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Late Prehistoric Bison Populations in Central and Southern Texas

by

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ABSTRACT

The remains of Bison bison show a dramatic increase in archaeological faunal collections from sites in Southern Texas post-dating 750 BP (ca. A.D. 1200). An analysis of spatial and temporal distributions of bison remains confirmed Dillehay's (1974) Absence Period II and Presence Period III for this region. Paleoenvironmental data from the fields of geomorphology, palynology, isotope chemistry, and range science are combined to construct an explanatory model for bison range expansion. As the climate of the Southern Plains became more xeric, ca. 1000 BP (ca. A.D. 950), bison populations grew in response to these more favorable conditions. With the climate change, previous ecological barriers to southern expansion were removed, creating a push-pull situation. The model incorporates the time transgressive nature of ecological succession in response to climate change and postulates a "bison corridor" between the Brazos and Colorado Rivers as the route taken by the bulk of herds moving into Southern Texas.

INTRODUCTION

The presence or absence of bison on the Southern Plains and adjacent regions has been the subject of several papers in the recent past. Unfortunately, none of these have been able to correlate specific changes in the prehistoric environment with the visibility of bison in the archaeological record. In this paper, the temporal and spatial distribution of bison (*Bison bison*) remains recovered from Late Prehistoric (1250-400 BP; ca. A.D. 700-1550) sites in Southern Texas will be examined. The results of this analysis will be used to assess Dillehay's (1974) Absence Period II and Presence Period III for the region. Using current paleoenvironmental and paleoclimatic data, a parsimonious explanation in the form of a model, will be presented to account for the appearance of bison in the archaeological record of Southern Texas.

THE STUDY AREA

The region identified as Southern Texas in this study falls within the bounds of 96°-101° West longitude between 27°-32° North latitude (Fig. 1). Physiographically, this area of ca. 157,000 km covers the Edwards Plateau, the Gulf Coastal Plain and the South Texas Plain which correspond roughly with the Balconian, Texan and Tamaulipan biotic provinces as identified by Blair (1950). The climate ranges from a modified sub-tropical in the north to a humid sub-tropical in the south and coastal areas, with rainfall increasing from west to east (Carr 1967).

From historic records and studies of remnant natural plant stands it is possible to reconstruct the Late Prehistoric vegetation communities in the study area. Within the last 100-150 years dramatic changes in land use patterns and urban growth have caused grasslands and riparian zones to be overrun by thorny brush. Deep well irrigation has lowered aquifer levels and caused many springs in the porous Edwards limestone to cease flowing. Prior to these changes much of Southern Texas had large expanses of prairie grasslands separated by motts and galeria forests (Weniger 1984). The

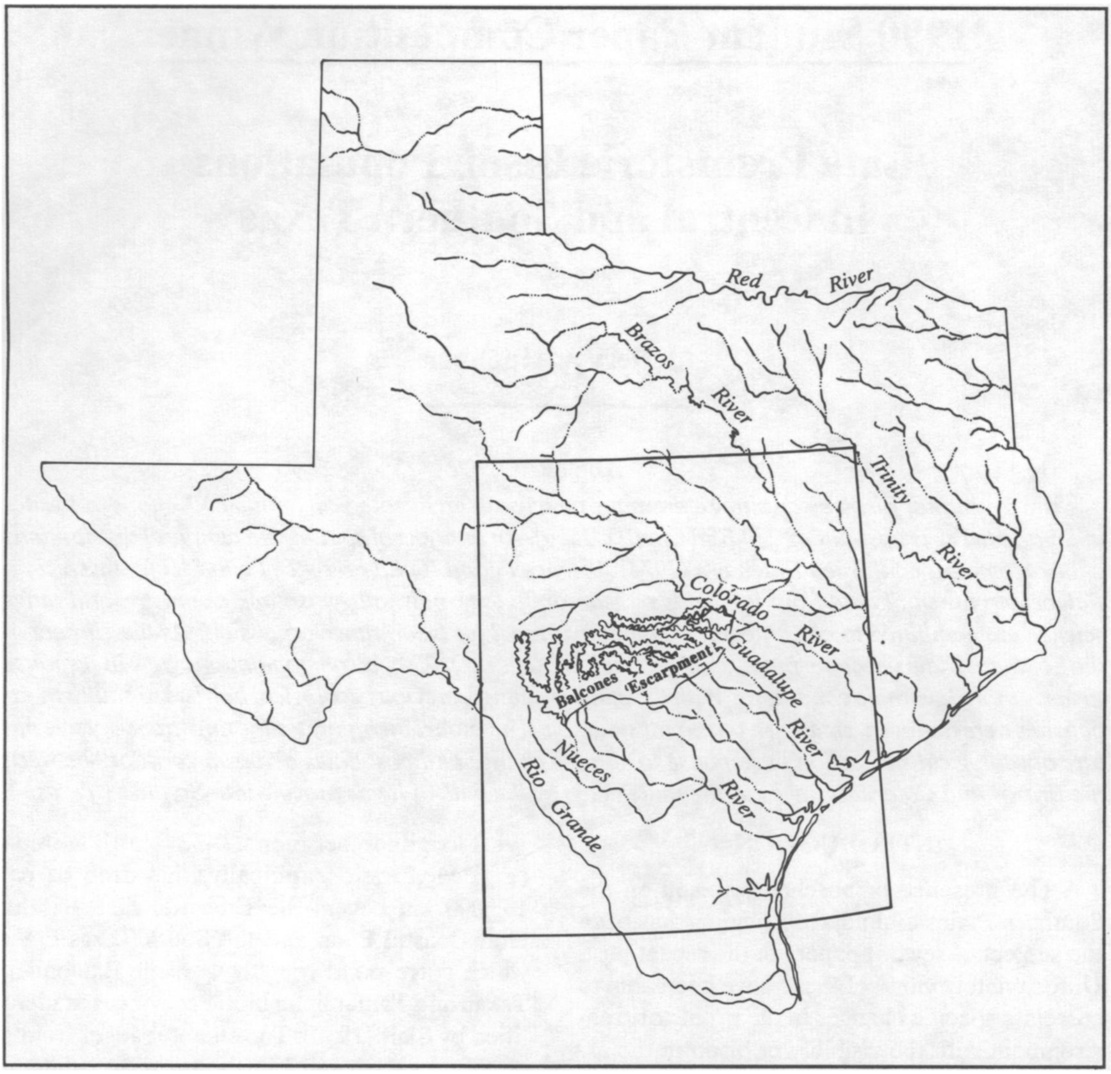

Figure 1. The study area, Balcones Escarpment, and major rivers.

western portion of the study area, which includes the Edwards Plateau and much of the South Texas Plain, is classified as Southern Mixed Grass Prairie (Risser et al. 1981). These xeric grasslands contained mid- and short-grass upland communities dominated by various gramma species, tall dropseed, tridens, little bluestem, buffalograss, and curly mesquite (Riskind and Diamond 1986). The grass understory was commonly intermixed with motts of oak, elm, and ash on uplands; and cypress, Texas sugarberry, pecan, cedar elm, and black walnut in the galeria forests (Ford and Van Auken 1982). Vegetation in the eastern half of the study area was comprised of mesic tallgrass prairies interspaced with post oak savannahs (Fig. 2). From northwest to southeast these include: Western Cross Timbers, Grand Prairie, Eastern Cross Timbers, Blackland Prairie, Post Oak Savannah, Fayette Prairie, and the Coastal Prairie. Prairie grasslands were found on clay substrate, and savannahs and woodlands were found on sandy soils. Tall- and mid-grass communities were common to both of these settings. Dominant species included: little bluestem, Indian grass, switchgrass, panicium, and gammagrasses (Diamond and Smeins 1985). Post oak and black hickory were the dominant upland

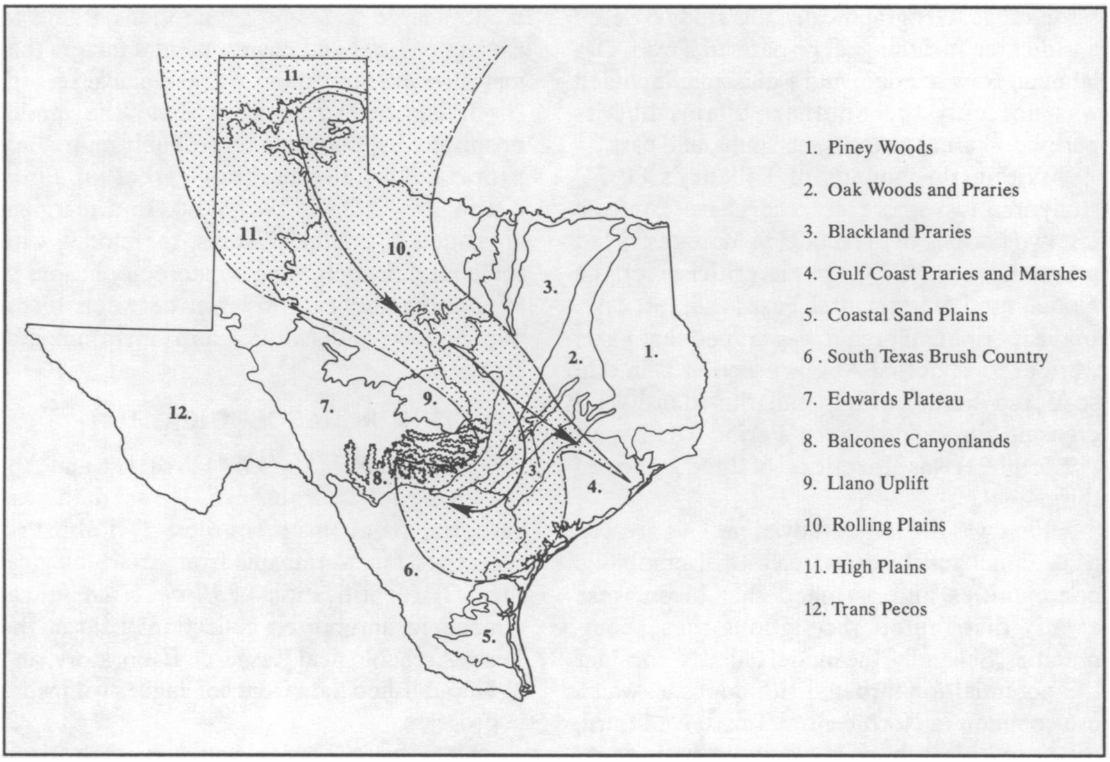

Figure 2. Natural vegetation areas and proposed bison corridor (stippled).

trees in the Cross Timbers and Post Oak Savannah. The riparian galeria forests in the eastern half were similar to those in the west in terms of species present, but the composition was different.

The boundary between the Mixed Grass Prairie and Tallgrass Prairie corresponds with that of the Kansan and Texan Biotic Provinces (Blair 1950). To the east of this line there is a moisture surplus, and to the west a moisture deficit. This line is not sharply defined and may shift through time as climatic conditions vary. Thus the prairie composition can be quite different depending upon the topographic position or the prevailing climate conditions. Wet years and moist topographic positions favor the tallgrasses; drought years and dry sites favor the shortgrasses (Risser et al. 1981: 14).

Aboriginal use of fire was important in the maintenance of prehistoric grassland biomes (Smeins 1980, Black 1989). Data from numerous modern burn studies compiled in Risser et al. (1981: 408-432) note that mid-and tall-grasses respond with increased primary production after being burned. Fire used to push game into favorable hunting locations had the secondary effect of stabilizing, and renewing the prairie grasslands.

SOUTHERN PLAINS BISON MODELS

Previous distributional studies of the Southern Plains have addressed Dillehay's (1974) presence and absence periods model. In the examination of ca. 150 archaeological and paleontological site reports, Dillehay outlined three periods of bison presence and two of absence from the period 10,000 BC-AD 1550:

Presence Period I 10,000-6000/5000 BC

Absence Period I 6000/5000-2500 BC

Presence Period II 2500 BC-AD 500

Absence Period II AD 500-1200/1300

Presence Period III AD 1200/1300-1550

The explanation offered for this periodicity are changes in climate, and rainfall patterns that either caused reduction or regional shifts in bison range. Geographically, this study covered a wide area including all or parts of Texas, Oklahoma, New Mexico, and Louisiana. Included was not only the Southern Plains but its peripheral areas to the west, south, and east.

Within the bounds of Dillehay's (1974) study area, two other researchers have tested the last two periods of the model in more restricted areas. Lynott (1979), in his criticism of the model, used Northcentral Texas as a test case. In this peripheral area it was argued that bison were present during Absence Period II in thin scattered herds, with population density increasing during Presence Period III. Lynott (1979: 90-91) was also critical of three aspects of this model.

First was the large study area. This created a false homogeneity in an area with diverse biotic communities and assumed that bison were evenly distributed throughout these communities. Secondly, the model failed to consider the potential for turbated site deposits, which are common in Northcentral Texas. And third, the use of bison bone horticulture tools as indicators of bison presence. Equating curated tools with bone refuse fails to recognize that tools may be moved though trade or migration and be incorporated into the archaeological record great distances from their origin.

Baugh (1986) limited her test of Dillehay's model to western and central Oklahoma, which is part of the Southern Plains proper. She also noted the presence of bison during Absence Period II, which led her to question the utility of presence and absence models in general. Specific criticisms included the monocausual explanation of climate variation and the assumption that "if bison do not appear in the subsistence inventory of a culture, they are not available for exploitation" (ibid.: 84). Unlike Lynott's (1979) analysis, bone tools are used as an indicator of presence. While it is noted that bison as a food source cannot be directly inferred, these tools are "well integrated into the cultural inventory" (Baugh 1986: 91), thus indicative of presence.

Both of these researchers noted that the presence and absence model was not generally applicable to their regions. Because of the model's large scale and assumptions, it fails to explain cultural and environmental factors that may have influenced the archaeological record.

It has been suggested that "the model proposed by Dillehay is probably more appropriate for the marginal areas of *Bison* distribution" (Davis 1987: 119). In a marginal area such as Southern Texas, the model, with some modification, may be more applicable in explaining the relationship between bison populations, and cultural and environmental change.

THE ARCHAEOLOGICAL DATA

To test Dillehay's (1974) Presence and Absence model in Southern Texas data was gathered from three sources: 1) Published reports of faunal remains from archaeological sites; 2) Identification of *Bison bison* faunal remains in unreported collections held at the Texas Archeological Research Laboratory; and 3) Unpublished data from colleagues with work in progress.

Data from 77 single and multiple component sites were examined. Only faunal remains were considered evidence of presence in this study. Following Lynott's (1979) argument for the possibility of long distance transport, any type of tool fabricated from bison bone was deleted from the study. This is not really a problem for Southern Texas because typical Plains horticulture tools are not present; and what bison bone tools are present were associated with bison faunal remains.

The temporal limits imposed on this study include Absence Period II and Presence Period III. These time frames cover the Late Prehistoric Period (1250-300 BP) in the study area. Sites of this era, more frequently than older sites, contain large, well preserved faunal collections that help control for the bias of differential preservation.

The chronology of the bison remains was established by associated temporally diagnostic artifacts or radiocarbon assays. Scallorn arrow points are the horizon marker for the Austin phase (1250-750 BP; Prewitt 1981). Perdiz arrow points, alternately beveled bifaces, and Leon Plain ceramics are indicative of the Toyah

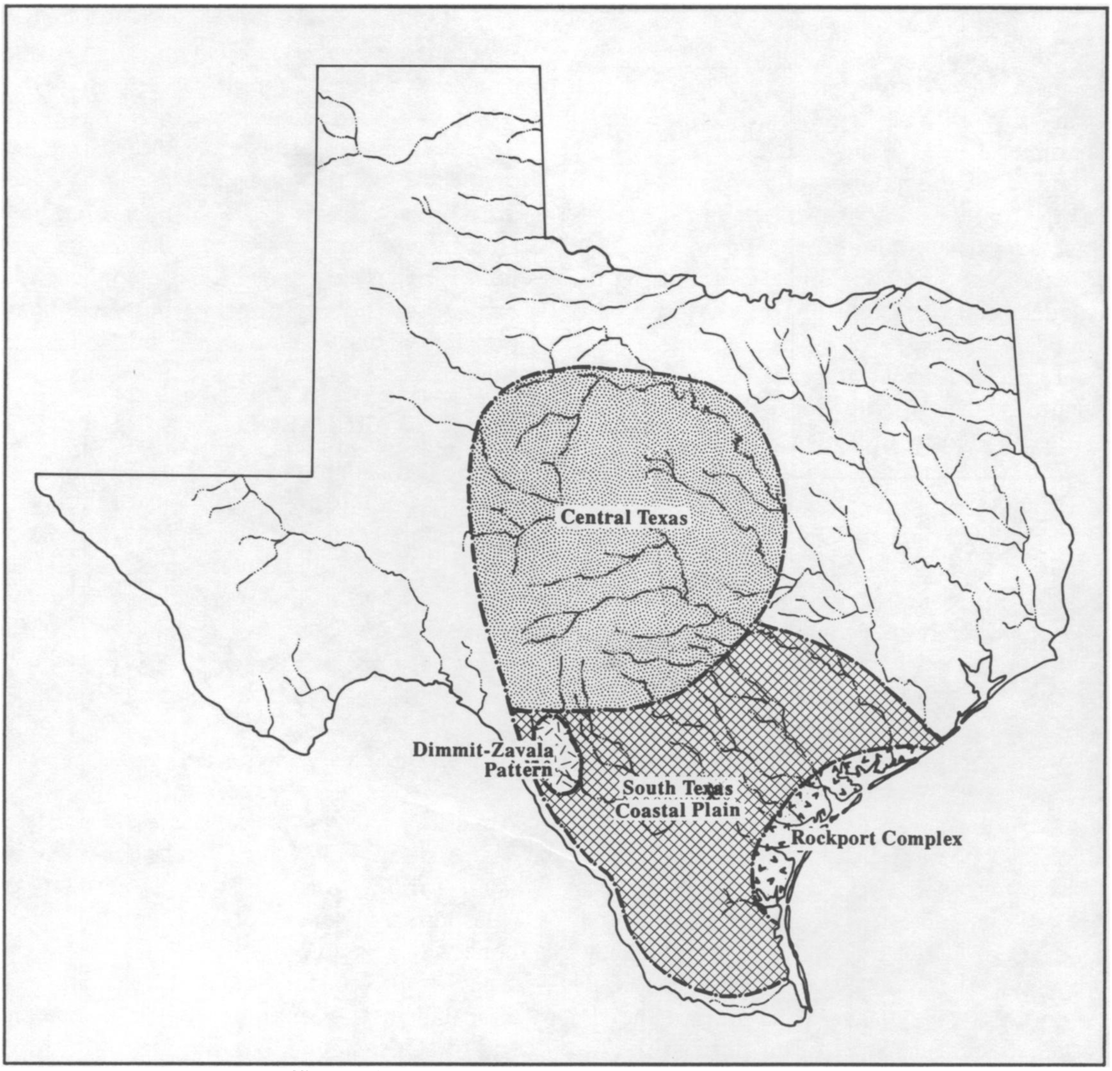

Figure 3. Late Prehistoric culture areas in Southern Texas.
Austin phase and Toyah horizon are found in both Central Texas and South Texas Coastal Plain.

horizon sites (750-350 BP; Black 1986). Dimmit-Zavala Pattern sites (550-400 BP) are distinctive in that a mixture of arrow and dart points are associated with late radiocarbon dates (Hester 1975). The hallmark of Rockport complex sites (950 BP-Historic) is Rockport Plain, Incised, or asphaltum decorated ceramics and various arrow points (Ricklis 1990). The geographic range of these cultures and the archaeological regions of Southern Texas are shown in Figure 3.

BISON DISTRIBUTIONS IN SOUTHERN TEXAS

Bison populations appear to be widespread in Southern Texas during the Late Prehistoric (Fig. 4, Tables 1 and 2). Of the 77 sites examined, 65 have bison faunal remains. Bison exploitation appears primarily in association with the Toyah horizon, and secondarily within the Dimmit-Zavala pattern and the Rockport complex. No unequivocal evidence of bison exploitation was associated with Austin phase sites. In the case of Rockport complex sites, where the culture period falls in both Absence Period II and

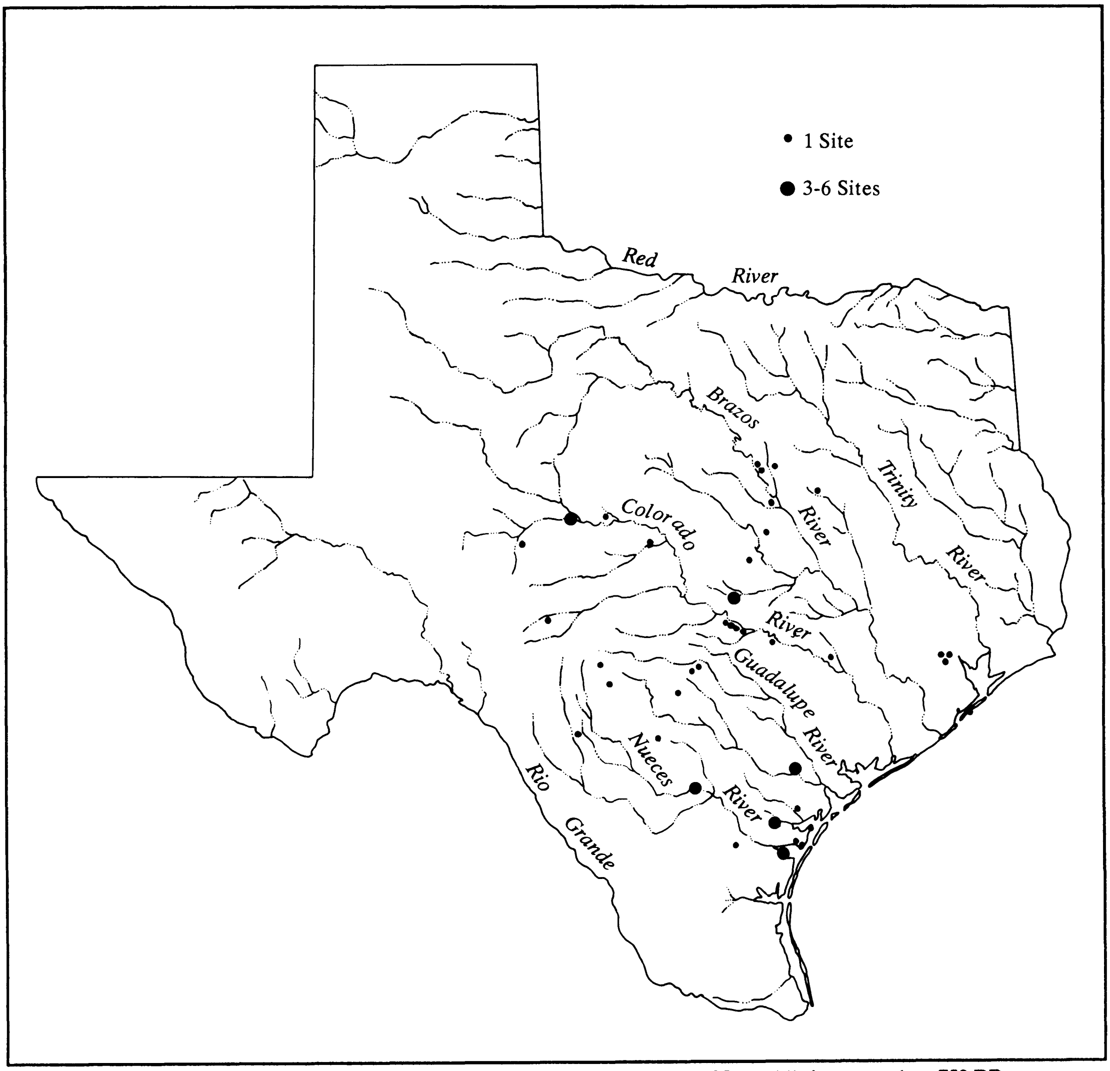

Figure 4. Late Prehistoric sites with reported Bison faunal remains. Note: All sites post-date 750 BP.

Presence Period III, the presence of Perdiz arrow points in context with bison bone was used to identify the post 750 BP era. The pattern of distribution seen is a result of both modern research, and prehistoric settlement patterns. Many counties and isolated small areas are well known archaeologically due to CRM, academic, and avocational research. But there are still many areas that have not been investigated at even the survey level. Thus the clustering of sites, noted in present research, along the Balcones Escarpment and the Nueces River, are products of intensive research and the lack of data in other, less studied, areas is not necessarily evidence of the absence of bison populations.

The settlement patterns of the Late Prehistoric Period also exert a degree of influence on the distribution of bison remains. The majority of sites used in this study are occupations. Only two sites, 41FY74 and 41WM230 have been reported as "kill" sites, and in both, only a single animal is indicated. The majority of the sites are located in good preservation settings, on lower terraces or valley margins. Thus we can only assume that bison were killed in the vicinity of the occupations.

Table 1. Late Prehistoric Sites with Bison Faunal Remains and Their Cultural Affiliations

Site #	Reference-Cultural Affiliation
41AS2	TARL files-Rockport
1BL23	Shafer et al. 1964-Toyah
41BN33	Henderson p.c.*-Toyah
41BL104	Sorrow et al. 1967-Toyah
41BP279	Robinson 1987-Toyah
41BX228	Black and McGraw 1985-Toyah
41CC131	Christopher Lintz p.c.-Toyah
41CC222	Christopher Lintz p.c.-Toyah
41CM1	Johnson et al. 1962-Toyah
41CM3	Johnson et al. 1962-Toyah
41CN245	TARL files-Toyah
41FY74	Skelton 1977-Toyah
41GD4	Hester and Parker 1970-Toyah
41GD21	Fox 1979-Toyah
41GD30A	Brown 1983-Toyah
41GD56	Huebner 1989-Toyah
41HI1	Jelks 1962-Toyah
41HI117	Lynott 1978-Toyah
41HI240	TARL files-Toyah
41HR206	TARL files-Late Ceramic
41HR406	Fields 1988-Late Ceramic
41HR541	McReynolds et al. 1988-Late Ceramic
41HY209	Robert Ricklis p.c.-Toyah
41GV66	Bonnie Yates p.c.-Late Ceramic
41KM16	Leroy Johnson p.c.-Toyah
41JW8	Black 1986-Toyah
41LI1	Bonnie Yates p.c.-Protohistoric
41LK41	Hall et al. 1982-Toyah
41LK67	Hall et al. 1982-Toyah
41LK201	Hall et al. 1982, Highley 1986-Toyah
41ME19	Hester and Kelly 1976-Toyah
41ML39	Watt 1978-Toyah
41NU4	Campbell 1956-Rockport
41NU33	Patterson and Ford 1964-Rockport
41NU37	Ricklis 1987-Rockport
41NU103	Patterson and Ford 1964-Rockport
41NU185	Carlson et al. 1983-Rockport
41NU221	Ricklis 1987-Rockport
41MC55	Hall et al. 1982, Hall et al. 1986-Toyah
41MC222	Hall et al. 1982, Hall et al. 1986-Toyah
41MC290	Hall et al. 1982, Hall et al. 1986-Toyah
41RF21	Ricklis 1989-Toyah/Rockport
41RN169	Christopher Lintz p.c.-Toyah
41SP43	Ricklis 1987-Rockport
41SP103	Ricklis 1987-Rockport
41SP120	Ricklis 1987-Rockport
41SP135	TARL files-Toyah
41SP159	Ricklis 1990-Rockport
41SP160	Ricklis 1990-Rockport
41SP167	Ricklis 1990-Rockport
41SP168	Ricklis 1990-Rockport
41SP170	Ricklis 1990-Rockport
41SS20	Green and Hester 1973-Toyah
41TG91	Creel et al. 1990-Toyah
41TV40	TARL collections-Toyah
41TV42	Suhm 1957-Toyah
41TV69	Pollard et al. 1963-Toyah
41TV132	TARL collections-Toyah
41TV151	Wesolowsky et al. 1976-Toyah
41UV21	Hester 1971, Hester et al. 1989-Toyah
41VT66	Huebner 1987-Toyah
41WM118	Eddy 1973-Toyah
41WM230	Prewitt 1974-Toyah
41WM437	Prewitt 1982-Toyah
41ZV155	Hill and Hester 1973-Dimmit-Zavala

*personal communication

Following this assumption, the distance of transport from kill to camp should have been relatively short. It is difficult to control factors such as the time of day of the kill, the number of individuals available, and the perceived needs of the group in any discussion of transport in the archaeological record. Ethnoarchaeological studies of the Hadza in northern Tanzania indicate that the distances large animal carcasses were transported are a product of the above reasons, as well as the experience and situational judgement of the hunter (O'Connell et al. 1988). Larger animals killed at a great distance from camp are under-represented in Hadza produced bone assemblages (ibid.: Figure 8). In these cases the meat is stripped from the bone prior to transport to decrease overall weight and increase the nutritional value in relation to energy expenditure. While it is difficult to directly apply these observations to the prehistoric

Table 2. ^{14}C Assays Associated with Archaeological Components Containing Bison Bone. (All Dates δ^{13}C Correctred Unless Noted Otherwise With *)

Site #	^{14}C Age
41BL23	290±95[1] (TX-71)
41BX228	480±140 (TX-2810)
41CC131	520±130 (TX-6521)
	448±70 (TX-6506)
	403±70(TX-6509)
	440±70 (TX-6512)
41HI1	390±130 (S-MC C-5)
	670±165 (S-MC C-8)
	660±150 (S-MC C-1)
	560±80 (TX-98)
	560±80 (TX-99)
41HI117	630±50 (TX-2939)
	770±100 (TX-2963)
41HR541	680±80* (BETA-17073)
	640±100* (BETA-25927)
	240±60* (BETA-24076)
	480±70* (BETA-24077
41HY209	270±70 (BETA-37277)
	380±50 (BETA-37287)
	310±50 (BETA-37284)
41KM16	230±50 (TX-2854
	260±60 (TX-2852)
	330±70 (TX-2853)
	350±60 (TX-2851)
41JW8	580±50 (TX-2207)
	520±90 (TX-4652)
	525±65 (UGA-4511)
	655±70 (UGA-5289)
	500±60 (TX-4654)
	700±80 (TX-4887)
41LK201	360±50 (TX-4667)
	320±60 (TX-4668)
41MC55	460±60 (TX-4692)
	760±80 (TX-4693)
41MC222	360±60 (TX-4666)
	540±60 (TX-4694)
41RF21	750±100 (TX-6126)
	720±190 (TX-6124)
	790±70 (TX-6125)
	760±130 (TX-6127)
41RN169	500±73 (TX-6771)
	430±76 (TX-5773)
	567±77 (TX-6770)
	468±77 (TX-6772)
	580±70 (TX-6325)
41TG91	520±60 (TX-4759)
41TV42	200±70 (TX-504)
	220±70 (TX-510)
	240±70 (TX-509)
	370±70 (TX-505)
	450±70 (TX-514)
	540±140 (TX-25)
	585±85 (TX-24)
	680±80 (TX-513)
	705±95 (TX-26)
41UV21	350±100 (TX-6695)
	660±70 (TX-687)
	710±70 (TX-664)
41VT66	610±40 (AA-2538)
41ZV155	170±60 (TX-1514)
	410±40 (TX-1515)

[1] All Dates B.P.

record of Southern Texas, it is assumed that the bison remains found in these sites represent animals killed within a 20 km range.

One other factor is important in the distributions presented by this study. The archaeological data not only reflects temporal and spatial distributions, but also the subsistence patterns of the aboriginal inhabitants of Southern Texas. The absence of bison during the Austin phase may not reflect their total absence on the landscape, but rather, their absence from the subsistence regime of these people. Interpretations of Austin phase subsistence indicate an emphasis on gathering and deer hunting (Prewitt 1981). Bison may not have been hunted during this time due to their low numbers, and the superabundance of deer in the region. An increase in bison hunting post 750 BP, is associated with the appearance of a very Plains-like lithic tool assemblage. These changes in technology and subsistence pattern are directly related to the increased number of bison available to Toyah horizon and Rockport complex hunters.

Within these potential biases, it appears that bison were well spread on the grasslands and savannahs of Southern Texas after 750 BP. While there is a preponderance of evidence in support of Dillehay's conclusions, absence of evidence does not necessarily constitute evidence of absence. Polemic, or nominal models are often difficult to support in the natural world. It is possible that bison were present in southern Texas prior to 750 BP, but at such low numbers that they have not been recognized in the archaeological record. Perhaps the terms High Visibility and Low Visibility are better suited than Presence and Absence Periods. Thus the major question is not were bison present or absent, but what caused their greater visibility in the post 750 BP prehistoric record? It would be difficult to estimate the size and composition of these herds based on the present data. But it is hypothesized that herds of bison were permanent additions to the biota of this time period albeit thinly spread and not present in all areas at all times. Local conditions of grass, topography and access to water would be limiting factors that could mean many bison in some areas and none in others.

CLIMATE CHANGE AND BISON AVAILABILITY

The greater visibility of bison in the post 750 BP archaeological record of Southern Texas is testament to their integration into aboriginal subsistence patterns. While culture change is related to increased visibility of bison, it does not explain any ecological reason why sufficient bison were available to support this type of adaptation.

Dillehay (1974: 185-186) used bison as the principal paleoenvironmental indicator in his model. While he presented no data from this study area, climatic change in the form of thirteenth century droughts and associated crop failures in the Southwest, were linked with increased bison visibility in the Middle Pecos Valley and southern Llano Estacado during the same time period. All this shows is that the climate was right for bison, it does not tell you what the climate was like, further, near simultaneous climatic change and increased bison visibility ignores the time transgressive nature of ecological change.

Drawing on current paleoenvironmental data from several disciplines, it is possible to construct a parsimonious model of climate change as it relates to increasing bison visibility in Southern Texas. In this model, increased bison visibility is a result of, not a direct indicator of, paleoclimatic change. Timing of the drought as discussed by Dillehay may be a threshold, but it is not the primary cause for increased visibility of bison. The cause started several hundred years earlier.

There are several lines of evidence that indicate an increasingly arid and grassy environment starting around 1000 BP. Recent geomorphological investigations of the Pedernales River, which drains the eastern margin of the Edwards Plateau, have identified a transition to a drier climate ca. 1000 BP (Blum and Valastro 1989). Between 4500 and 1000 BP the Pedernales was an aggrading, gravel-dominated meandering stream. Channel incision and a shift in sedimentation style to finer-grained, gravel-poor depositional system occur ca. 1000 BP in response to a more xeric climate. Within the study area, similar geomorphic patterns have been seen on the upper Colorado River (Blum 1989a; Blum and Valastro 1991), the upper Brazos River (Blum 1989b) and the North Fork of the San Gabriel River (Hays 1982). A similar pattern of channel incision around 1000 BP has been identified at 12 other localities in Oklahoma and Texas indicating that the xeric climate pattern was a regional event over the Southern Plains and adjacent areas at this time (Hall 1990).

The episode of channel trenching is synchronous with declining amounts of hickory pollen and an increase in grass pollen in the Oklahoma Cross Timbers (Hall 1982). An increase in grass pollen at this time is also evidenced from Weakly Bog (Bryant and Holloway 1985) in Leon County Texas. In a reinterpretation of this data, Collins and Bousman (ms.) have identified spikes of grass pollen at roughly 1500, 900, and 500 BP.

Table 3. Bone Collagen Stable Carbon Isotope Ratios from Post-750 BP Bison in Texas (in Mils).

	Range	Mean ± s.d.
Panhandle (n = 6)	-11.6 to -8.0	-9.5 ± 1.24
Edwards Plateau (n = 10)	-13.6 to -7.8	-9.5 ± 1.70
Blackland Prairie (n = 8)	-11.6 to -7.9	-9.8 ± 1.19
Coastal Plain (n = 9)	-13.4 to -8.2	-9.7 ± 1.66
South Texas (n = 5)	-12.2 to -8.7	-10.4 ± 1.74

Stable carbon isotope data from soil humates at Jewett Mine, also in Leon County, show increased grass at these time intervals (Collins and Bousman ms.). Increased grass in this Post Oak Savannah locality is indicated by heaver isotope values. There is a strong dichotomy in photosynthetic pathways used by the plants in the study area. All of the dominant grass species mentioned earlier are Krantz, or C_4 pathway, which have enriched isotope ratios relative to the major woody dicots and trees which use the Slack-Hatch, or C_3 pathway. The isotope data also correlates with the percentage of arboreal pollen at Weakly bog. Periods of increased grass tend to be associated with decreases in arboreal pollen.

A second set of stable carbon isotope data is available from the Asa paleosol which is found along the Brazos River in Robertson County, Texas. Results from the analysis of soil organic matter (SOM) and pedogenic carbonates denote a steady increase in the proportion of grass in this Post Oak Savannah community from 8000 to 1000 BP (Jacob and Boutton 1990). The $\delta^{13}C$ values from SOM at the top of the paleosol, -14.5‰, are characteristic of a C_4 grass dominated community at 1000 BP.

The isotopic analysis of bison diets from Texas substantiates other evidence of large amounts of C_4 grasses in the region (Huebner and Boutton 1990). $\delta^{13}C$ ratios from the collagen fraction of 38 individuals from throughout the state, all post dating 750 BP, indicate an average diet of ca. 87% C_4 grasses ($\delta^{13}C$ = -9.3‰). This average is maintained in both the short grass communities of the Panhandle and the mid- and tall-grass prairies of Southern Texas (Table 3). While the species composition of the various grasslands differs, bison would have been subsisting on grasses of similar nutritional content from the High Plains to deep South Texas.

The analysis of floral biosilica, or phytoliths from two sites in the Coastal Prairie and three in the Rio Grande Plain, also indicate a drying climate. Robinson's (1979) interpretations from 41GD21 and 41GD21A indicate a mixed wet/dry environment that probably represents rapid changes from wet to dry around 1000 BP. Evidence from the Rio Grande Plain imply that by approximately 1000 BP the environment was more xeric with short grasses being dominant over tall grasses and only minimal evidence of oak or other woody species (Robinson 1982). Unfortunately, these studies suffer from poor temporal control. Most of the samples are from contexts bracketed between radiocarbon assays that represent 500 to 2000 year spans of time. In a recent paper, Robinson (1990) reported similar findings from several other Texas sites with better chronological controls; however, a full discussion of these data must await their publication.

A final piece of evidence for a drying environment comes from the Upper Texas Coast just east of Houston, Texas. Analysis of marine invertebrates from Peggy Lake has identified periods of increased salinity in Galveston Bay at 950 and 550 BP (Gadus and Howard 1990). These changes are related to decreased discharge of the San Jacinto River with an associated increase in bay salinity.

This drying trend had an effect on the bison populations of the Southern Plains. As the western Cross Timbers in Oklahoma and northern Texas experienced the transition from Oak Woodlands to more open, grassy oak savannahs ca. 1000 BP, bison would have started to utilize this more hospitable environment. This initial movement into Central Oklahoma and northcentral Texas prior to 750 BP is supported by the conclusions reached by Baugh (1986) and Lynott (1979). As drought conditions began to peak ca. 700 to 600 BP in the Southern Plains, the expanding bison populations continued their movement south into Central Texas and the Coastal Prairies. The period of roughly 250 years from the onset of the xeric trend to the appearance of bison in Southern Texas accounts for the time necessary for community succession (cf. Davis 1986) in the Cross Timbers and the increase in bison populations from expanded habitat range. These same processes that facilitated bison expansion to the southeast may be similar to ones that caused bison expansion into the Middle Pecos valley at about the same time (cf. Jelinek 1967). In both these cases the origin of these herds would be the short grass plains of the Llano Estacado, which brings us to the second problem, the route of population movements into Southern Texas.

If Southern Texas were just an extension of the Llano Estacado, then a question of migration route would be academic. But the diverse ecology and geography of the study area must be considered in any examination of this question. In this discussion, migration refers only to the route taken to reach the maximum range expansion shown by the distribution. Seasonal or other regular migrations are not considered. Seasonality studies necessary to identify these patterns have, unfortunately, not been done in a systematic manner in the study area.

The logical origin of the bison that moved into the study area would be the short grass High Plains of the Texas Panhandle and the mixed grass prairies of Western Oklahoma and Northern Texas. The route south proposed here, based on the distribution, is through a corridor formed by the Brazos and the Colorado Rivers (Figure 2). The southeasterly flow of these rivers cross-cut the bands of oak woodlands, savannahs, and prairies and would have provided a path of least resistance to the Coastal Prairies. From here, the bison range would expand into the northern Blackland Prairies, south across the western coastal plain and up the Guadalupe, San Antonio, and Nueces Rivers, and onto the southern edge of the Edwards Plateau.

This scenario is favored over others for several reasons. The bison corridor would have supplied the best habitat in terms of forage and water. Each of the natural regions is homogeneous enough to be classified as a separate environmental area, but in their marginal zones, the mixture of two regions create broad ecotones. Blair (1950: 101) recognized the entire Texan Biotic Province, which includes most of the oak savannahs and grasslands of the study area, as an ecotonal area between the wetter Austroriparian to the east and the drier Kansan and Tamaulipan to the west. The species composition of this province fluctuated on the rainfall gradient as it shifted east or west (Risser et al. 1981). Thus the east-west rainfall gradient and the cross-cutting northeast-southwest trending natural regions create a montage of ecologically diverse micro-habitats. These would have provided continuous grasslands, albeit sparse in some areas, along the migration route of the bison from the Rolling Plains down the Brazos and Colorado Rivers into the Coastal Plain.

A western migration route following the Llano Estacado southward onto the Edwards Plateau and out on to the Coastal Plain is not substantiated by the distributions of faunal remains. The western Edwards Plateau was occupied by *Bison* in earlier time periods, evidenced by small amounts of skeletal remains in dry caves and rockshelters (Graham 1987). The exception to this is Bonfire Shelter, situated off the Rio Grande in One Mile Canyon ca. 23 km upstream from its confluence with the Pecos River (Dibble and Lorrain 1968). Two of the three bone beds at this site are culturally derived. Bone Bed 2 consists of the remains of at least 27 individuals of the extinct bison forms *Bison antiquus* or *B. occidentalis* (ibid.: 30). These remains were associated with Paleoindian dart points of the Plainview and Folsom types. A radiocarbon assay run on charcoal from Feature 1 yielded a date of 10,230 ± 160 BP (TX 153; Pearson et al. 1965).

Bone Bed 3 is represented by the remains of ca. 800 individuals of the species *B. bison*.

Based on the diagnostic artifacts (Castroville and Montell dart points) and four radiocarbon assays, Dibble and Lorrain (1968: 51) estimated the age of this deposit at 2645 ±75 BP. These two bone beds represent the southern most evidence for the use of bison jumps.

The occupation of the western Edwards Plateau by *Bison* spp. appears to be limited to the Paleoindian and Late Archaic time periods. During the Late Prehistoric the limited evidence of bison remains south of the upper Colorado River does not suggest the movement of large herds. Further, a model showing movement of bison across the Plateau onto the coastal prairies would have to account for canyon lands along the Balcones escarpment. This area of deeply entrenched streams and tight canyons would have been a severe impediment to southward movement. Figure 4 shows a large number of sites along the escarpment edge that contain bison. It is reasoned that these animals moved upstream from the mouths of these canyons off of the Blackland and Coastal Prairies, not downstream from the headwaters. Indeed, if bison had moved south through these canyons, there would be some evidence of it. This rough terrain would have presented numerous "knickpoints" where bison could have been easily exploited (Frison 1978; Kelly 1987). Despite several surveys in this region, no evidence of this type of site has been found.

On the eastern edge of the bison corridor, movements of bison herds out of Eastern Oklahoma across the Red River into Northcentral and Northeastern Texas seem unlikely. The limited density of bison in Southeast Oklahoma (Perttula 1984) and the small number of sites with bison non-tool remains in Northcentral Texas (Lynott 1979) and eastern Oklahoma (Neuman 1983) argue for the corridor concept. In Lynott's study area, all sites with faunal remains are in the Blackland Prairies. Bison may have arrived there by turning north into the upper portion of the Blackland Prairie while the bulk of herds turned south after coming through the corridor.

These arguments do not deny that some bison movements may have taken place to the east or west of the corridor. Based on the distribution data and environmental zonation, the concept of a bison corridor between the Brazos and Colorado offers the best explanation of the bulk of bison migration into Southern Texas, post 750 BP.

Finally, the question of how long did it take for bison to reach the limits of their Southern Texas range needs to be addressed. Presently, data which apply to the question are limited, but indicate that it was a relatively short amount of time. Four radiocarbon assays from the Coastal Plain site 41RF21 (Ricklis 1989) provide the earliest available dates on bison availability. A single charcoal, and three $\delta^{13}C$ corrected bison bone apatite assays, in association with Toyah and Rockport cultural materials, yielded ages of 750 ± 100 (TX-6126), 720 ± 190 (TX-6124), 790 ± 70 (TX-6125), and 760 ± 130 (TX-6127) respectively. These dates are roughly contemporaneous with others from Toyah sites in the northern portion of the study area (Prewitt 1983), indicating that bison movement was very rapid during the first half of the thirteenth century A.D.

SUMMARY

This study has presented evidence for climatic change and the associated expansion of bison herds in Southern Texas ca. 750 BP. In the examination of Dillehay's Presence/Absence model, it was found to be fundamentally correct in timing for Southern Texas, but it failed to explain the ecological events that lead to the expansion of bison populations. From the data presented, it is possible to summarize the events that lead to favorable range conditions that permitted the expansion of bison populations.

1) *Dessication Event Starts ca. 1000 BP.* Drier climate favors grasses over trees and begins the eastward movement of the line between the shortgrass and mid- and tall-grass prairies (cf. Risser et al. 1980).

2) *Bison Populations in Southern Plains Increase.* The drier climate favored the growth of bison populations in the Southern Plains.

3) *Cross Timbers and Post Oak Savannah Become Grassier.* The more open understory permits enlarged bison herds greater access

to the prairies of Southern Texas. This point is in effect the threshold at which bison begin to be visible in the archaeological record of Southern Texas.

4) *Bison Populations Expand Into Southern Texas ca. 750 BP.* Movement through the "Bison Corridor" continues through prehistoric times.

In effect this is a push-pull model. As the climate of the Southern Plains became drier and more favorable for bison, their populations grew. As population growth expanded to and beyond carrying capacity, herds were drawn into the prairies of Southern Texas where the grassland econiche that had been underexploited for centuries was now accessible.

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