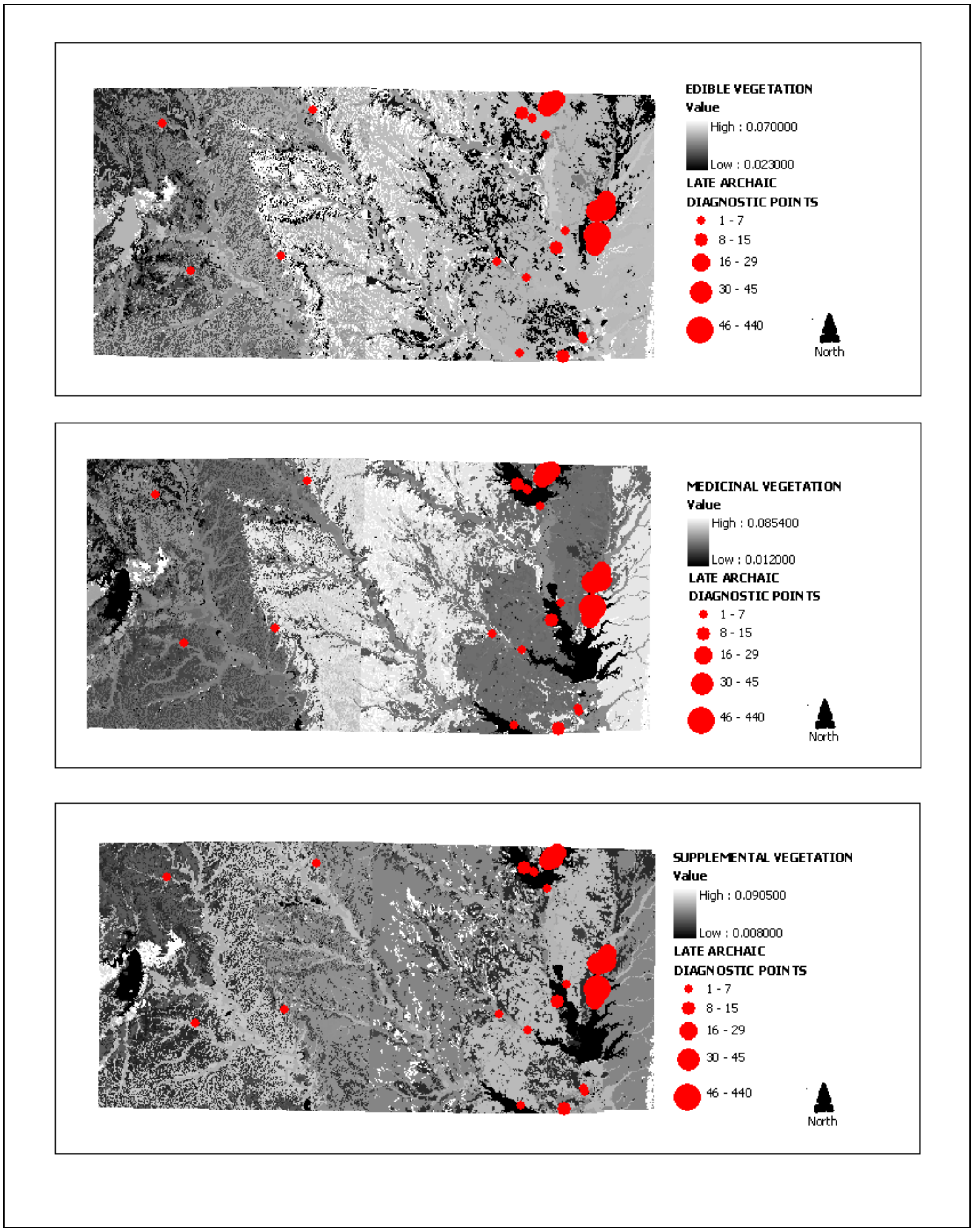

Figure A21. Economic potentials and Late Archaic projectile points.

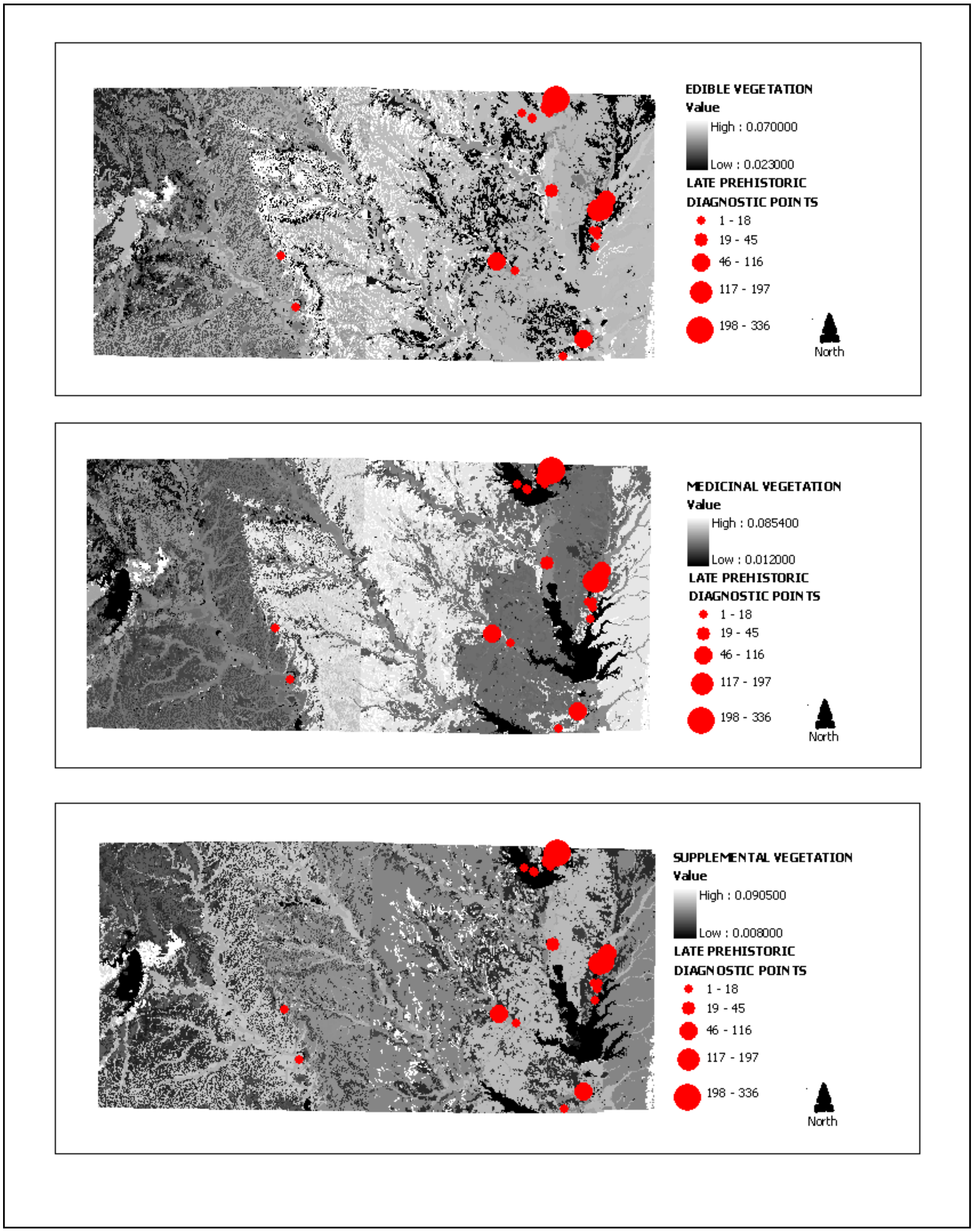

Figure A22. Economic potentials and Late Prehistoric projectile points.

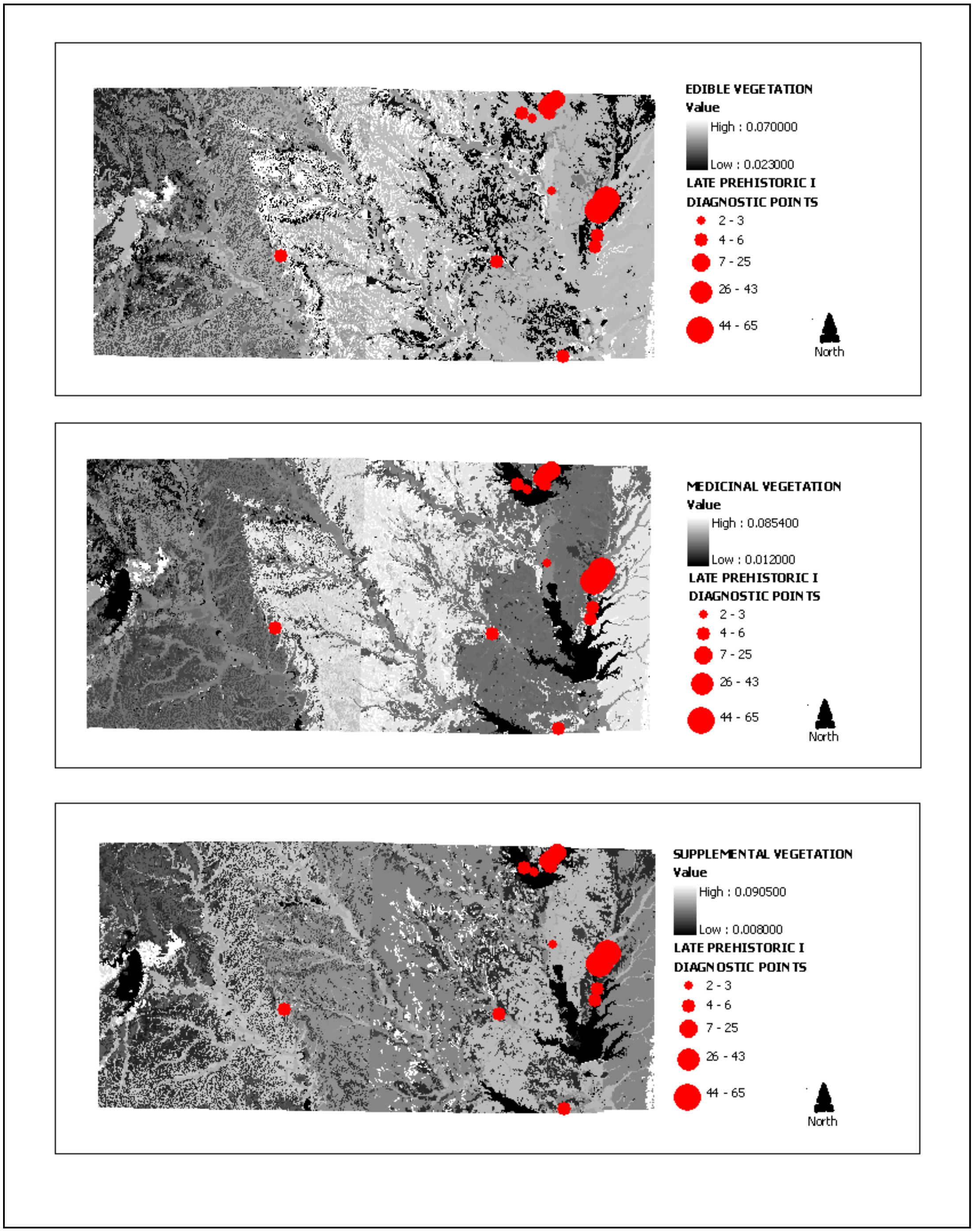

Figure A23. Economic potentials and Late Prehistoric I projectile points.

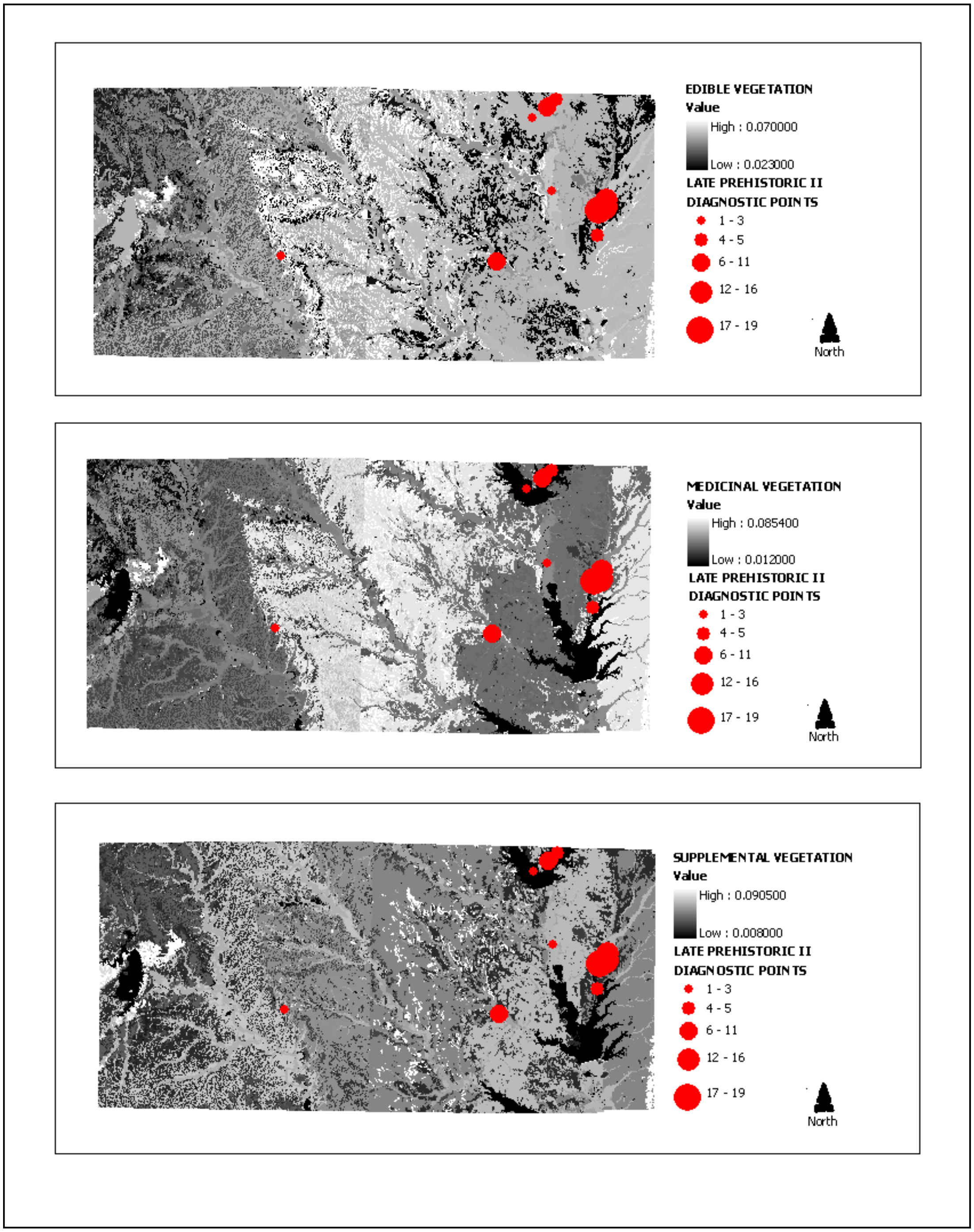

Figure A24. Economic potentials and Late Prehistoric II projectile points.

Table A1. Raw data for hypothesis testing.

EAST FORK	**OCCUPATION FREQUENCY**				**CHANGE THROUGH TIME**							
GREAT GROUPS	SINGLE	DUAL	TRI	MULTI	P	A	EA	MA	LA	LP	LPI	LPII
CHROMUDERTS	44	2	1	1	19	13	1	2	1	18	3	16
CHROMUSTERTS	27	0	1	0	13	6	0	1	0	10	1	9
HAPLAQUOLLS	37	2	1	1	16	10	1	2	1	17	3	15
HAPLUSTOLLS	32	2	1	2	12	13	1	3	1	15	4	13
OCHRAQUALFS	17	1	0	0	11	3	0	0	0	3	0	3
PALEUSTALFS	1	0	0	0	1	0	1	0	0	0	0	0
PELLUSTERTS	45	2	1	3	17	16	2	4	2	2	5	20
RENDOLLS	1	0	0	0	0	0	0	0	0	1	0	1
USTOCHREPTS	35	2	1	3	14	14	2	4	2	17	5	15
TOTAL	47	2	1	3	19	16	2	3	2	22	5	20

	OCCUPATION FREQUENCY				**CHANGE THROUGH TIME**							
TOPOGRAPHIC SETTING	SINGLE	DUAL	TRI	MULTI	P	A	EA	MA	LA	LP	LPI	LPII
ALLUVIAL TERRACES	45	2	1	3	17	16	2	4	2	22	5	20
FLOODPLAINS	37	2	1	1	16	10	1	2	1	17	3	15
UPLANDS	44	2	1	1	19	13	1	2	1	18	3	16
UPLANDS, STREAM TERRACES	32	2	1	3	10	14	2	4	2	18	5	16
TOTAL	47	2	1	3	19	16	2	3	2	22	5	20

	OCCUPATION FREQUENCY				**CHANGE THROUGH TIME**							
GEOLOGICAL SETTING	SINGLE	DUAL	TRI	MULTI	P	A	EA	MA	LA	LP	LPI	LPII
ALLUVIUM	36	2	1	1	15	9	1	2	1	18	3	16
AUSTIN GROUP	5	0	0	0	0	2	0	0	0	4	0	4
FLUVATILE TERRACE DEPOSITS	21	1	0	3	9	9	2	3	2	9	3	9
MARLBROOK MARL	4	0	0	0	4	0	0	0	0	0	0	0
OZAN FORMATION	26	2	1	0	9	7	0	1	0	14	2	12
PECAN GAP CHALK	10	0	0	0	10	0	0	0	0	0	0	0
WOLFE CITY SAND	7	0	0	0	7	0	0	0	0	0	0	0
WATER	14	0	0	2	7	5	1	2	1	6	2	6
TOTAL	47	2	1	3	19	16	2	3	2	22	5	20

	OCCUPATION FREQUENCY				**CHANGE THROUGH TIME**							
PHYSIOGRAPHIC REGION	SINGLE	DUAL	TRI	MULTI	P	A	EA	MA	LA	LP	LPI	LPII
BLACKLAND PRAIRIE	47	2	1	3	19	16	2	3	2	22	5	20
RIPARIAN ZONE (EAST FORK) (2KM)	13	0	0	1	0	6	1	1	1	9	1	9
RIPARIAN ZONE (MINOR TRIB 2KM)	24	2	1	1	8	7	1	2	1	15	3	13
EPHEMERAL STREAMS (1KM)	13	0	1	0	9	2	0	1	0	4	1	3
TOTAL	47	2	1	3	19	16	2	3	2	22	5	20

Table A2. Raw data for hypothesis testing.

ELM/WEST FORKS	OCCUPATION FREQUENCY				CHANGE THROUGH TIME							
GREAT GROUP	**SING**	**DUAL**	**TRI**	**MULTI**	**P**	**A**	**EA**	**MA**	**LA**	**LP**	**LPI**	**LPII**
ARGIUSTOLLS	5	2	1	1	4	2	1	2	4	2	2	2
CALCIUSTOLLS	28	3	5	5	21	9	6	6	15	11	7	6
HAPLUDERTS	31	10	4	3	29	10	7	3	13	15	4	4
HAPLUSTALFS	57	13	7	12	46	21	17	10	27	29	12	17
HAPLUSTEPTS	39	17	4	10	33	16	14	9	23	28	11	13
HAPLUSTERTS	48	11	8	10	38	18	16	8	24	28	12	15
HAPLUSTOLLS	45	14	6	11	42	17	13	9	26	27	12	15
PALEUSTALFS	70	20	8	12	58	26	19	10	33	35	12	17
PALEUSTOLLS	15	2	1	0	12	3	2	0	2	2	0	1
RHODUSTALFS	3	0	0	0	3	0	0	0	0	0	0	0
USTIFLUVENTS	34	11	4	5	28	16	10	4	16	16	2	8
TOPOGRAPHIC SETTING	**SING**	**DUAL**	**TRI**	**MULTI**	**P**	**A**	**EA**	**MA**	**LA**	**LP**	**LPI**	**LPII**
BOTTOMLANDS	26	9	4	4	20	14	9	3	14	15	2	6
FLOODPLAINS	55	17	7	12	47	22	16	10	30	31	12	17
LOW HILLS AND RIDGES	50	11	8	9	36	19	14	6	26	30	11	13
OLD TERRACES AND VALLEY FILLS	2	1	0	1	2	1	1	2	2	1	1	1
PLAINS	6	3	0	2	6	3	2	3	4	2	1	3
PLEISTOCENE AGE TERRACES	27	4	7	8	17	13	11	6	18	21	10	12
RIDGES	11	2	0	3	11	3	3	4	4	4	1	3
STREAM DIVIDES	9	0	0	1	9	1	0	0	1	1	1	1
STREAM TERRACES	57	14	7	11	48	22	15	10	26	27	11	16
TERRACES	41	7	6	8	30	13	12	6	20	22	10	12
UPLAND RIDGES	13	1	0	3	13	3	2	3	4	4	2	2
UPLANDS	68	20	8	12	59	44	32	15	55	57	21	26
TERRACES, FOOTSLOPES, FANS	28	15	4	8	23	14	12	6	20	25	10	10
GEOLOGICAL SETTING	**SING**	**DUAL**	**TRI**	**MULTI**	**P**	**A**	**EA**	**MA**	**LA**	**LP**	**LPI**	**LPII**
ALLUVIUM	40	11	7	8	33	19	13	7	23	22	7	11
ANTLERS SAND	9	2	0	0	9	1	0	1	2	0	0	0
BOKCHITO FORMATION	2	0	0	0	2	0	0	0	0	0	0	0
EAGLE FORD FORMATION	10	5	1	2	8	3	4	2	4	7	3	4
FLUVATILE TERRACE DEPOSITS	36	14	5	9	31	17	12	7	22	25	9	13
GLEN ROSE LIMESTONE	1	0	0	0	1	0	0	0		0	0	0
LIMESTONE AND CLAY	6	1	0	1	6	1	1	2	2	1	1	1
MARL AND LIMESTONE	2	0	0	1	2	1	0	0	1	1	1	1
KIAMICHI FORMATION	1	0	0	0	1	0	0	0	0	0	0	0
PALUXY SAND	1	0	0	2	1	2	2	2	2	3	1	1
PAWPAW FORMATION	4	0	0	0	4	0	0	0	0	0	0	0
SURFICIAL DEPOSITS	1	0	0	1	1	1	1	1	1	2	0	0

Table A3. Raw data for hypothesis testing.

ELM / WEST FORKS	OCCUPATION FREQUENCY						CHANGE THROUGH TIME					
SOIL SETTING	SING	DUAL	TRI	M	P	A	EA	MA	LA	LP	LPI	LPII
BLACKLAND	37	8	6	9	29	13	13	7	20	21	11	13
CLAY LOAM	43	17	5	9	35	17	14	8	23	28	11	13
CLAYEY BOTTOMLAND	36	11	7	6	30	15	11	6	21	21	7	8
CLAYPAN PRAIRIE	52	15	6	11	43	20	15	9	26	27	12	16
DEEP REDLAND	6	0	0	0	5	1	0	0	0	0	0	0
DEEP SAND	14	2	4	6	11	8	8	8	13	10	5	7
ERODED BLACKLAND	15	5	2	5	11	4	7	3	9	15	7	7
LOAMY BOTTOMLAND	56	17	8	12	48	24	17	10	31	32	12	17
LOAMY PRAIRIE	0	1	0	0	0	1	0	0	0	0	0	1
LOAMY SAND	24	6	4	8	17	12	10	7	15	18	6	12
LOW STONY HILL	2	0	0	0	2	0	0	0	0	0	0	0
REDLAND	4	1	1	0	3	0	0	1	3	1	1	0
ROCKY HILL	1	0	0	0	1	0	0	0	0	0	0	0
SANDSTONE	3	1	0	0	3	1	0	0	1	0	0	0
SANDY LOAM	69	20	8	12	57	26	19	10	33	35	12	17
SANDY	19	2	3	4	11	12	5	2	11	8	3	6
SHALLOW CLAY	2	1	0	2	2	2	1	1	2	2	1	3
SHALLOW	1	0	0	0	1	0	0	0	0	0	0	0
STEEP ADOBE	8	1	0	1	7	1	1	2	2	2	1	1
TIGHT SANDY LOAM	11	3	0	3	11	4	3	4	5	4	1	3
WATER	61	16	8	11	51	23	18	9	30	32	11	16

ELM/WEST FORKS	OCCUPATION FREQUENCY						CHANGE THROUGH TIME					
PHYSIOGRAPHIC REGION	SING	DUAL	TRI	M	P	A	EA	MA	LA	LP	LPI	LPII
BLACKLAND PRAIRIE	13	7	1	0	14	4	3	1	4	2	1	1
EAST CROSS TIMBERS	49	11	8	9	36	19	14	6	26	29	11	13
GRAND PRAIRIE	22	4	3	2	17	7	3	2	9	10	2	3
ROLLING PLAINS	1	0	0	0	1	0	0	0	0	0	0	0
WEST CROSS TIMBERS	11	3	0	3	11	4	3	4	5	4	1	3
RIPARIAN ZONE (ELM FORK) (2K)	16	1	3	0	11	4	3	0	4	5	0	1
RIPARIAN ZONE (WEST FORK) (2K)	2	0	0	1	2	1	1	1	1	2	0	0
RIPARIAN ZONE (DENTON CREEK) (2K)	3	1	0	0	4	0	0	0	1	0	0	0
RIPARIAN ZONE (MINOR TRIBUTARIES) (2K)	28	4	4	7	19	12	9	5	16	19	8	8
EPHEMERAL STREAMS (1KM)	20	4	4	4	15	12	6	3	11	11	3	4
ECOTONE (B PRAIRIE/E CROSS TIMBERS) (2K)	5	0	1	0	3	1	1	1	2	1	1	0
ECOTONE (E CROSS TIMBERS/G PRAIRIE) (2K)	14	3	3	1	10	6	2	0	7	8	1	2
ECOTONE (G PRAIRIE/W CROSS TIMBERS) (2K)	6	1	0	1	6	1	1	2	2	1	1	1
TOTAL	71	16	8	11	59	26	19	10	33	35	12	17

Table A4. Raw data for hypothesis testing.

ELM/WEST FORKS	OCCUPATION DENSITY			
GREAT GROUP	EPHEMERAL	MODERATE	INTENSIVE	TOTAL
ARGIUSTOLLS	5	2	2	9
CALCIUSTOLLS	25	6	10	41
HAPLUDERTS	29	12	7	48
HAPLUSTALFS	55	21	13	89
HAPLUSTEPTS	39	18	13	70
HAPLUSTERTS	45	18	14	77
HAPLUSTOLLS	43	19	14	76
PALEUSTALFS	67	28	15	110
PALEUSTOLLS	14	3	1	18
RHODUSTALFS	3	0	0	3
USTIFLUVENTS	30	18	6	54
TOPOGRAPHIC SETTING	EPHEMERAL	MODERATE	INTENSIVE	TOTAL
BOTTOMLANDS	22	15	6	43
FLOODPLAINS	52	24	15	91
LOW HILLS AND RIDGES	48	18	12	78
OLD TERRACES AND VALLEY FILLS	2	1	1	4
PLAINS	6	4	1	11
PLEISTOCENE AGE TERRACES	26	9	11	46
RIDGES	10	4	2	16
STREAM DIVIDES	9	0	1	10
STREAM TERRACES	53	23	12	88
TERRACES	39	13	10	62
UPLAND RIDGES	12	2	3	17
UPLANDS	66	28	15	109
TERRACES, FOOTSLOPES, ALLUVIAL FANS	29	15	11	55
GEOLOGICAL SETTING	EPHEMERAL	MODERATE	INTENSIVE	TOTAL
ALLUVIUM	35	19	12	66
ANTLERS SAND	9	2	0	11
BOKCHITO FORMATION (UNDIVIDED)	2	0	0	2
EAGLE FORD FORMATION	10	6	2	18
FLUVATILE TERRACE DEPOSITS	34	18	12	64
GOODLAND LIMESTONE AND WALNUT CLAY (UNDIVIDED)	6	1	1	8
GRAYSON MARL AND MAIN STREET LIMESTONE	2	0	1	3
PALUXY SAND	0	1	2	3
PAWPAW FORMATION	4	0	0	4
SURFICIAL DEPOSITS (UNDIVIDED)	0	1	1	2
TWIN MOUNTAINS FORMATION	1	2	0	3
WOODBINE FORMATION	39	18	11	68

Table A5. Raw data for hypothesis testing.

ELM/WEST FORKS	OCCUPATION DENSITY			
SOIL SETTING	EPHEMERAL	MODERATE	INTENSIVE	TOTAL
BLACKLAND	36	13	11	60
CLAY LOAM	42	19	13	74
CLAYEY BOTTOMLAND	32	16	12	60
CLAYPAN PRAIRIE	50	21	13	84
DEEP REDLAND	5	1	0	6
DEEP SAND	11	8	7	26
ERODED BLACKLAND	15	7	5	27
LOAMY BOTTOMLAND	53	25	15	93
LOAMY PRAIRIE	0	1	0	1
LOAMY SAND	23	12	7	42
LOW STONY HILL	2	0	0	2
REDLAND	4	1	1	6
ROCKY HILL	1	0	0	1
SANDSTONE	3	1	0	4
SANDY LOAM	66	28	15	109
SANDY	17	8	3	28
SHALLOW CLAY	2	2	1	5
SHALLOW	1	0	0	1
STEEP ADOBE	7	1	2	10
TIGHT SANDY LOAM	10	5	2	17
WATER	56	26	14	96
TOTAL SITES	68	28	15	111
ELM/WEST FORKS	**OCCUPATION DENSITY**			
PHYSIOGRAPHIC REGION	EPHEMERAL	MODERATE	INTENSIVE	TOTAL
BLACKLAND PRAIRIE	10	5	1	16
EAST CROSS TIMBERS	39	14	10	63
GRAND PRAIRIE	8	4	2	14
ROLLING PLAINS	1	0	0	1
WEST CROSS TIMBERS	10	5	2	17
RIPARIAN ZONE (ELM FORK) (2KM)	14	4	2	20
RIPARIAN ZONE (WEST FORK) (2KM)	1	1	1	3
RIPARIAN ZONE (DENTON CREEK) (2KM)	3	1	0	4
RIPARIAN ZONE (MINOR TRIBUTARIES) (2KM)	28	8	8	44
EPHEMERAL STREAMS (1KM)	17	8	7	32
ECOTONE (BLACKLAND PRAIRIE/EAST CROSS TIMBERS) (2KM)	4	1	1	6
ECOTONE (EAST CROSS TIMBERS/GRAND PRAIRIE) (2KM)	12	6	3	21
ECOTONE (GRAND PRAIRIE/WEST CROSS TIMBERS) (2KM)	6	1	1	8
TOTAL	68	28	15	111

Table A6. Raw data for hypothesis testing.

ELM/WEST FORKS	ACTIVITIES			
GREAT GROUP	TOOL MANUFACTURE	FOOD PREP	HUNTING	LITHIC SCATTER
ARGIUSTOLLS	3	4	4	4
CALCIUSTOLLS	9	16	15	14
HAPLUDERTS	15	24	19	17
HAPLUSTALFS	18	34	35	38
HAPLUSTEPTS	18	35	32	23
HAPLUSTERTS	17	35	33	29
HAPLUSTOLLS	21	40	34	21
PALEUSTALFS	26	45	44	40
PALEUSTOLLS	7	7	3	11
RHODUSTALFS	1	1	0	1
USTIFLUVENTS	15	20	24	16
TOPOGRAPHIC SETTING	TOOL MANUFACTURE	FOOD PREP	HUNTING	LITHIC SCATTER
BOTTOMLANDS	13	17	21	12
FLOODPLAINS	23	43	40	27
LOW HILLS AND RIDGES	16	29	31	30
OLD TERRACES/VALLEY FILLS	1	2	2	1
PLAINS	3	3	5	3
PLEISTOCENE AGE TERRACES	12	27	28	19
RIDGES	4	6	6	5
STREAM DIVIDES	3	0	1	8
STREAM TERRACES	20	36	36	33
TERRACES	14	24	25	31
UPLAND RIDGES	2	6	5	8
UPLANDS	26	45	44	39
TERRACES, FOOTSLOPES, FANS	14	28	27	19
GEOLOGICAL SETTING	TOOL MANUFACTURE	FOOD PREP	HUNTING	LITHIC SCATTER
ALLUVIUM	21	31	31	18
ANTLERS SAND	0	4	2	5
BOKCHITO FORMATION	0	0	0	2
EAGLE FORD FORMATION	2	7	8	6
FLUVATILE TERRACE DEPOSITS	21	32	32	19
GOODLAND LIMESTONE AND WALNUT CLAY	1	4	2	3
GRAYSON MARL AND MAIN STREET LIMESTONE	0	1	1	2
PALUXY SAND	2	2	3	0
PAWPAW FORMATION	0	0	0	4
SURFICIAL DEPOSITS	1	1	2	0
TWIN MOUNTAINS FORMATION	1	1	2	0
WOODBINE FORMATION	14	26	30	23

Table A7. Raw data for hypothesis testing.

ELM/WEST FORKS		**ACTIVITIES**		
SOIL SETTING	TOOL MANUFACTURE	FOOD PREPARATION	HUNTING ACTIVITIES	LITHIC SCATTER
BLACKLAND	14	25	26	27
CLAY LOAM	19	36	32	24
CLAYEY BOTTOMLAND	21	29	29	17
CLAYPAN PRAIRIE	21	36	35	36
DEEP REDLAND	1	0	0	3
DEEP SAND	7	12	16	7
ERODED BLACKLAND	3	12	13	10
LOAMY BOTTOMLAND	23	43	40	27
LOAMY PRAIRIE	1	1	1	0
LOAMY SAND	7	19	21	11
LOW STONY HILL	1	1	0	0
REDLAND	2	3	2	2
ROCKY HILL	1	0	0	0
SANDSTONE	0	1	1	2
SANDY LOAM	26	45	44	39
SANDY	4	9	11	11
SHALLOW CLAY	1	2	3	1
STEEP ADOBE	2	6	3	2
TIGHT SANDY LOAM	4	6	7	5

ELM/WEST FORKS		**ACTIVITIES**		
PHYSIOGRAPHIC REGION	TOOL MANUFACTURE	FOOD PREPARATION	HUNTING ACTIVITIES	LITHIC SCATTER
BLACKLAND PRAIRIE	7	11	6	5
EAST CROSS TIMBERS	11	22	25	27
GRAND PRAIRIE	4	6	6	3
WEST CROSS TIMBERS	3	7	7	5
RIPARIAN ZONE (ELM FORK) (2KM)	5	8	5	4
RIPARIAN ZONE (WEST FORK) (2KM)	2	1	2	0
RIPARIAN ZONE (DENTON CREEK) (2KM)	0	1	1	2
RIPARIAN ZONE (MINOR TRIBUTARIES) (2KM)	12	17	18	19
EPHEMERAL STREAMS (1KM)	8	14	15	10
ECOTONE (BLACKLAND PRAIRIE/EAST CROSS TIMBERS) (2KM)	3	2	2	4
ECOTONE (EAST CROSS TIMBERS/GRAND PRAIRIE) (2KM)	6	9	8	6
ECOTONE (GRAND PRAIRIE/WEST CROSS TIMBERS) (2KM)	1	5	2	2

Table A8. Raw data for hypothesis testing.

ELM/WEST FORKS	OCCUPATION FREQUENCY				CHANGE THROUGH TIME							
OCCUPATION DENSITY	SINGLE	DUAL	TRI	MULTI	P	A	EA	MA	LA	LP	LPI	LPII
EPHEMERAL	64	4	0	0	51	4	2	0	5	10	0	0
MODERATE	6	15	2	4	6	15	8	3	16	11	2	9
INTENSIVE	1	1	5	8	3	7	9	5	13	14	10	8
ACTIVITIES												
TOOL MANUFACTURE	11	5	5	5	12	7	9	3	12	12	7	7
CORES												
HAMMERSTONES												
PREFORMS												
BIFACES												
DEBITAGE												
FOOD PREPARATION	17	14	5	10	18	15	14	6	20	24	12	14
TOOLS												
GROUNDSTONE												
CERAMICS												
ANIMAL BONES												
FCR												
HUNTING ACTIVITIES	8	16	8	12	9	21	17	8	30	26	12	17
DIAGNOSTIC POINTS												
LITHIC SCATTER	39	1	0	0	31	2	0	0	4	4	0	0
ISOLATED LITHIC DEBRIS												

Table A9. Economic values: Vegetation scores for soil settings.

Common Name	Family	Genus	Species	Edibility	Medicinal	Toxicity	Forage	Other
Boxelder	ACERACEAE	Acer	various	0%	0%	0%	0%	100%
Yarrow	ASTERACEAE	Achillea	millefolium L.	50%	50%	0%	0%	0%
Canada garlic	LILIACEAE	Allium	canadense	0%	0%	0%	0%	100%
Drummond onion	LILIACEAE	Allium	mutabile	0%	0%	0%	0%	100%
Wild onion	LILIACEAE	Allium sp.	various	0%	0%	0%	0%	100%
Amaranth	AMARANTHACEAE	Amaranthus	spinosis L.	100%	0%	0%	0%	0%
Red-Root Rigweed	AMARANTHACEAE	Amaranthus	retroflexus L.	100%	0%	0%	0%	0%
Western ragweed	ASTERACEAE	Ambrosia	various	50%	50%	0%	0%	0%
Bluestem, big	POACEAE	Andropogon	gerardii	0%	0%	0%	50%	50%
Bluestem, sand	POACEAE	Andropogon	various	0%	0%	0%	50%	50%
Potato bean	FABACEAE	Apios	americana	100%	0%	0%	0%	0%
Threeawn, perennial	POACEAE	Aristida	various	50%	0%	0%	50%	0%
Threeawn, purple	POACEAE	Aristida	various	0%	0%	0%	100%	0%
Threeawn, Wright	POACEAE	Aristida	various	0%	0%	0%	100%	0%
Sagewort	ASTERACEAE	Artemisia	various	50%	50%	0%	0%	0%
Butterfly weed	ASCLEPIADACEAE	Asclepias	tuberosa	10%	90%	0%	0%	0%
Milkweed	ASCLEPIADACEAE	Asclepias	verticillata L.	10%	90%	0%	0%	0%
Whorled milkweed	ASCLEPIADACEAE	Asclepias	verticillata	10%	90%	0%	0%	0%
Green antelope horn	ASCLEPIADACEAE	Asclepias	viridis	10%	90%	0%	0%	0%
Heath aster	ASTERACEAE	Aster	various	0%	0%	0%	0%	0%
Bluestem, cane	POACEAE	Bothriochloa	various	0%	0%	0%	100%	0%
Bluestem, silver	POACEAE	Bothriochloa	various	0%	0%	0%	100%	0%
Grama, blue	POACEAE	Bouteloua	various	0%	0%	0%	100%	0%
Grama, hairy	POACEAE	Bouteloua	various	0%	0%	0%	100%	0%
Grama, sideoats	POACEAE	Bouteloua	various	0%	0%	0%	100%	0%
Grama, tall	POACEAE	Bouteloua	various	0%	0%	0%	100%	0%
Buffalograss	POACEAE	Buchloe	various	0%	0%	0%	100%	0%
W. bumelia	SAPOTACEAE	Bumelia	lanuginosa	100%	0%	0%	0%	0%
American Beauty Berry	VERBENACEAE	Callicarpa	americana	0%	50%	50%	0%	0%
Winecup	MALVACEAE	Callirhoe	various	0%	0%	0%	100%	0%
Eveningprimrose	ONAGRACEAE	Calylophus	various	100%	0%	0%	0%	0%
Halfshrub sundrop	ONAGRACEAE	Calylophus	various	0%	0%	0%	0%	0%
Thistle	ASTERACEAE	Carduus	austrinus	10%	90%	0%	0%	0%
Pecan	FABACEAE	Carya	illinoesis	100%	0%	0%	0%	0%
Coffee senna	FABACEAE	Cassia	fasciculata	100%	0%	0%	0%	0%
Showy partridge pea	FABACEAE	Cassia	occidentalis	100%	0%	0%	0%	0%
Scarlet Paint Brush	SCROPHULARIACEAE	Castilleja	Englemann	0%	100%	0%	0%	0%
Hackberry	ULMACEAE	Celtis	occidentalis	25%	0%	0%	0%	75%
Sugar hackberry	ULMACEAE	Celtis	laevigata	25%	0%	0%	0%	75%
Grass Bar	POACEAE	Cenchrus	incertus	50%	0%	0%	50%	0%
Basket flower	ASTERACEAE	Centaurea	americana	0%	0%	100%	0%	0%
Redbud	FABACEAE	Cercis	canadensis	25%	25%	0%	0%	50%
Prairie senna	FABACEAE	Chamaecrista	fasciculata	0%	0%	100%	0%	0%
Partridge Pea	FABACEAE	Chamaecrista	Michaux	0%	0%	100%	0%	0%
Windmillgrass	POACEAE	Chloris	various	50%	0%	0%	50%	0%
Yellow spine thistle	ASTERACEAE	Cirsum	ochrocentrum	50%	50%	0%	0%	0%
Wavyleaf thistle	ASTERACEAE	Cirsum	undulatum	50%	50%	0%	0%	0%
Virginia springbeauty	PORTULACCACEAE	Claytonia	virginica	100%	0%	0%	0%	0%
Bullnettle	EUPHORBIACEAE	Cnidoscolus	texanus	100%	0%	0%	0%	0%
Carolina jointtail	POACEAE	Coelorachis	various	0%	0%	0%	100%	0%
Dayflower	COMMELINACEAE	Commelina	various	100%	0%	0%	0%	0%
Hawthorn	ROSACEAE	Crataegus	various	100%	0%	0%	0%	0%
Haw	ROSACEAE	sp.	various	100%	0%	0%	0%	0%
Croton	EUPHORBIACEAE	Croton	various	0%	100%	0%	0%	0%
Yellow Nutsedge	CYPERACEAE	Cyperus	esculentus	100%	0%	0%	0%	0%
Dalea	FABACEAE	Dalea	various	100%	0%	0%	0%	0%
Prairie-clover	FABACEAE	Dalea	purpurea	100%	0%	0%	0%	0%
White prairie clover	FABACEAE	Dalea	candide	75%	25%	100%	0%	0%

Table A10. Economic values: Vegetation scores for soil settings.

Common Name	Family	Genus	Species	Edibility	Medicinal	Toxicity	Forage	Other
Bundleflower	FABACEAE	Desmanthus	various	0%	0%	0%	100%	0%
Tickclover	FABACEAE	Desmodium	various	0%	0%	0%	100%	0%
Arizona cottontop	POACEAE	Digitaria	californica	50%	0%	0%	50%	0%
Fall witchgrass	POACEAE	Digitaria	various	0%	0%	0%	100%	0%
Wood Sorrel	OXALIDACEAE	Jacquin	dillenii	0%	100%	0%	0%	0%
Common persimmon	EBENACEAE	Diospyros	virginiana	100%	0%	0%	0%	0%
Persimmon	EBENACEAE	Diospyros	virginiana L.	50%	50%	0%	0%	0%
Blacksamson	ASTERACEAE	Echinacea	angustifolia	0%	100%	0%	0%	0%
Coneflower	ASTERACEAE	Echinacea	various	0%	100%	0%	0%	0%
Wildrye, Canada	POACEAE	Elymus	various	50%	0%	0%	50%	0%
Wildrye, Virginia	POACEAE	Elymus	various	50%	0%	0%	50%	0%
Engelmann-daisy	ASTERACEAE	Engelmannia	various	0%	0%	0%	0%	100%
Ephedra	EPHEDRACEAE	Ephedra	various	0%	100%	0%	0%	0%
Lovegrass, plains	POACEAE	Eragrostis	various	50%	0%	0%	50%	0%
Lovegrass, purple	POACEAE	Eragrostis	various	50%	0%	0%	50%	0%
Lovegrass, red	POACEAE	Eragrostis	various	50%	0%	0%	50%	0%
Lovegrass, sand	POACEAE	Eragrostis	various	50%	0%	0%	50%	0%
Texas cupgrass	POACEAE	Eriochloa	various	50%	0%	0%	50%	0%
L. wild buckwheat	POLYGONACEAE	Eriogonum	longifolium	100%	0%	0%	0%	0%
Buckwheat	POLYGONACEAE	Eriogunum	various	100%	0%	0%	0%	0%
White ash	OLEACEAE	Fraxinus	americana	50%	0%	0%	0%	50%
Snakecotton	AMARANTHACEAE	Frielichia	various	100%	0%	0%	0%	0%
Downy milkpea	FABACEAE	Galactia	volubilis	75%	25%	100%	0%	0%
Honey locust	FABACEAE	Gleditsia	tricanthos	40%	10%	0%	0%	50%
C. sunflower	ASTERACEAE	Helianthus	annus	50%	50%	0%	0%	0%
M. sunflower	ASTERACEAE	Helianthus	various	50%	50%	0%	0%	0%
Sunflower	ASTERACEAE	Helianthus	anmus l.	50%	50%	0%	0%	0%
Curlymesquite	POACEAE	Hilaria	various	50%	0%	0%	50%	0%
Western Indigo	FABACEAE	Indigofera	various	0%	0%	0%	0%	100%
Black Walnut	FABACEAE	Juglans	nigra L.	100%	0%	0%	0%	0%
Rush	FABACEAE	Juncus	various	100%	0%	0%	0%	0%
Juniper	CUPRESSACEAE	Juniperus	various	0%	75%	0%	0%	25%
Red Cedar	PINACEAE	Juniperus	virginiana	50%	0%	25%	0%	25%
Trailing ratany	FABACEAE	Krameria	various	100%	0%	0%	0%	0%
G. sprangletop	POACEAE	Leptochloa	various	50%	0%	0%	50%	0%
Lespedeza	FABACEAE	Lespedeza	various	0%	50%	0%	50%	0%
Honeysuckle	CAPRIFOLIACEAE	Lonicera	various	0%	0%	0%	0%	0%
T.Honeysuckle	CAPRIFOLIACEAE	Lonicera	sempervirens	0%	100%	0%	0%	0%
Bluebonnet	FABACEAE	Lupinus	texensis	0%	0%	100%	0%	0%
Mint	FABACEAE	Mentha sp.	various	100%	0%	0%	0%	0%
Catclaw	FABACEAE	Mimosa	various	50%	0%	0%	0%	50%
Sensitivebriar	FABACEAE	Mimosa	various	0%	0%	50%	50%	0%
Horsemint	LAMIACEAE	Monarda	citriodora C.	0%	0%	0%	0%	100%
Red mulberry	MORACEAE	Morus	rubra	75%	25%	0%	0%	0%
Seep muhly	POACEAE	Muhlenbergia	various	50%	0%	0%	50%	0%
T. wintergrass	POACEAE	Nassella	various	50%	0%	0%	50%	0%
Water lily	NYMPHAEACEAE	Nelubo	lutea	100%	0%	0%	0%	0%

Table A11. Economic values: Vegetation scores for soil settings.

Common Name	Family	Genus	Species	Edibility	Medicinal	Toxicity	Forage	Other
Common prickly pear	CACTACEAE	Opuntia	compressa	75%	25%	0%	0%	0%
Prickly Pear	CACTACEAE	Opuntia	phaeacantha E.	50%	50%	0%	0%	0%
Agrito	OXALIDACEAE	Oxalis	corniculata	25%	0%	75%	0%	0%
Panicum, low	POACEAE	Panicum	various	50%	0%	0%	50%	0%
Panicum, Scribner	POACEAE	Panicum	various	50%	0%	0%	50%	0%
Switchgrass	POACEAE	Panicum	various	50%	0%	0%	50%	0%
Vine-mesquite	POACEAE	Panicum	various	0%	0%	0%	100%	0%
Western wheatgrass	POACEAE	Pascopyrum	various	50%	0%	0%	50%	0%
Paspalum, Florida	POACEAE	Paspalum	various	50%	0%	0%	50%	0%
Paspalum, fringeleaf	POACEAE	Paspalum	various	50%	0%	0%	50%	0%
Scurfpea	FABACEAE	Pediomelum	various	100%	0%	0%	0%	0%
Penstemon	SCROPHULARIACEAE	Penstemon	various	0%	0%	0%	0%	0%
Purple groundcherry	SOLANACEAE	Physalis	lobata	75%	0%	0%	0%	25%
Common pokeberry	PHYTOLACCACEAE	Phytolacca	various	25%	0%	50%	0%	25%
Buckthorn	PLANTAGINACEAE	Plantago	various	0%	0%	0%	0%	0%
Plantain	PLANTAGINACEAE	Plantago sp.	various	50%	50%	0%	0%	0%
Texas bluegrass	POACEAE	Poa	various	50%	0%	0%	50%	0%
Milkwort	POLYGALACEAE	Polygala	various	75%	25%	0%	0%	0%
Cottonwood	SALICACEAE	Populus	D.	0%	50%	0%	0%	50%
Common mesquite	FABACEAE	Prosopis	juliflora	70%	0%	0%	0%	30%
Honey mesquite	FABACEAE	Prosopis	glandulosa	70%	0%	0%	0%	30%
Mesquite	FABACEAE	Prosopis	glandulosa C	70%	0%	0%	0%	30%
American plum	ROSACEAE	Prunus	americana	100%	0%	0%	0%	0%
Chickasaw plum	ROSACEAE	Prunus	angustifolia	80%	10%	0%	0%	10%
Common chokecherry	ROSACEAE	Prunus	virginiana	100%	0%	0%	0%	0%
Oklahoma plum	ROSACEAE	Prunus	gracilis	100%	0%	0%	0%	0%
Mexican plum	ROSACEAE	Prunus	mexicana	80%	10%	0%	0%	10%
Wild plum	ROSACEAE	Prunus sp.	various	100%	0%	0%	0%	0%
Indian breadroot	FABACEAE	Psoralea	hypogeae	100%	0%	0%	0%	0%
Wild alfafa	FABACEAE	Psoralidium	various	50%	0%	0%	50%	0%
Caroline false-dandelion	ASTERACEAE	Pyrrhopappus	carolinianus	50%	50%	0%	0%	0%
Oak, bur	FABACEAE	Quercus	macrocarpa	100%	0%	0%	0%	0%
Oak, blackjack	FABACEAE	Quercus	marilandica	100%	0%	0%	0%	0%
Oak, willow	FAGACEAE	Quercus	phellos L.	0%	0%	0%	0%	100%
Shumard oak	FABACEAE	Quercus	shumardii	100%	0%	0%	0%	0%
Oak	FABACEAE	Quercus sp.	various	100%	0%	0%	0%	0%
Oak, post	FABACEAE	Quercus	stellata	100%	0%	0%	0%	0%
Oak, live	FAGACEAE	Quercus	virginiana Mill	0%	25%	0%	0%	75%
Skink bush	ANACARDIACEAE	Rhus	aromatica	10%	75%	0%	0%	15%
Flame leaf sumac	ANACARDIACEAE	Rhus	copallina	50%	25%	0%	0%	25%
Smooth sumac	ANACARDIACEAE	Rhus	glabra	50%	25%	0%	0%	25%
Sumac	ANACARDIACEAE	Rhus spp.	various	25%	50%	0%	0%	25%
Poison Ivy	ANACARDIACEAE	Rhus	toxicodendron L.	0%	100%	0%	0%	0%
Snoutbean	FABACEAE	Rhynchosia	various	50%	0%	0%	50%	0%
Clove current	SAXIFRAGACEAE	Ribes	odoratum	100%	0%	0%	0%	0%
Black Locust	FABACEAE	Robinia	pseudo-acacia L.	0%	0%	25%	0%	75%
Black raspberry	ROSACEAE	Rubus	occidentialis	100%	0%	0%	0%	0%
Dewberry	ROSACEAE	Rubus	aboriginum	100%	0%	0%	0%	0%
Red raspberry	ROSACEAE	Rubus	idaeaus	100%	0%	0%	0%	0%
Louisiana blackberry	ROSACEAE	Rubus	lousianus	100%	0%	0%	0%	0%
Southern Dewberry	ROSACEAE	Rubus	triviklis M.	100%	0%	0%	0%	0%
Ruella	ACANTHACEAE	Ruellia	various	0%	0%	0%	0%	100%
Arrowhead	ALISMATACEAE	Sagittaria	latiforlia	100%	0%	0%	0%	0%
Black Willow	SALICACEAE	Salix	nigra Marsh.	0%	100%	0%	0%	0%
Sage	FABACEAE	Salvia	various	100%	0%	0%	0%	0%
Bluestem, little	POACEAE	Schizachyrium	various	50%	0%	0%	50%	0%
Soft stem bulrush	CYPERACEAE	Scirpus	validus	100%	0%	0%	0%	0%
Skullcap	FABACEAE	Scutellaria	various	100%	0%	0%	0%	0%
Knottroot bristlegrass	POACEAE	Setaria	various	50%	0%	0%	50%	0%
Sida	MALVACEAE	Sida	various	100%	0%	0%	0%	0%

Table A12. Economic values: Vegetation scores for soil settings.

Common Name	Family	Genus	Species	Edibility	Medicinal	Toxicity	Forage	Other
Bumelia	SAPOTACEAE	Sideroxylon	various	0%	0%	0%	0%	0%
Compassplant	ASTERACEAE	Silphium	laciniatum	0%	100%	0%	0%	0%
Bushsunflower	ASTERACEAE	Simsia	various	0%	100%	0%	0%	0%
Greenbriar	SMILACACEAE	Smilax	various	100%	0%	0%	0%	0%
Saw greenbriar	SMILACACEAE	Smilax	bona-nox	75%	0%	0%	0%	25%
Indiangrass	POACEAE	Sorghastrum	various	50%	0%	0%	50%	0%
Dropseed, meadow	POACEAE	Sporobolus	various	50%	0%	0%	50%	0%
Dropseed, sand	POACEAE	Sporobolus	various	50%	0%	0%	50%	0%
Dropseed, tall	POACEAE	Sporobolus	various	50%	0%	0%	50%	0%
Falsegaura	ONAGRACEAE	Steinosiphon	various	0%	0%	0%	0%	0%
Queensdelight	EUPHORBIACEAE	Stillingia	various	0%	0%	0%	0%	0%
Wildbean	FABACEAE	Strophostyles	various	80%	10%	0%	10%	0%
Trailing wild bean	FABACEAE	Strophostyles	helvola	80%	10%	0%	10%	0%
Coralberry	CAPRIFOLIACEAE	Symphoricarpos	various	0%	0%	100%	0%	0%
Tridens, purpletop	POACEAE	Tridens	various	50%	0%	0%	50%	0%
Tridens, rough	POACEAE	Tridens	various	50%	0%	0%	50%	0%
Tridens, slim	POACEAE	Tridens	various	50%	0%	0%	50%	0%
Tridens, white	POACEAE	Tridens	various	50%	0%	0%	50%	0%
Clover	FABACEAE	Trifolium	repens L.	25%	25%	0%	50%	0%
Eastern gamagrass	POACEAE	Tripsacum	various	50%	0%	0%	50%	0%
Cattail	TYPHACEAE	Typha	latifolia	90%	10%	0%	0%	0%
Cedar Elm	ULMACEAE	Ulmus	crassifolia Nutt	0%	0%	0%	0%	100%
Elm, American	ULMACEAE	Ulmus	americana L.	25%	0%	0%	0%	75%
Elm, cedar	ULMACEAE	Ulmus	various	0%	0%	0%	0%	100%
Elm, winged	ULMACEAE	Ulmus	various	0%	0%	0%	0%	100%
Slippery elm	ULMACEAE	Ulmus	rubra	25%	0%	0%	0%	75%
Blue Vervain	VERBENACEAE	Verbena	halei	0%	100%	0%	0%	0%
Verbena	VERBENACEAE	Verbena	various	0%	100%	0%	0%	0%
Ironweed	ASTERACEAE	Verononia	various	0%	0%	0%	0%	0%
Haw	ROSACEAE	Viburnum	prunifolium	75%	25%	0%	0%	0%
Vetch	FABACEAE	Vicia	various	0%	0%	0%	100%	0%
Grape	VITACEAE	Vitis spp.	various	50%	50%	0%	0%	0%
Soap weed	AGAVACEAE	Yucca	glauca	50%	50%	0%	0%	0%
Yucca	AGAVACEAE	Yucca	louisianensis T.	25%	25%	0%	0%	50%
Prickly Ash	RUTACEAE	Zanthoxylum	clavaherculis L.	0%	100%	0%	0%	0%
Indian Corn	FABACEAE	Zea mays	various	100%	0%	0%	0%	0%
Lotebush	RHAMNACEAE	Ziziphus	various	100%	0%	0%	0%	0%
Dropseed, hairy	POACEAE		various	50%	0%	0%	50%	0%
Grain Sorghum	POACEAE		various	50%	0%	0%	50%	0%
L. hackberry	ULMACEAE		various	0%	0%	0%	0%	100%
Oak, shin	FAGACEAE		various	0%	0%	0%	0%	100%
Oak, Texas	FAGACEAE		various	50%	0%	0%	0%	50%
Peanuts	FABACEAE		various	100%	0%	0%	0%	0%
Roughleaf dogwood	CORNACEAE		various	0%	0%	0%	0%	100%
Sedge	CYPERACEAE		various	100%	0%	0%	0%	0%
Stemless actinea	POACEAE		various	50%	0%	0%	50%	0%
Texas ash	OLEACEAE		various	0%	0%	0%	0%	100%
Texas sophora	FABACEAE		various	0%	0%	0%	0%	0%
Western soapberry	SAPINDACEAE		various	0%	0%	100%	0%	0%
Wheat	POACEAE		various	100%	0%	0%	0%	0%

Table A13. Economic values of site catchment areas in the Upper Trinity Basin.

ECONOMIC VALUE OF TRINITY RIVER WEST FORK AND ELM FORK SITE CATCHMENTS BY OCCUPATION FREQUENCY																
ARCHAEOLOGICAL SITES	EDIBILITY VALUE				MEDICINAL VALUE				SUPPLEMENTAL VALUE				ECONOMIC VALUE			
TRINITY WEST FORK	Sum	Mean	St Dev	Var/Mean	Sum	Mean	St Dev	Var/Mean	Sum	Mean	St Dev	Var/Mean	Sum	Mean	St Dev	Var/Mean
ARCHAIC	0.1800	0.0450	0.0107	0.0026	0.1576	0.0394	0.0116	0.0034	0.1709	0.0427	0.0074	0.0013	0.1689	0.0422	0.0095	0.00214
EARLY ARCHAIC	0.1324	0.0441	0.0122	0.0034	0.1176	0.0392	0.0133	0.0045	0.1257	0.0419	0.0073	0.0013	0.1242	0.0414	0.0107	0.00276
MIDDLE ARCHAIC	0.1902	0.0475	0.0121	0.0031	0.1743	0.0436	0.0138	0.0044	0.1790	0.0448	0.0081	0.0014	0.1788	0.0447	0.0109	0.00265
LATE ARCHAIC	0.2360	0.0472	0.0108	0.0025	0.2133	0.0427	0.0125	0.0037	0.2196	0.0439	0.0740	0.1247	0.2213	0.0443	0.0098	0.00217
LATE PREHISTORIC	0.1596	0.0399	0.0129	0.0041	0.1397	0.0349	0.0137	0.0054	0.1541	0.0385	0.0087	0.0019	0.1503	0.0376	0.1138	0.34492
LATE PREHISTORIC I	0.0568	0.0568	0.0000	0.0000	0.0551	0.0551	0.0000	0.0000	0.0479	0.0479	0.0000	0.0000	0.0524	0.0524	0.0000	0.0000
LATE PREHISTORIC II	0.1543	0.0514	0.0039	0.0003	0.1360	0.0453	0.0069	0.0011	0.1450	0.0483	0.0019	0.0001	0.1444	0.0481	0.0032	0.00021
PREHISTORIC	0.5838	0.0486	0.0081	0.0014	0.5128	0.0427	0.0101	0.0024	0.5634	0.0469	0.0089	0.0017	0.5498	0.0458	0.0078	0.00133
TRINITY ELM FORK																
ARCHAIC	1.2124	0.0551	0.0135	0.0033	0.9599	0.0436	0.0120	0.0033	1.1491	0.0522	0.0187	0.0067	1.1196	0.0509	0.0137	0.00369
EARLY ARCHAIC	0.8137	0.0509	0.0039	0.0003	0.6638	0.0414	0.0047	0.0005	0.7376	0.0461	0.0128	0.0036	0.7446	0.0465	0.0045	0.00044
MIDDLE ARCHAIC	0.2879	0.0479	0.0018	0.0001	0.2593	0.0432	0.0046	0.0005	0.2522	0.0420	0.0059	0.0008	0.2665	0.0444	0.0120	0.00324
LATE ARCHAIC	1.5218	0.0544	0.0120	0.0026	1.2129	0.0433	0.0118	0.0032	1.3979	0.0499	0.0183	0.0067	1.3971	0.0499	0.0123	0.00303
LATE PREHISTORIC	1.6021	0.0517	0.0050	0.0005	1.3266	0.0428	0.0056	0.0007	1.4584	0.0470	0.0139	0.0041	1.4785	0.0477	0.0061	0.00078
LATE PREHISTORIC I	0.5468	0.0497	0.0032	0.0002	0.4871	0.0443	0.0059	0.0008	0.4859	0.0442	0.0110	0.0028	0.5078	0.0462	0.0046	0.00046
LATE PREHISTORIC II	0.6994	0.0500	0.0028	0.0002	0.5850	0.0418	0.0045	0.0005	0.6075	0.0434	0.0119	0.0033	0.6396	0.0457	0.0044	0.00042
PREHISTORIC	2.5729	0.0547	0.0091	0.0015	1.9450	0.0414	0.0098	0.0023	2.2058	0.0469	0.0147	0.0046	2.3181	0.0493	0.0081	0.00133
ECONOMIC VALUE OF TRINITY RIVER WEST FORK AND ELM FORK SITE CATCHMENTS BY OCCUPATION FREQUENCY																
ARCHAEOLOGICAL SITES	EDIBILITY VALUE				MEDICINAL VALUE				SUPPLEMENTAL VALUE				ECONOMIC VALUE			
TRINITY WEST FORK	Sum	Mean	St Dev	Var/Mean	Sum	Mean	St Dev	Var/Mean	Sum	Mean	St Dev	Var/Mean	Sum	Mean	St Dev	Var/Mean
SINGLE	0.5800	0.0486	0.0080	0.0013	0.5120	0.0420	0.0100	0.0024	0.5800	0.0486	0.0080	0.0013	0.5490	0.0450	0.0080	0.00142
DUAL	0.1532	0.0511	0.0049	0.0005	0.1367	0.0456	0.0079	0.0014	0.1448	0.0483	0.0055	0.0006	0.1442	0.0481	0.0050	0.00052
TRI	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
MULTI	0.1324	0.0441	0.0122	0.0034	0.1176	0.0392	0.0133	0.0045	0.1257	0.0419	0.0073	0.0013	0.1242	0.0414	0.0107	0.00277
TRINITY ELM FORK																
SINGLE	3.1760	0.0530	0.0080	0.0012	2.4400	0.0410	0.0080	0.0016	2.8000	0.0470	0.0140	0.0042	2.8800	0.0480	0.0070	0.00102
DUAL	0.9838	0.0578	0.0143	0.0035	0.7718	0.0454	0.0141	0.0044	0.9115	0.0536	0.0227	0.0096	0.9043	0.0532	0.0150	0.00423
TRI	0.4098	0.0512	0.0042	0.0003	0.3451	0.0431	0.0062	0.0009	0.3909	0.0489	0.0063	0.0008	0.3270	0.0478	0.0036	0.00027
MULTI	0.4500	0.0500	0.0024	0.0001	0.3772	0.0419	0.0052	0.0006	0.3889	0.0432	0.0115	0.0031	0.4110	0.0457	0.0044	0.00042

Table A14. Vegetation potentials of site catchment areas in the Upper Trinity Basin.

POTENTIAL VEGETATION TYPE WITHIN TRINITY RIVER WEST FORK AND ELM FORK SITE CATCHMENTS BY OCCUPATION FREQUENCY																
ARCHAEOLOGICAL SITES	GRAINS AND SEED CROPS				GRASSES AND LEGUMES				WILD HERBACEOUS PLANTS				SHRUBS			
TRINITY WEST FORK	Sum	Mean	St Dev	Var/Mean	Sum	Mean	St Dev	Var/Mean	Sum	Mean	St Dev	Var/Mean	Sum	Mean	St Dev	Var/Mean
ARCHAIC	0.918	0.230	0.072	0.0224	1.307	0.327	0.129	0.0505	1.551	0.388	0.117	0.0350	1.688	0.422	0.117	0.03237
EARLY ARCHAIC	0.678	0.226	0.077	0.0260	0.913	0.304	0.141	0.0657	1.033	0.344	0.107	0.0331	1.133	0.378	0.105	0.02933
MIDDLE ARCHAIC	1.014	0.254	0.082	0.0264	1.277	0.319	0.125	0.0491	1.360	0.340	0.093	0.0253	1.546	0.386	0.092	0.02205
LATE ARCHAIC	1.233	0.247	0.074	0.0225	1.667	0.333	0.116	0.0400	1.853	0.371	0.103	0.0287	2.076	0.415	0.101	0.02438
LATE PREHISTORIC	0.781	0.195	0.085	0.0374	1.119	0.280	0.130	0.0601	1.218	0.304	0.115	0.0437	1.326	0.332	0.121	0.04439
LATE PREHISTORIC I	0.276	0.276	0.000	0.0000	0.408	0.408	0.000	0.0000	0.397	0.397	0.000	0.0000	0.410	0.410	0.000	0.000
LATE PREHISTORIC II	0.866	0.289	0.013	0.0005	1.213	0.404	0.003	0.0000	1.303	0.434	0.029	0.0019	1.410	0.470	0.044	0.00403
PREHISTORIC	3.248	0.271	0.075	0.0206	4.584	0.324	0.104	0.0331	4.882	0.407	0.096	0.0224	5.231	0.436	0.076	0.01332
TRINITY ELM FORK																
ARCHAIC	6.093	0.277	0.086	0.0266	7.092	0.322	0.096	0.0286	8.352	0.380	0.104	0.0284	9.094	0.413	0.130	0.04089
EARLY ARCHAIC	4.581	0.286	0.094	0.0306	5.263	0.329	0.095	0.0274	6.000	0.375	0.101	0.0271	5.919	0.370	0.107	0.03078
MIDDLE ARCHAIC	1.803	0.300	0.063	0.0130	1.953	0.325	0.064	0.0124	2.180	0.363	0.059	0.0096	2.008	0.334	0.058	0.01007
LATE ARCHAIC	7.324	0.264	0.091	0.0316	8.454	0.302	0.099	0.0325	10.337	0.369	0.109	0.0321	10.887	0.389	0.133	0.04543
LATE PREHISTORIC	7.483	0.241	0.084	0.0290	8.539	0.275	0.083	0.0253	10.730	0.346	0.075	0.0163	11.061	0.357	0.095	0.02519
LATE PREHISTORIC I	2.966	0.270	0.772	2.2102	3.289	0.299	0.068	0.0154	3.818	0.347	0.072	0.0149	3.783	0.344	0.082	0.01931
LATE PREHISTORIC II	3.548	0.253	0.087	0.0299	4.028	0.288	0.092	0.0293	4.525	0.347	0.088	0.0224	4.937	0.353	0.101	0.02879
PREHISTORIC	11.901	0.253	0.102	0.0409	13.721	0.292	0.122	0.0509	14.876	0.317	0.094	0.0279	16.133	0.343	0.102	0.03049

POTENTIAL VEGETATION TYPE WITHIN TRINITY RIVER WEST FORK AND ELM FORK SITE CATCHMENTS BY OCCUPATION FREQUENCY																
ARCHAEOLOGICAL SITES	GRAINS AND SEED CROPS				GRASSES AND LEGUMES				WILD HERBACEOUS				SHRUBS			
TRINITY WEST FORK	Sum	Mean	St Dev	Var/Mean	Sum	Mean	St Dev	Var/Mean	Sum	Mean	St Dev	Var/Mean	Sum	Mean	St Dev	Var/Mean
SINGLE	4.689	0.390	0.082	0.0172	3.232	0.269	0.077	0.0221	4.872	0.406	0.097	0.0232	5.188	0.432	0.085	0.01672
DUAL	1.159	0.386	0.017	0.0007	0.861	0.287	0.049	0.0084	1.286	0.429	0.073	0.0124	1.455	0.485	0.052	0.00558
TRI	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
MULTI	0.913	0.304	0.141	0.0657	0.678	0.226	0.077	0.0260	1.033	0.344	0.107	0.0331	1.133	0.378	0.105	0.02929
TRINITY ELM FORK																
SINGLE	16.888	0.286	0.105	0.0385	14.838	0.251	0.096	0.0367	19.522	0.330	0.098	0.0291	20.835	0.353	0.104	0.03064
DUAL	5.571	0.327	0.140	0.0599	4.626	0.272	0.113	0.0469	6.234	0.366	0.133	0.0483	6.741	0.396	0.163	0.06709
TRI	2.416	0.302	0.066	0.0144	2.228	0.279	0.070	0.0176	2.943	0.368	0.045	0.0055	3.138	0.392	0.061	0.00949
MULTI	2.633	0.293	0.073	0.0182	2.300	0.255	0.079	0.0245	3.107	0.345	0.081	0.0190	3.107	0.345	0.088	0.02245

Table A15. Wildlife potentials of site catchment areas in the Upper Trinity Basin.

WILDLIFE POTENTIAL WITHIN TRINITY RIVER WEST FORK AND EAST FORK SITE CATCHMENTS BY TIME PERIOD																
ARCHAEOLOGICAL SITES	OPENLAND WILDLIFE				RANGELAND WILDLIFE				WETLAND WILDLIFE				WILDLIFE			
TRINITY WEST FORK	Sum	Mean	St Dev	Var/Mean	Sum	Mean	St Dev	Var/Mean	Sum	Mean	St Dev	Var/Mean	Sum	Mean	St Dev	Var/Mean
ARCHAIC	1.332	0.333	0.112	0.0378	1.483	0.371	0.105	0.0298	0.110	0.028	0.007	0.0019	2.926	0.732	0.224	0.06856
EARLY ARCHAIC	0.924	0.308	0.119	0.0458	1.034	0.344	0.108	0.0339	0.078	0.026	0.008	0.0022	2.036	0.679	0.234	0.08069
MIDDLE ARCHAIC	1.307	0.325	0.107	0.0353	1.412	0.353	0.095	0.0257	0.116	0.029	0.008	0.0025	2.827	0.707	0.209	0.06159
LATE ARCHAIC	1.691	0.332	0.099	0.0297	1.843	0.369	0.091	0.0224	0.146	0.029	0.076	0.1968	3.680	0.736	0.196	0.05193
LATE PREHISTORIC	1.074	0.269	0.124	0.0568	1.220	0.305	0.117	0.0446	0.119	0.030	0.009	0.0030	2.413	0.603	0.241	0.09645
LATE PREHISTORIC I	0.380	0.380	0.000	0.0000	0.383	0.383	0.000	0.0000	0.032	0.032	0.000	0.0000	0.800	0.800	0.000	0.000
LATE PREHISTORIC II	1.205	0.402	0.017	0.0008	1.307	0.436	0.034	0.0027	0.095	0.032	0.001	0.0000	2.607	0.869	0.051	0.00299
PREHISTORIC	4.290	0.357	0.091	0.0231	4.841	0.403	0.086	0.0182	0.385	0.032	0.007	0.0017	9.515	0.793	0.172	0.03709
TRINITY ELM FORK																
ARCHAIC	7.099	0.323	0.079	0.0192	8.007	0.364	0.105	0.0304	1.385	0.063	0.031	0.0150	16.491	0.750	0.179	0.04274
EARLY ARCHAIC	5.233	0.327	0.094	0.0272	5.642	0.353	0.098	0.0272	1.106	0.069	0.033	0.0158	11.982	0.748	0.200	0.05332
MIDDLE ARCHAIC	1.907	0.318	0.061	0.0117	1.942	0.324	0.053	0.0086	0.536	0.089	0.031	0.0108	4.385	0.738	0.123	0.02064
LATE ARCHAIC	8.593	0.307	0.089	0.0259	9.783	0.349	0.108	0.0333	2.015	0.072	0.035	0.0167	20.391	0.728	0.203	0.05644
LATE PREHISTORIC	8.658	0.279	0.077	0.0212	10.058	0.324	0.073	0.0162	2.386	0.077	0.049	0.0307	21.103	0.681	0.147	0.03175
LATE PREHISTORIC I	3.270	0.297	0.068	0.0155	3.490	0.317	0.060	0.0113	0.919	0.084	0.041	0.0204	7.679	0.698	0.151	0.0327
LATE PREHISTORIC II	4.088	0.292	0.090	0.0279	4.517	0.323	0.078	0.0189	0.949	0.068	0.031	0.0141	9.553	0.682	0.185	0.05001
PREHISTORIC	13.418	0.285	0.100	0.0351	14.419	0.307	0.084	0.0229	3.464	0.074	0.045	0.0274	31.301	0.665	0.191	0.05457

WILDLIFE POTENTIAL WITHIN TRINITY RIVER WEST FORK AND EAST FORK SITE CATCHMENTS BY TIME PERIOD																
ARCHAEOLOGICAL SITES	OPENLAND WILDLIFE				RANGELAND WILDLIFE				WETLAND WILDLIFE				WILDLIFE VALUE			
TRINITY WEST FORK	Sum	Mean	St Dev	Var/Mean	Sum	Mean	St Dev	Var/Mean	Sum	Mean	St Dev	Var/Mean	Sum	Mean	St Dev	Var/Mean
SINGLE	4.299	0.358	0.089	0.0221	4.830	0.402	0.087	0.0188	0.411	0.034	0.005	0.0007	9.541	0.795	0.165	0.03425
DUAL	1.189	0.396	0.019	0.0009	1.277	0.426	0.037	0.0032	0.101	0.034	0.003	0.0003	2.566	0.855	0.053	0.00329
TRI	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
MULTI	0.924	0.308	0.119	0.0458	1.034	0.345	0.109	0.0343	0.078	0.026	0.008	0.0022	2.036	0.679	0.234	0.08083
TRINITY ELM FORK																
SINGLE	16.871	0.285	0.093	0.0303	18.998	0.322	0.090	0.0252	4.569	0.077	0.053	0.0365	40.440	0.685	0.182	0.04836
DUAL	5.451	0.321	0.121	0.0456	6.059	0.356	0.135	0.0512	1.119	0.065	0.030	0.0138	12.631	0.743	0.254	0.08683
TRI	2.506	0.313	0.050	0.0080	2.729	0.341	0.044	0.0057	0.645	0.081	0.035	0.0151	5.884	0.735	0.101	0.01388
MULTI	2.626	0.292	0.074	0.0188	2.876	0.319	0.067	0.0141	0.619	0.068	0.036	0.0191	6.119	0.679	0.159	0.03723

GIS GLOSSARY

Buffer: Procedure conducted with ArcMap Geoprocessing tools which generates a circle or polygon at a specified distance around a point.

Clip: Procedure conducted with ArcMap Geoprocessing tools that "trims features in one layer at the boundaries of features in another layer" (Ormsby et al., 2001: 282).

Dissolve: Procedure conducted with ArcMap Geoprocessing tools that "creates a new data set in which all features in an input layer that have the same value for a specified attribute become a single feature" (Ormsby et al., 2001: 270).

Joining: To associate a non-spatial table with a spatial data layer based on a unique identification code (i.e. soils series). This assigns meaning to a spatial data layer.

Overlay analysis: A method of analysis that "creates a new data set by superimposing one layer on another. The output data has the attributes of both input layers" (Ormsby et al., 2001: 306).

Projection: the transformation of descriptive data to spatial location with a geographic coordinate system.

Query: A procedure conducted in ArcMap to extract data that involves "a question or request for selecting features. A query often appears in the form of a statement or logical expression. In ArcMap, a query contains a field, an operator, and a value" (Minami, 2000: 510).

Raster: An image that uses a "grid structure to store geographic information" (Minami, 2000: 510).

Selection: Selecting data can be conducted in ArcMap by location or attributes. Selecting features by location involves specifying "a selection method, a selection layer, a spatial relationship, a reference layer, and sometimes a distance buffer" (Ormsby et al., 2001: 250). Selecting features by attribute involves specifying a specific attribute (i.e. time period) to create a new data layer.

Symbology: A term that refers to "criteria used to determine symbols for the features in a layer" (Minami, 2000: 513).

Tabular data: A phrase that refers to "descriptive information that is stored in rows and colums and can be linked to map features" (Minami, 2000: 513).

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