Paleoindian and later occupations along ancient shorelines of the San Agustín Plains, New Mexico

Matthew E. Hill, Jr[1] and Vance T. Holliday[2]

[1]University of Iowa, Iowa City, Iowa [2]University of Arizona, Tucson, Arizona

To better understand the residential behavior of Paleoindian (14,000–8000 CAL B.P.) and later groups (Archaic and Formative period), our project undertook an investigation of the eastern sub-basins of the high elevation (> 2070 masl) San Agustín Plains in west-central New Mexico. The work included pedestrian survey of 390 ha, geoarchaeological studies, an analysis of private collections consisting of 210 artifacts from 75 sites, and site-file record searches. The preliminary results from this project suggest the presence of significant Archaic and Paleoindian occupations along paleolake shorelines in the northeastern portion of the San Agustín Plains. Most of the archaeological sites from this area represent isolated finds of diagnostic projectile points, although a few large multicomponent sites were also identified. Functional and temporal differences between the occupations of the two sub-basins show that human use of the area shifted gradually from one focused on moderate to low-intensity habitation (Paleoindian and Archaic period) to one of short-term seasonal visits associated with special-function resource extraction activities (Formative period) in response to the disappearance of surface water features.

Keywords: San Agustín Plains, Paleoindian, Archaic, paleolake, Ake Site

Introduction

Our research on the Paleoindian and later occupation and paleoenvironmental history of the eastern portion of the San Agustín Basin (Holliday *et al.* 2006; Hill *et al.* 2007) expands on a rich record of research into the Quaternary landscape evolution and paleoenvironmental history of the basin (Clisby and Sears 1956; McFadden *et al.* 1994; Markgraf *et al.* 1984). Our goal is a better understanding of long-term changes in forager land-use and subsistence strategies in this high altitude basin. Moreover, the evidence indicates a nearly continuous occupation from early Paleoindian times to the historical period. Bat Cave, which contains some of the earliest evidence of maize in the United States, is in the southwestern portion of the basin (Dick 1965; Wills 1988a, 1996). Our project area, therefore, is an excellent place to examine long-term trends in human-environmental interactions with significant environmental changes as a late Pleistocene lake evolved into a *playa* (a dry basin floor with a seasonal lake) complex in the Holocene.

Paleoindian foragers, especially those living in the Great Plains and Rocky Mountains, have been stereotypically portrayed as technology-dependent, highly mobile, specialized big game hunters (Hofman and Todd 2001; Kelly and Todd 1988; Waguespack and Surovell 2003). From this perspective, Paleoindians were thought to be constantly on the move, carrying a flexible and highly reliable biface-based tool kit (M. G. Hill 2008; Hofman and Todd 2001; Kelly and Todd 1988).

The onset of much warmer and drier conditions beginning about 8000 years ago resulted in reduction of the large herbivore populations that had formed the core of the Paleoindian economy and lifeway. This change forced Archaic foragers to shift from their formerly highly mobile, big-game hunting-focused lifestyle to one focused on exploiting a broader spectrum of resources that were locally available, such as plants and small game (e.g. Hofman 1997). These changes resulted in Archaic foragers making adjustments to their settlement pattern and land-use strategies. In response to the harsher Holocene environments, Archaic groups less mobile than Paleoindian groups invested in constructing permanent or semi-permanent features such as house pits, hearths, and storage pits, and using lower quality, but locally available lithic raw materials to make their tools (e.g. Larson 1997). Eventually this sedentary lifestyle, focused on intensively exploiting local resources, made foragers more willing to

Correspondence to: Matthew E. Hill, Department of Anthropology, University of Iowa, 114 Macbride Hall, Iowa City, IA 52242. Email: matthew-e-hill@uiowa.edu

DOI 10.1179/009346910X12707321242557

adopt an agricultural lifestyle when domesticates became available.

In recent years, researchers have developed alternate reconstructions for Paleoindian and Archaic lifeways that are at odds with the traditional models outlined above, and approach the issue of the Paleoindian-Archaic-Agricultural transitions from a fundamentally different perspective (Kornfeld 2007, Kornfeld and Larson 2008). In this newer approach Paleoindian hunter-gatherers are considered to be less mobile and more reliant on small game and plant resources (e.g. Bamforth 2002a, Cannon and Meltzer 2004), foraged intensively, repeatedly occupied regions of high ecological diversity, and sporadically made long-distance treks to hunt large game, such as bison and mammoth (Bamforth and Becker 2000; LaBelle 2005). These groups occasionally stopped to make bifacial tools, practicing informal core-based reduction of locally available raw materials (Bamforth 2002a, 2007, 2009).

From this new perspective, the Paleoindian-Archaic transition does not represent as significant a change in subsistence-settlement systems as once believed. Many of the key attributes thought to define the Archaic period, such as low mobility, exploitation of plants and small game, and evidence of structures and storage pits, are all present at some Paleoindian sites (Bamforth 2007; Frison and Walker 2007; Stiger 2006).

Recent research shows that neither model is entirely correct. Paleoindian foragers probably spent more time in heterogeneous environments such as alluvial valleys, margins of lakes and ponds, and foothill/mountain settings, than they did in homogenous environments like Plains grasslands and rolling hills (Bamforth *et al.* 2005; M. E. Hill 2007, 2008). A key reason for this land-use difference is that alluvial valleys, lake margins, and upland settings are richer in high quality predictable resources such as potable water, wood, and lithic raw materials, and these environments also have greater abundance of edible plants and game than do grassland or rolling hill settings (Knell 2007: table 3). In settings with dense clusters of important resources, prehistoric people performed a variety of activities related to raw material acquisition, tool production, and food preparation and processing. Furthermore, they probably established habitation sites in these settings more often than in homogeneous habitats like High Plains grassland environments which are rich in large game, but often lack key resources in predictable locations. Although occasionally used for habitation sites or multi-function camps, Plains grasslands environments seem to have primarily served as hunting areas.

The San Agustín project

To learn more about the nature of the Paleoindian-Archaic transition, archaeologists need to focus research in areas of heterogeneous habitats rather than continue to focus attention primarily on Great Plains grassland settings (Bamforth 2007; Cannon and Meltzer 2004). The central and western portions of New Mexico, especially the Albuquerque Basin, Estancia Basin, Jornada del Muerto, Plains of San Agustín, and Tularosa Basin (FIG. 1), contain hundreds of sites situated in ecologically diverse heterogeneous settings such as large river valleys, lake basins, and foothill and mountain settings (Dawson and Judge 1969; Judge 1973). Both camps and kill sites are found here (Beckett 1980; Holliday *et al.* 2007; Huckell and Kilby 2002) in settings with a tendency to be shallowly buried or heavily disturbed, rather than intact and deeply buried as in the High Plains (Holliday 2005; Holliday and Mandel 2006). The nature of the archaeological record in the project area means that while it has potential for providing data on past life-ways, technology, mobility, and social interaction, careful attention must be given to its placement in the landscape.

Providing more information on the archaeology of western New Mexico not only helps Plains Paleoindian research for studying all late Pleistocene/early Holocene hunter-gatherers, but has comparative value for researchers studying changes in populations in the intermountain region during the Pleistocene-Holocene transition (e.g. Jones *et al.* 2003; Beck and Jones 1997). For example, the shifts from Paleoarchaic (11,500–8000 years ago) to the Desert Archaic (8000–2500 years ago) subsistence-settlement strategies in the Great Basin represent mobile foragers developing creative new responses to rapidly changing biological and hydrological landscape around ever-shrinking pluvial lakes in intermountain basins (Beck and Jones 1990). The long-term behavioral and demographic shifts seen in the Great Basin, which represent forager transitions from an occupation focused on exploiting valley bottom wetlands habitats to one that utilizes many environmental zones, especially upland woodlands, is similar to the patterns observed in the high altitude basins of western New Mexico.

Our data come from new surveys, geoarchaeological investigations, the analysis of private artifact collections, and site file records. Our goals include the documentation of the size and diversity of the Paleoindian occupation in this area, evaluation of the formational history and site integrity of archaeological deposits located along paleolake shorelines, and comparison of the nature and expression of the Paleoindian archaeological record to those of later occupants.

The Late Quaternary Environmental History of San Agustín Basin

The study area occupies a high intermountain basin in the Datil-Mogollon volcanic field between the

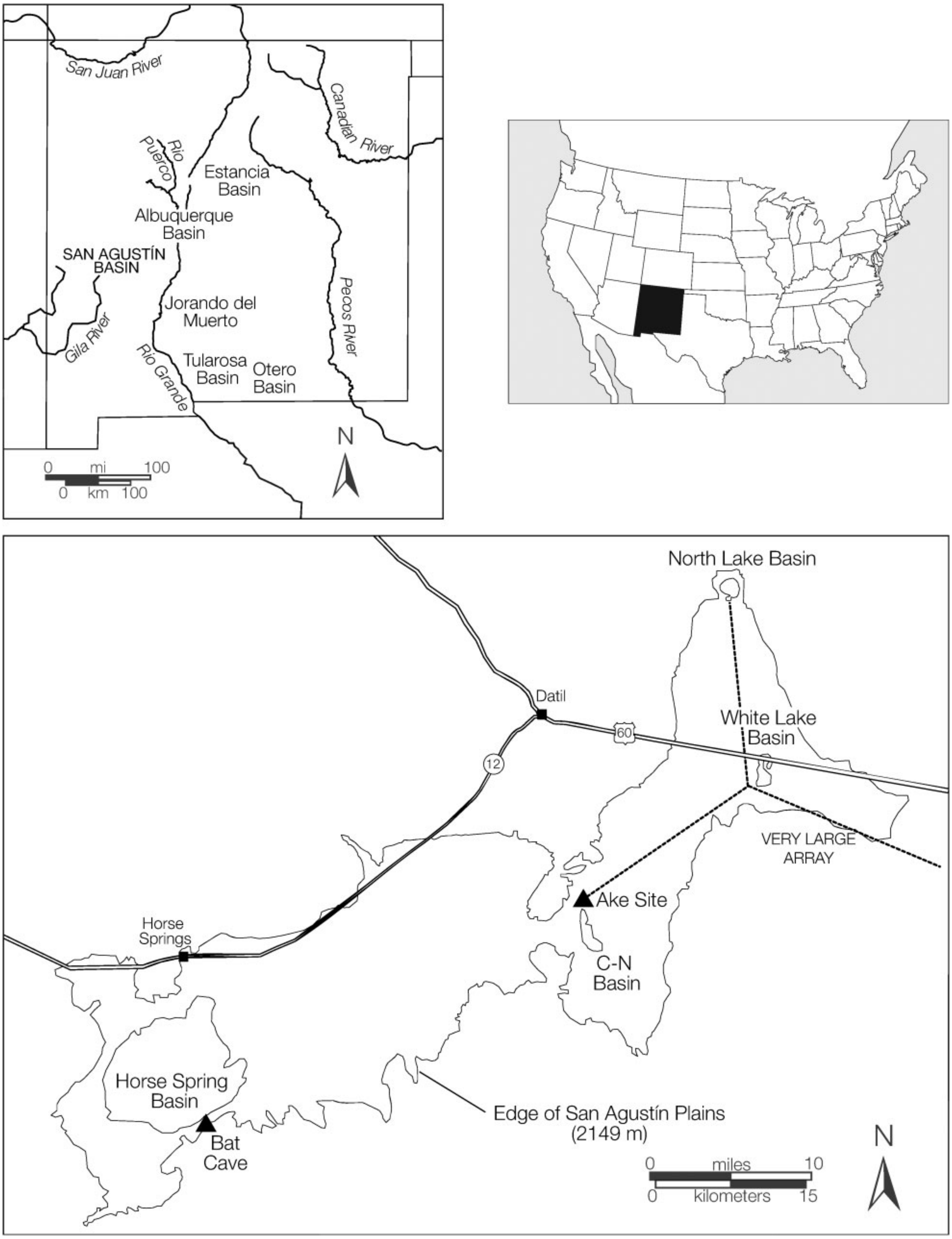

Figure 1 Topographic map of the San Agustín Plains showing the location of the Horse Spring, C-N, and White Lake Basins. Inset map shows map of New Mexico depicting location of San Agustín Plains and other major physiographic regions mentioned in text.

southeastern flank of the Colorado Plateau and the eastern portion of the Basin and Range (Weber 1980, 1994; Hawley 2005). It is located on either side of the boundary between western Socorro and eastern Catron counties, approximately 70–100 km west of Socorro, New Mexico. The San Agustín Basin is ca. 90 km long and divided into three interconnected sub-basins connected by channels. From SW to NW the basins are (with elevation of the basin floor): Horse Spring (2065 m), C-N (2102 m), and White Lake (2120 m) (FIG. 1).

During the Pleistocene, and possibly earlier, Lake San Agustín formed in the basin (Powers 1939; Weber 1980, 1994). At its peak Lake San Agustín covered almost 1075 sq km. High and low stands of the lake produced at least 16 preserved wave-cut shorelines ranging in elevation from 2070 to 2149 m (Markgraf *et al.* 1983; Powers 1939). Historically, no lakes existed in the basin, although in wet years small playas sometimes form (Blodgett and Titus 1973). A playa is the dry floor of a basin that contains an ephemeral or seasonal lake; these intermittent lakes in arid and semiarid regions are also referred to as playa lakes (Reeves 1968: 87–88, Nuendorf *et al.* 2005: 499). They can hold water for more than a season and can also be dry for more than a season.

The San Agustín Basin has been the scene of research into Quaternary paleoenvironmental history since the early 1900s (Bryan 1926; Powers 1939), but it was the recovery of the 600-m-long "Oberlin Cores" in the 1950s that formed the basis for understanding Pleistocene and possibly late Pliocene paleoenvironmental conditions (Clisby and Forman 1957; Clisby and Sears 1956; Foreman *et al.* 1959; Sears 1961). Based on this research, it appears that the highest shorelines (2122–2149 m) predate the Last Glacial Maximum (LGM), although their exact age is unknown. Recent radiocarbon dating and analysis of pollen, diatoms, stable isotopes, and ostracode data from Oberlin Cores and newer, shallower, cores suggest pre-LGM (>27,600 years B.P. in uncalibrated radiocarbon years) lake levels were fairly low and associated with relatively warm temperatures (Markgraf *et al.* 1983, 1984; Phillips *et al.* 1992). The probable LGM (ca. 20,900 years B.P.) shoreline spans 2110–2120 m, and was likely associated with cooler temperatures. The LGM lake was high enough to encompass all three sub-basins.

A warming trend began around 19,800 years ago, although lake levels remained at or near LGM levels until roughly 19,000 years ago because of high inflow rates (Markgraf *et al.* 1983, 1984). Since that time lake levels fluctuated but became progressively lower. The post-LGM drop in lake level resulted in the draining of the White Lake Basin below its sill into the C-N and Horse Spring Basins. Lake level records from the White Lake and C-N Basins and from Bat Cave provide clues to environmental changes in the San Agustín Basin during the Paleoindian occupation. The dating at Bat Cave (Holliday *et al.* 2006) shows that by Clovis time (ca. 11,300 years B.P.; based on dating of Clovis from Holliday [2000] and Waters and Stafford [2007]) water was below the level of the site and likely close to the 2105 m shoreline. This shows that the White Lake Basin was drained of standing water before the Clovis occupation. The Ake Site (Holliday *et al.* 2006) shows that water was at or below the 2105 m shoreline by Folsom time (ca. 10,900–10,200 years B.P.; based on dating of Folsom on the Great Plains from Haynes [1993] and Holliday [2000]). The lake could have retreated below the 2105 m level well before Clovis or Folsom time.

Work by Holliday and colleagues (2006) suggests that even after the paleolake drained from C-N and White Lake Basins, playa or wetland conditions persisted in both into the early Holocene. Coring near the Ake Site in the C-N Basin revealed the presence of playa or lake-marginal wetland muds (Unit Y) from around 14,935 to 10,345 years B.P. Similar terminal Pleistocene playa mud deposits were also found in White Lake Basin. Erosion of these playas produced sand dunes and sand sheets along the margins of C-N and White Lake Basins. By the beginning of the Holocene (10,000 years B.P.), playas formed only seasonally, or even less frequently. An alkaline lake survived in the Horse Spring Basin until approximately 5000 years ago when the modern playa formed (Markgraf *et al.* 1984).

Prior Archaeological Research

Archaeological interest in the Paleoindian occupation of San Agustín Basin began in the late 1940s with work at Bat Cave (Dick 1965: vii) and a regional archaeological survey (Hurt and McKnight 1949). This early research recognized that the playa margins and adjacent dune fields were attractive habitats for Paleoindian and later human groups (Weber 1994). Although Hurt and McKnight (1949) and the later work at Bat Cave (Dick 1965) identified only 13 sites scattered around the margins of Horse Spring and C-N Basins, the results of this work identified some of the salient features of the occupational history of the basin, which have been confirmed by later researchers (e.g. Weber 1994; Hill *et al.* 2007). First, a high proportion of the localities in the basin is located on highly deflated surfaces and contains a mixture of artifacts dating from different periods. Second, the Paleoindian occupational history of the southern and northern portions of the basin appears to be different. The northern portion of the San Agustín Basin was occupied by Paleoindian, mostly Folsom, populations; however, no comparable early occupation is found in the southern portion of the basin. In the Horse Spring Basin, there is evidence for only Archaic and Formative period sites.

In the last few decades, several cultural resource management projects were conducted in the basin, although these projects were mostly small-scale pedestrian surveys in support of public utility projects, road construction, or federal land exchanges

Figure 2 Photograph (looking south) of the opening of Bat Cave. The prominent bench in the foreground is the 2105 m shoreline. Photograph by Matthew Hill.

(e.g. Alexander and Behan 1964; Bertram *et al*. 1989; Bussey and Beckett 1974). Project areas were often limited to a narrow linear corridor, and frequently occurred within previously disturbed rights-of-way. An exception to this trend was survey work ahead of construction of the Very Large Array and discovery of the Ake Site (Beckett 1980), discussed below.

More information on Paleoindian occupation of the San Agustín Basin was produced by dissertation projects that analyzed Folsom projectile points and preforms from privately owned artifacts collections (Amick 2002; LeTourneau and Weber 2004). Although their research provides valuable insights about the prehistoric occupation of this valley, it focused only on Folsom projectile points from a handful of private collections. Amick (1999) and others (Bamforth 2002b, 2007; Kuhn 1991, 1994) have cautioned archaeologists to be wary of relying only on information from projectile provenance because differing patterns of land-use strategies are indicated depending on whether researchers analyze only projectile points versus when they consider information from other tools and lithic debitage. Our current perspective on the Paleoindian occupation of the basin, therefore, is fairly limited.

The most thoroughly investigated archaeological localities in the San Agustín Basin are Bat Cave and the Ake Site. Interpretations of the regional prehistoric occupation thus tend to be shaped by the results from the work at these two localities. A potentially more valuable source of information about the Paleoindian occupation of the San Agustín Plains is the Robert Weber private artifact collection. All three sources of data are discussed below.

Bat Cave

Bat Cave is a series of adjacent rock shelters located at the far southwestern edge of the Horse Spring Basin (FIG. 2, see FIG. 1). Three years of excavations at the site in 1947, 1948, and 1950 by Harvard University produced the first dated specimens of preceramic maize in North America (Dick 1965; Wills 1988a, 1988b, 1989, 1998). While the initial age estimates for this corn suggested they were nearly 6000 years old, recent AMS dating of museum samples of the maize cupules and a reanalysis of site stratigraphy suggest that these samples date to roughly 3100 years old (Wills 1994: 88). This still makes the specimens from Bat Cave some of the oldest maize in the U.S. Southwest (Wills 1990, 1994). Although Bat Cave contains geological deposits dating between ca. 14,000 and 10,500 B.P., as yet there is no evidence for human occupations at the site during this period (Wills 1998; Holliday *et al*. 2007).

Because the Harvard excavators dug in arbitrary levels that likely crosscut different geological strata, interpreting the cultural sequence at Bat Cave is difficult (Smith 1950; Wills 1988b, 1998). Based on the available information from the early work at the site as well as the excellent later excavations, it appears that the oldest cultural component at the site is the "Buff Sand" level dating between 10,500 and 3500 years B.P. (Wills 1998). Diagnostic projectile points recovered from this level share many attributes with Jay and Bajada points (Wills 1998; c.f. Dick 1965). The presence of diagnostic projectile points (e.g. Bat Cave, Gypsum/Agustín, and Pelona) in the upper portion of this level indicates a Middle Archaic component in the upper portion of the Buff Sand level. Overall, the low quantity of artifacts, the presence of only a few scattered features, and the lack of obvious midden deposits from this level suggest the earliest occupation of the cave was quite limited. In fact, Wills (1994) characterizes use of the site during this period as an occasional hunting camp.

Overlying the Buff Sands level is a thick cultural midden deposit that the excavators separated into six arbitrary 12-inch levels. The lower portion of this midden is a rich deposit of charcoal, ash, bone, and other debris representing an intensive human occupation that dates between ca. 3500 and 1800 years B.P. The lowest portion of this midden (Level VI) contains a low number of Middle Archaic diagnostics, including specimens similar to Cortaro, Chiricahua, Gypsum/Agustín, and Pinto/San Jose points. The upper part (Levels II–V) represents a mixture of Late Archaic (e.g. San Pedro) and Middle Archaic deposits. In general, the density of artifacts in the lower portion of the midden (Levels VI–IV) is low, while the density in the upper portion (Levels III–I) is much higher. Throughout the preceramic horizons (Levels VI–II), midden debris is likely from generalized seasonal (summer-fall) base camp activities associated with local maize production, processing, and storage (Wills 1989, 1998).

Figure 3 Photograph (looking east) of area of the Ake Site (LA 13423) (indicated by arrow). The southwestern track of the Very Large Array (VLA) is apparent on the near side of the site. Photograph by Matthew Hill.

The uppermost deposit in the midden (Level I) represents a shift in use of the shelter from a Late Archaic (3000–1900 years B.P.) habitation locale to a seasonal hunting camp during the Formative period (< 1700 years B.P.). According to Wills (1988b: 471, 1996: 353), the presence in the North Shelter of the cave of a 50-cm-thick deposit of sterile colluvium between the Late Archaic levels and the ceramic layers argues strongly for an extended hiatus in the occupation of the sites between these different occupations.

The Level I midden deposits contain thousands of bison bones, a lower diversity of artifacts, and limited evidence for use of maize. These units also contain numerous examples of perishable artifacts (e.g. arrow shafts, gourd containers, netting, basketry, sandals, cordage, and fiber bundles), bone tools, butchered bison remains, and also ceramics. The presence of atlatls in this midden suggests that portions of it predate the ceramic period (or at least predate A.D. 1000) (Shott 1997); however, as VanPool (2006) suggests there is the possibility that atlatls continued to be used late into the Formative period, especially in situations where big game hunting occurred. The duration of this Formative period occupation is unknown because the historical period occupation by Apache Indians and Hispanic sheepherders destroyed much of the later prehistoric deposits in the cave (Wills 1998).

Ake site (LA 13423)

The Ake Site is a large (600 × 550 m) dense artifact scatter consisting of chipped stone, ground stone, and ceramic artifacts (FIG. 3, see FIG. 1). In 1978, archaeologists with New Mexico State University conducted surface artifact collection and excavations of portions of this site associated with mitigation efforts for the construction of the Very Large Array (VLA) radio astronomy observatory (Beckett 1980). Beckett's (1980) work at the site identified over 30,000 artifacts distributed across six surface artifact concentrations along the 550 × 75 m right-of-way of the VLA (FIG. 4).

Although Archaic and Formative period artifacts dominated the assemblage and were encountered across the entire site surface, diagnostic Folsom artifacts were only found in the southwestern portion of the site. In this area, Robert Weber, who discovered the site, recovered three Folsom point fragments and seven channel flakes. During the 1978 season, New Mexico State University excavations recovered an additional seven Folsom projectile points and two channel flakes within the VLA corridor. Our surface survey of the site in 2006 identified another channel flake in the area of Weber's earlier Folsom discoveries (M. E. Hill 2006).

Area 4 at Ake, where New Mexico State University archaeologists recovered most of the Folsom material, does not represent an intact Folsom occupation level. Instead, this area contains a wedge (Unit X) of sediment and Folsom artifacts that eroded from an older intact beach ridge during the middle Holocene (Weber 1980; Holliday *et al.* 2006) (FIG. 5). Weber's find locality approximately 200 m SE of Area 4 is located along a beach ridge. Holliday and colleagues (2006: 113) indicate that the base of the stratigraphic profile in this part of Ake consists of thick clayey and muddy lake deposits (Units A and B) overlain by 80-cm-thick cross-bedded fine sand and clay beach ridge deposits (Unit C) and a firm brown, loamy eolian sand with an ABtwb soil (Unit D). A weakly consolidated dark gray brown eolian sand with A-Bw soil (Unit E) caps this entire area. A Folsom artifact recovered by Weber in 2006 originated from the base of the ABtwb soil from Unit D (Holliday *et al.* 2006).

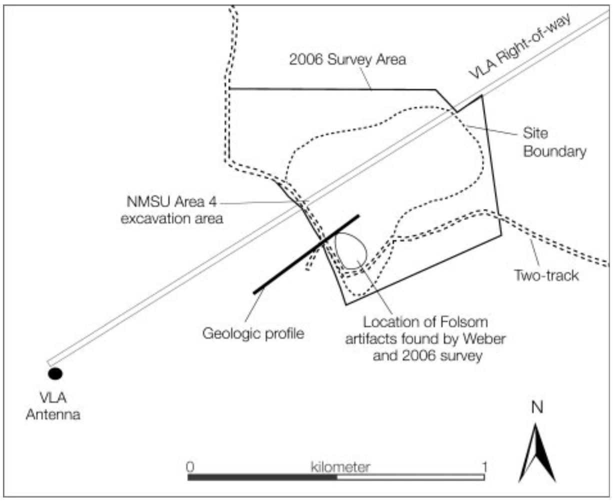

Figure 4 Plan of the Ake Site (LA 13423) showing the relationship of the VLA right-of-way, New Mexico State University Area 4 excavation area, Folsom artifact discoveries by Robert Weber, and location of stratigraphic profile depicted in Figure 5.

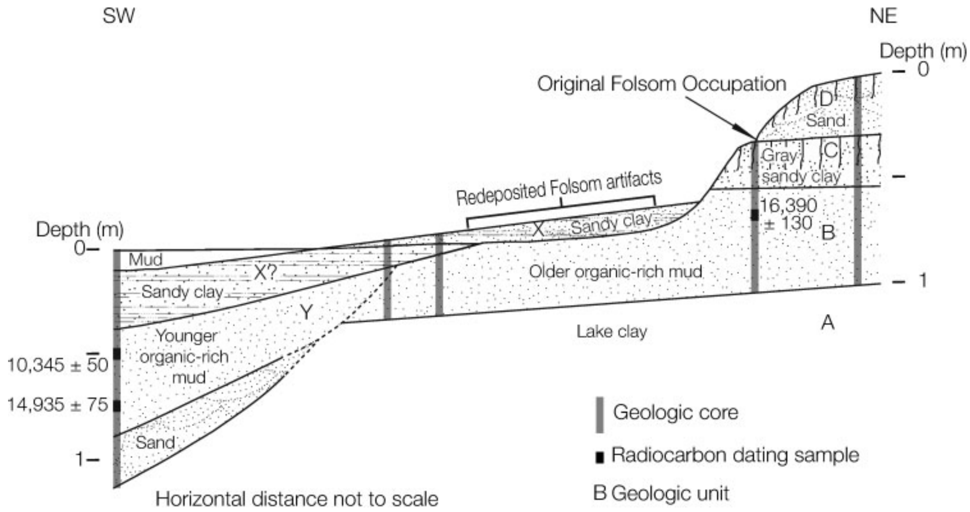

Figure 5 Stratigraphic cross-section of the Ake Site (LA 13423) depicting major geological units, location of geological cores, and radiocarbon sampling (from Holliday *et al.* 2006).

The 2006 survey of the site recorded a surface assemblage dominated by chipped stone debitage (M. E. Hill 2006). All stages of lithic reduction are well represented in the Ake assemblage, and indicate reduction of both cores and bifaces. In addition, the assemblage contains a moderate number of formal tools, including nine grinding slab fragments, four scrapers, four projectile points (i.e. Jay, Gypsum/ Augustín, Pelona, and Formative period side-notched), two manos, and one drill. These formal tools appear to be scattered more or less uniformly across the surface of the site.

The total lithic assemblage is heavily dominated (84%) by low quality lithic raw materials, including welded tuffs, rhyolites, basalts, and quartzites, which may have come from the hills immediately south and west of the site. The high-quality raw materials at Ake consist mostly of cherts and jaspers, as well as a small number of chalcedony and obsidian artifacts that do not appear to come from sources within the San Agustín Plains. Fire-cracked-rock (FCR) is a significant component of the surface assemblage, especially in blowout areas. The abundance of FCR suggests that thermal features were once present at the site. Our survey, however, could not locate any intact features.

Artifact density is highest in the southwestern portion of the site and generally low everywhere else. The distribution of surface artifacts is uneven and most abundant in blowouts. The six excavation areas investigated by New Mexico State University (Beckett 1980) correspond to the major surface concentrations within blowout features. Beyond the right-of-way, there are additional concentrations, also in blowout areas. Currently the densest concentration of surface artifacts is located beyond the VLA right-of-way in the southwestern corner of the site, where deflation has exposed the underlying lake deposits.

While the diagnostic Folsom materials (i.e. projectile points and channel flakes) are clearly clustered in the southwestern portion of the site, this material is mixed with artifacts from later occupations, including later diagnostic projectile points, FCR, and ground stone artifacts. Except for the diagnostic points and flakes, it is difficult to separate artifacts associated with Paleoindian occupation from that associated with the Archaic or Formative period occupation.

While it is likely that the vast majority of artifacts, especially FCR and ground stone from the southwestern portion of the site are associated with the non-Folsom occupations at Ake, it is not possible to assign this material to any particular occupation. While one might use lithic raw material (for example Folsom artifacts made of exotic cherts and later artifacts made of local raw materials) to distinguish different components based on their use of non-diagnostic artifacts, our examination of the evidence suggests this might be problematic. By combining data from our own observations and collections by Weber and Beckett, it is clear that Folsom points and channel flakes from Ake are made exclusively of regionally available high quality cherts, chalcedony, and rhyolites (e.g. Black Canyon Silicified Rhyolite). Archaic points are primarily (ca. 70%) made from locally available, lower quality welded tuffs, basalts, and rhyolites; however, approximately 30% of Archaic points are made with from non-local high quality cherts, obsidian, and Black Canyon Silicified Rhyolite. Thus, it is not possible to assume that all non-diagnostic tools or flakes made of high quality exotics are part of the Folsom component and not the byproduct of a later occupation at the site.

Robert Weber collection

The single largest source of information on archaeological sites from the San Agustín Plains is the collection of surface artifacts made by Robert Weber while working as a geologist for the New Mexico Bureau of Geology and Mineral Resources (Alexander 1997; Huckell *et al.* 2008). Weber began collecting artifacts from the basin in the late 1950s during a period when he was mapping the surface geology of the White Lake and C-N Basins. He continued his archaeological research at various sites in the basin through early 2000s. During this nearly 50-year period, he made regular visits to the eastern portion (White Lake and C-N Basins) of the San Agustín Basin to collect surface artifacts. Except for a few years in the late 1950s/early 1960s, Weber usually did not look for artifacts within Horse Spring Basin because he almost never found Paleoindian material in that sub-basin, although material dating to the Archaic and Formative periods was recovered. None of the Paleoindian material discussed in this paper comes from the southern portion of the basin.

As a result of Weber's decades of work, 75 archaeological and 20 paleontological localities were identified and recorded in C-N and White Lake Basins. He mapped each location on a 7.5-minute quadrangle map, systematically collected any diagnostic surface artifacts, and assigned each artifact a unique catalogue number associated with the specific find locality. In his field notes Weber recorded other artifacts present in the area, even if they were not collected. Occasionally non-diagnostic artifacts were also collected at these localities, although most were not assigned an individual catalogue number.

Despite multiple visits to his find localities over several years, Weber rarely identified more than one artifact per locality. The majority (81%; n = 61) of his find locations consist of an isolated projectile point or small number of diagnostic artifacts. Just 14 (19%) of localities can be considered sites in the usual sense rather than isolated findspots, having produced evidence for many artifact types, including diagnostic points, preforms, debitage, and other tools.

Our inventory of Weber's Paleoindian artifact collection identified 87 projectile points and preforms, 23 scrapers, 5 gravers/drills, 3 bifaces, 25 channel flakes, and 67 flakes and flake tools. Various Paleoindian and later diagnostic projectile point and preform types are represented in the collection, including Clovis (n = 13), Folsom (n = 30), Agate Basin/Hell Gap (n = 2), Plainview (n = 7), Cody/Scottsbluff (n = 22), Angostura (n = 1), and unidentified point fragments (n = 10). In addition, 5 Archaic points (one each of Bajada, Chiricahua, Jay, Pinto/San Jose, and San Pedro points) and 2 unidentified non-Paleoindian points were also part of his collection.

2006 Archaeological Survey

As discussed above, Weber reported a large number of Paleoindian localities from the C-N and White Lakes Basins. Because Weber focused his attention primarily on collecting diagnostic projectile points and tools from this area, however, it is difficult to evaluate how representative his collection is of the prehistoric occupation of the region. To investigate this issue, we conducted a pedestrian survey in 2006 in areas around the margins of the C-N paleolake, with more limited investigation of the White Lake Basin (FIGS. 6, 7). The goals of this survey were to evaluate the nature of the surface expression of the localities where Weber had previously identified Paleoindian artifacts, determine whether these localities also contained later Archaic and Formative period components, and evaluate the potential for identifying Paleoindian and other archaeological sites in areas where Weber did not report finding material.

Fieldwork was conducted in June and July of 2006, and involved the systematic survey (ca. 10 m interval transects) of 391 ha in 12 separate survey blocks (TABLE 1) (Hill 2006; Hill *et al.* 2007). Areas surveyed either were areas where Robert Weber previously identified Paleoindian artifacts or sites (Survey Areas #1, 2, 3, 4, 7, 10, and 11) or were landscape features, such as high paleolake shorelines, where sites had not been reported previously.

Sites were classified as any discrete concentration of 10 or more artifacts or association of an

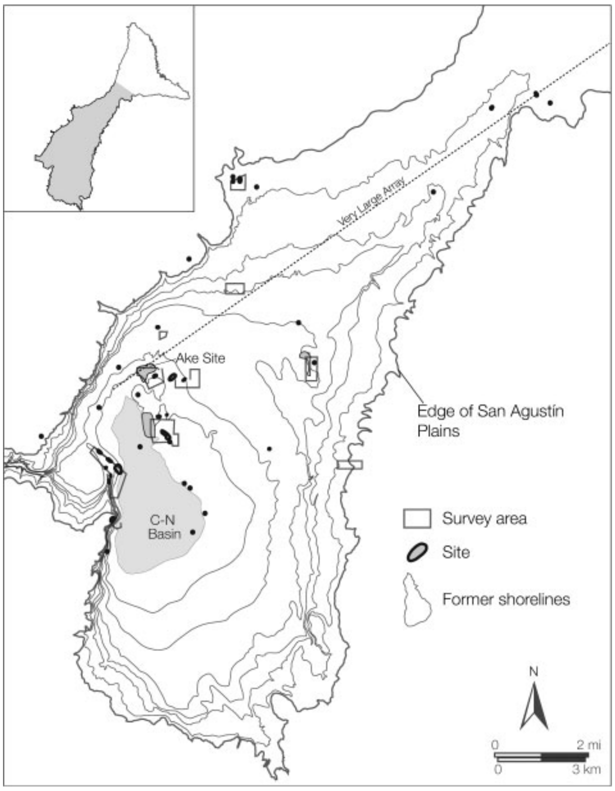

Figure 6 Map of C-N Basin showing locations of known prehistoric archaeological sites and 2006 pedestrian survey areas in relation to major paleoshore line features. Inset map shows location of drainage basin for the C-N sub-basin in relationship to eastern portion of San Agustín Plains.

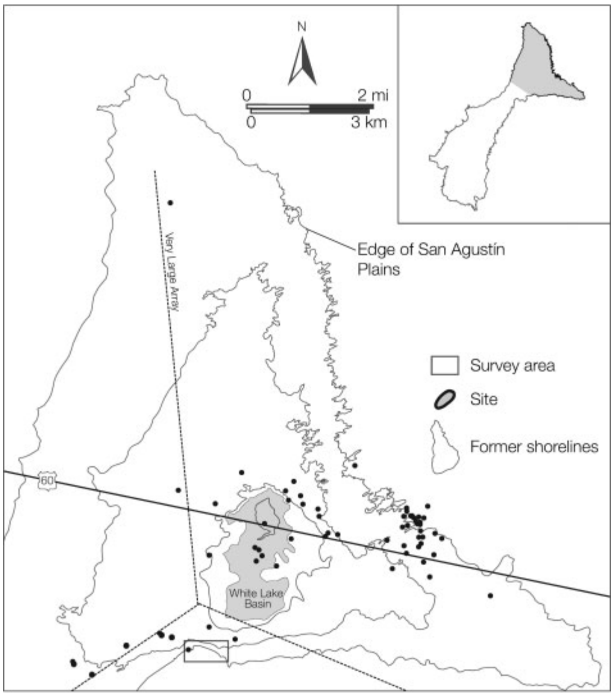

Figure 7 Map of White Lake basin showing locations of known prehistoric archaeological sites and 2006 pedestrian survey area in relation to major paleoshore line features. Inset map shows location of drainage basin for the White Lake sub-basin in relationship to eastern portion of the San Agustín Plains.

archaeological feature, such as a hearth, with any number of artifacts. All cultural remains were recorded by artifact type and lithic raw material. The locations of all artifacts were plotted with a GPS unit. The integrity and subsurface potential of each site was evaluated as accurately as possible. No artifact collections were made and no subsurface testing was conducted.

Survey results

Based on Weber's collection, one would have the impression that the San Agustín Basin had a significant Paleoindian occupation (especially during Folsom times), with a lower occupational intensity during the Archaic period. As discussed below, the occupational history of the basin is complex, and while Paleoindian components outnumber those dating to the Archaic period there does seem to be a geomorphic shift in where Paleoindian and Archaic occupations occur. Therefore, the simple model of a decline in occupational intensity from Paleoindian to Archaic periods is not supported by this study. Our survey recorded 17 archaeological sites (TABLE 2) and 42 isolated artifacts within the project area. Our results support the idea that the northeastern portion of the San Agustín Plains had Paleoindian occupation; however, at least for the C-N Basin there also appears to be a noticeable Archaic period occupation. Unfortunately, it is not possible to distinguish between these occupations in many cases. Some sites with large surface artifact assemblages are multicomponent palimpsest exposures with a number of different diagnostic projectile points present. This does not preclude the possibility that single component (Paleoindian and later) limited-use (e.g. kill/butchery) and seasonal short-term residential localities (e.g. camps) are present in the basin and remain to be discovered.

Of the 17 sites investigated by this project, 5 produced diagnostic artifacts suggestive of Paleoindian occupation. Previously unidentified sites were assigned a sequential field designations number with the prefix AARF for Argonaut Archaeological Research Fund. Together, Weber and our survey have identified Folsom projectile points (n = 18), a perform (n = 1), and channel flakes (n = 22) from 4 sites (Ake, AARF-7, 8, and 15), a Clovis point from AARF-11, a base of a Milnesand point from AARF-15, and portions of a couple of possible Paleoindian points from AARF-15 and 16.

Unlike evidence from the Weber's collection, however, Archaic and Formative period diagnostics are also common from the sites in the survey. Early Archaic-period Jay and long-tapering stemmed projectile points were recorded at Ake, AARF-1, 8, and 15. Middle Archaic diagnostics (Chiricahua, Pinto/San Jose, and Gypsum/Agustín) were identified from Ake, AARF-7, 13, and 15. A Late Archaic component was present at AARF-7 based on the presence of a fragment of a San Pedro point. In addition, our identification of substantial assemblages of ground

Table 1 2006 survey area, legal description, acreage, and sites identified.

Survey area	Township	Range	Section(s)	USGS quadrangle	Hectacres surveyed	AARF sites no.
1	4S	9W	18, 19, 20	C-N Lake	87.8	AARF-1, 2, 3, 4, 5, and 6
2	4S	9W	30	C-N Lake	2.4	AARF-7
3	4S	9W	16, 17	C-N Lake	68.8	AARF-8, 9, 10, 11; Weber-67
4	4S	9W	5, 8	C-N Lake	42.9	Ake; AARF-12
5	4S	9W	4, 9	C-N Lake	33.2	AARF-13. 14
6	4S	9W	5	C-N Lake	5.7	AARF-17
7	4S	9W	2, 11	Kellog Well	27.9	AARF-15
8	3S	8W	1	Arrowhead Well	50.2	AARF #16
9	3S	9W	34	Anderson Peak	21	
10	4S	10W	13	C-N Lake	12.1	Weber #63
11	3S	9W	15, 22	Anderson Peak	19	Weber #56, 57, 60
12	4S	9W	13	Kellog Well	19.4	

Table 2 Count of select artifact categories for archaeological sites recorded during 2006 survey.

Site	Total artifacts	Diagnostic artifacts	Cores	Bifaces	Uniface tools	Utilized flakes	Ground stone	Ceramics	FCR
Ake*	18,490	10 Folsom point 11 Channel flake 1 Jay point 13 Agustín/Gypsum point 1 Long Tapering Stemmed points 10 Pelona point 1 Chiricahua point 1 Datil point 2 Formative period points 10 Alma Plain sherd	58	87	12	438	321	10	321
AARF-1†	48	1 Jay point	1	–	1	–	6	–	–
AARF-2	26	None	–	1	1	–	2	–	–
AARF-3	20	1 Archaic corner notched point	–	3	1	–	–	–	–
AARF-4	16	2 Archaic side notched point	–	1	1	–	–	–	–
AARF-5	49	None	–	–	–	4	–	–	–
AARF-6	hundreds	None	–	–	–	–	§	–	††
AARF-7†	104	1 Folsom preform 1 Chiricahua 1 Pinto points 1 San Pedro	1	3	15	6	1	–	–
AARF-8†	219	2 Folsom channel flakes 1 Long Tapering Stemmed points 2 possible Archaic points	1	1	2	26	4	–	6
AARF-9	17	None	–	–	–	2	–	–	–
AARF-10	110	1 Cibola White Ware sherds	–	–	1	2	11	1	–
AARF-11‡	thousands	1 Clovis 1 possible Archaic point 1 San Pedro point 8 Tusayan White and Grey ware sherds	§	§	§	**	§	**	††
AARF-12	17	None	–	1	–	–	1	–	–
AARF-13	35	1 Agustín/Gypsum point	–	–	–	–	1	–	–
AARF-14	22	None	–	–	–	–	–	–	–
AARF-15†	574	8 Folsom points 9 Folsom channel flakes 1 Milnesand point 1 possible Paleoindian point 2 Jay point 1 Chiricahua point 2 San Jose point 1 Augustín/Gypsum point 1 Formative period point	3	11	5	33	35	–	108
AARF-16	28	1 possible Paleoindian point	–	–	2	5	1	–	–

*Includes data compiled from 2006 survey, Weber collection, and Beckett (1980).
† Includes data compiled from 2006 survey and Weber collection.
‡ Includes data compiled from 2006 survey, Weber collection, and Ake collection.
§Artifact class present but not abundant (n < 10).
** Artifact class present and moderately abundant (n = 10–100).
††Artifact class present and abundant (n > 100).

stone milling equipment and FCR at sites such as Ake, AARF-6, 11, and 15 also indicate a substantial if not perhaps more intensive, occupation during the Archaic period compared to the Paleoindian period. Our survey suggests that the Formative period occupation in the basin was relatively limited. The only direct evidence for a Formative period occupation comes from a small number of Alma Plain, Cibola White Ware, Tusayan White Ware, and Tusayan Gray Ware sherds identified at Ake, AARF-10 and 11, and the presence a couple Formative period arrow points form Ake and AARF-15.

If we combine data from our survey, the Weber Collection, and Beckett's (1980) excavations at the Ake Site, we can draw a more comprehensive picture of lithic raw material use in the San Agustín Basin. Table 3 presents raw material types used for making diagnostic (projectile points and channel flakes) artifacts in the Paleoindian, Archaic, and Formative periods. Based on visual comparison of comparative specimens, the majority of Paleoindian points and channel flakes appear to be made from either very distant lithic sources (i.e. Chuska [420 km] and Rancheria [290 km]) or regionally available (30–

Table 3 Frequency of diagnostic projectile points and channel flakes by raw material source from San Agustín Basin. Data from 2006 survey, inventory of Weber's private collection, and Beckett (1980).

	Local sources (< 10 km)	Regional sources (30–100 km)		Distant sources (>100 km)			Indeterminate sources
Time period	Welded Tuffs/ other volcanics	Black Canyon rhyolite	Rio Grande gravels	Rancheria or Lake Valley chert	Cumbres Pass chert	Obsidian	Unknown
Late Prehistoric	0	1	2	0	0	0	2
Archaic	18	1	1	0	0	13	9
Paleoindian	1	7	11	8	5	0	11

100 km) chalcedony (e.g. Rio Grande gravels) and rhyolites (e.g. Black Canyon Silicified Rhyolite). Just one Paleoindian projectile point was made from a locally available rhyolite source. Archaic projectile points roughly evenly split between being made of locally available welded tuffs (n = 18) and very distant sources of obsidian (n = 13). Two additional Archaic points are made from regionally available Rio Grande gravels and Black Canyon Silicified Rhyolite. Finally, the source of just two Formative period projectile points could be determined. Both were made of regionally available materials.

Discussion

Individually, the studies within the San Agustín Basin provide a limited view of the prehistoric occupation. If we combine the results of the current work, prior work in the basin, and Weber's private artifact collection, it is possible to make preliminary conclusions about land-use in the eastern portion of the project area.

Site formation history and occupational intensity

We have clues regarding landscape evolution in the White Lake and C-N Basins as related to Paleoindian and later occupations. The data on lake level history (based on Bat Cave and the Ake Site) suggest that the paleolake was gone from the White Lake Basin or was below the 2105 m shoreline by the time of the Clovis occupation, the paleolake level was at or below 2105 m by the time of the Folsom occupation of the basin, water levels probably did not fluctuate significantly during Folsom time, and there were no lake transgressions above 2105 m at any time during the Paleoindian occupation of the basin. As noted, at the Ake Site we recovered marsh/playa mud that yielded a Folsom age of ca. 10,345 years B.P. But the Folsom occupation itself at Ake is within the lower part of sandy eolian deposits on top of the 2105 m-shore line. These eolian sediments indicate local drying and wind erosion. The floor of the C-N Basin has very low relief (no more than 3 m) and a minor change in lake level, therefore, could expose a large area, especially in proximity to the beach, to wind erosion, or in turn inundate most of the area at or below 2105 m. As noted above, Weber observed a Late Paleoindian feature within dunes on the east side of the White Lake Basin. Combined, these data suggest episodic drying and wind erosion in post-Clovis time. There is no evidence of declining water levels or aridity during the Clovis occupation, but our paleoenvironmental data are limited. Seasonal playa or wetland conditions persisted in both basins throughout the rest of the Holocene.

A key difference between the two sub-basins relates to site formation histories and occupational intensity in site use. Here, we define occupational intensity as the amount of time spent at the site by all inhabitants, and recognize that high occupational intensity can result from either a large number of people occupying a site for short period of time or a small group of people repeatedly reoccupying the same locality (Surovell 2009) over a long period. As discussed above, many of the sites are not single component localities but represent palimpsests (time averaged deposits) in which successive occupational episodes have been superimposed upon one another (in sensu Bailey 2007). In addition to the multiple occupation episodes at some localities, this area is characterized by deflation, erosion, and horizontal mixing of sediments (Holliday 2005) with the result that at many localities in the project area artifacts from the different occupational episodes are so mixed together that it is nearly impossible to separate them out except in terms of temporally diagnostic artifacts such as projectile points.

As recognized by Bailey (2007: 204, 2008), even if materials from different occupation episodes are present all details of past occupations are not lost. By using temporally diagnostic artifacts, such as projectile points, it is possible to compare the relative abundance of different components. In addition, as seen in Area 4 of the Ake Site (Beckett 1980), it is possible at some sites to recognize limited spatial segregation of different components and perhaps even some intact buried deposits, although the degree of buried components for most of these sites still needs to be determined. This said, we must accept that any patterns we might observe in the archaeological record of this area are the result of repetitive behaviors maintained over long periods of not, not the result of discrete groups of individuals acting over

Table 4 Frequency of assemblage types from the San Agustín Basin and surrounding upland areas.

Assemblage type	C-N Basin	White Lake Basin	Upland
C-N isolate (< 3 artifacts)	46	29	5
Small assemblages (< 100 artifacts)	14	14	8
Large assemblages (> 100 artifacts)	6	1	1

a short time period (Bailey 2008; Binford 1982; Foley 1981). Therefore, the temporal scale of our research questions must match that of the available data: i.e. centuries and millennia not days or years.

To investigate potential difference in occupational intensity, Table 4 compares the frequency of localities that area associated with isolated artifacts (one or two artifacts), small assemblages (< 100 artifacts), and moderate/large assemblages (> 100 artifacts). Given that no site in the project area represents a lithic quarry and workshop locality, it is likely that small assemblages represent limit use or short term occupation of an locality, while the larger assemblages represent a more intensive occupation, which often consists of repeat visitation over an extended period of time.

The data indicate that both C-N and White Lake Basins, as well as the surrounding upland areas, are dominated by localities consisting of isolated projectile points or very small lithic assemblages. A G-test of independence (Sokal and Rohlf 1995: 729) run on the relative frequency of different types of assemblage (i.e. isolates, small, and large assemblages) for 124 assemblages from different regions of the San Agustín Basin shows no significant differences across the project area ($G = 9.28$; $df = 4$; $p = .06$). The entire project area is dominated by localities that are associated with modest artifact assemblages not because surface visibility is limited or deposits are deeply buried, neither which seem to be the case. Neither has limited archaeological attention resulted in artifacts being overlooked. In many cases, localities in which Weber recovered a single artifact or small assemblage were visited repeatedly, without producing additional artifacts. Overall, the evidence argues for prehistoric populations having a low occupational intensity at most localities in the basin.

There are, however, a small number of assemblages from the project area consisting of large, diverse collections of surface artifacts (e.g. multiple diagnostic projectile points, channel flakes, high frequency of chipped stone debitage, and other tools). Considering that many temporally different diagnostics have been recovered from these sites, their large size and the high artifact diversity observed in these artifact assemblages suggests these localities were used multiple times, and at least some of these visits involved camp-related activities, such as lithic reduction and hearth/fire pit creation and use. This said, given the high frequency of debitage made of local raw materials, presence of ground stone milling equipment, fire-cracked-rock, and ceramics at many of these multicomponent sites, the higher occupational intensity at these localities reflects a difference not in the intensity of the Paleoindian occupations, which likely had a very low occupational intensity, but in the later Archaic or Formative period occupations.

Cultural chronology and component frequency

The above discussion does not consider whether there were changes in use of different parts of the basin through time. Currently, 173 different components from 151 sites and findspots are known from the eastern portion of the San Agustín Basin and surrounding foothills (TABLE 5; see FIGS. 6, 7). The term "component" is defined here as a culturally and temporally homogenous unit within a single site. The number of components represented at each site was determined based on the minimum number of temporally discrete episodes represented by the temporally diagnostic artifact present. For example, a site totally lacking diagnostics would represent a single component, while a site that produced five Folsom points, two Jay points, and a San Jose/Pinto point would represent three components. Age estimates for 66 localities could not be made due to a lack of diagnostic artifacts.

Of the sites with diagnostics, Paleoindian components ($n = 61$) far outnumber the known later components for localities: Archaic ($n = 31$), Formative ($n = 9$), or Historical ($n = 5$). Even among the well-represented Paleoindian components, Folsom ($n = 30$), Cody ($n = 17$), and Clovis ($n = 6$) finds dominate. In comparison, Archaic period components with diagnostic projectile points are less abundant: San Jose/Pinto ($n = 5$), San Pedro ($n = 4$), Jay ($n = 4$), Chiricahua ($n = 4$), Long-tapered stemmed ($n = 3$), and Gypsum/Agustín ($n = 3$).

Table 5 Frequency of site/localities associated with different cultural components based on presence of diagnostic projectile from the San Agustín Basin and surrounding upland areas.

Components	C-N Basin	White Lake Basin	Uplands
Clovis	1	5	0
Folsom	9	17	3
Late Paleoindian	2	22	2
Archaic	16	10	6
Formative	3	1	5
Historic	0	0	5
Unknown affiliation	50	8	8

Using data from Table 5, a G-test was run to see whether there were significant temporal differences between the frequencies of site occupations in the project area. To maximize sample size the test was limited to comparing the relative frequency of early Paleoindian (Clovis and Folsom), late Paleoindian (Cody, Plainview, Agate Basin, Hell Gap, and Angostura), and Archaic components among the two basins and surrounding uplands. The test results suggest there is significant difference among the regions (G = 19.3; df = 4; p = .0007). The analysis of residual values suggests the C-N and White Lake Basins have an inverse occupational history. C-N Basin has a lower than expected frequency of late Paleoindian components and a higher than expected frequency of Archaic components, while the White Lake Basin has a much higher than expected frequency of late Paleoindian components and lower than expected frequency of Archaic components. The analysis of residuals for the uplands show only a slightly higher number of Archaic components than expected based on sample size.

The abundance of Folsom diagnostics in the C-N basin is not surprising and Holliday and colleagues (2006) suggest that during the Folsom period wetlands likely existed along the margins adjacent to the 2105 m shoreline. The Ake Site and three other Folsom occupational localities are situated directly along this shoreline, possibly to allow the site's occupants easy access to this rich habitat.

The large Folsom occupation (n = 17) in the White Lake Basin is accompanied by a significant number of Clovis (n = 5) and Late Paleoindian (n = 22) components. As noted above, the basin likely was drained of permanent water before the Clovis occupation, though seasonal pools or temporary wet meadows likely were present. The occupants of the White Lake Basin seem to have focused their activities in dune areas on the margins of the playa. Possibly Paleoindian foragers utilized seeps or springs located near the base of the hills adjacent to the White Lake Basin.

The region experienced increased drying through the Holocene, and perhaps a decline in occupational intensity through time as well. This regional drying pattern likely influenced human occupation differently in the two basins. The relative paucity of Archaic occupation in the White Lake Basin probably related to a decline or even disappearance in seeps or springs in this area during the middle Holocene. Humans responded by preferentially shifting their focus to exploiting the surviving surface water sources in C-N Basin.

Populations were probably low during the Late Holocene as no major Formative period habitation sites are known from the northern portion of the San Agustín Basin. The sites that are present in this portion of the basin are usually associated with a handful of later Mogollon or Ancestral Puebloan sherds or a couple Formative periods projectile points. This is probably the result of the drying of surface water sources.

Relationship of site location and paleoshores

Our research expands on a number of archaeological studies that consider how early foragers utilized paleolake basins in the West (e.g. Beck and Jones 1997; Jones *et al.* 2003; Judge 1973; Wessel *et al.* 1997). In general, previous work suggested that the oldest occupations (i.e. Clovis and Folsom) tended to be located in proximity to paleolakes and playas, whereas later occupations were more widely scattered. This pattern is often interpreted as indicating foragers shifting from a nearly exclusive use of lacustrine habitats to the use of a mixture of lacustrine (or playa) and montane habitats as paleolakes retreated.

Langford (2003) speculates that formational processes influence our understanding of site distribution patterning around paleolakes. Based on his work in the Tularosa and Otero Basins (see FIG. 1), Langford (2003) showed that sites may be found along or above high shorelines today but may also have existed lower in the basin, perhaps along the water's edge. Because basin floors are often subject to deflation, such sites are destroyed or buried by eolian sediments. As discussed above, destruction of sites in the floor of the San Agustín Basin may be less of a problem than elsewhere in the desert west. For example, in the C-N Basin there are likely preserved Folsom-age deposits near a lower shoreline at the Ake Site (Holliday *et al.* 2006; see also Weber 1980). In addition, Weber (1994) suggests that Clovis artifacts were deposited within playa mud and marsh deposits associated with the higher shorelines of the White Lake Basin, whereas younger Folsom artifacts were in eolian deposits on lower elevation beach ridge deposits.

As with other basins throughout the West, archaeologists working in the San Agustín Basin have been interested in locating sites relative to the paleolakes in the White Lake and C-N Basins (Beckett 1980; Dick 1965; Hurt and McKnight 1949). Using the known elevations for sites within C-N and White Lake, it is possible to examine the relationship between site placement and shoreline features. Figures 8 and 9 depict the elevation distribution of Clovis, Folsom, Late Paleoindian, and Archaic components in the two basins. In general, sites do not seem to cluster strongly with shoreline features. In the White Lake Basin, the lack of such a relationship is unsurprising given that the lake in this sub-basin likely drained prior to human occupation of this area. In fact, the lowest known shoreline (ca. 2120 m) in this basin

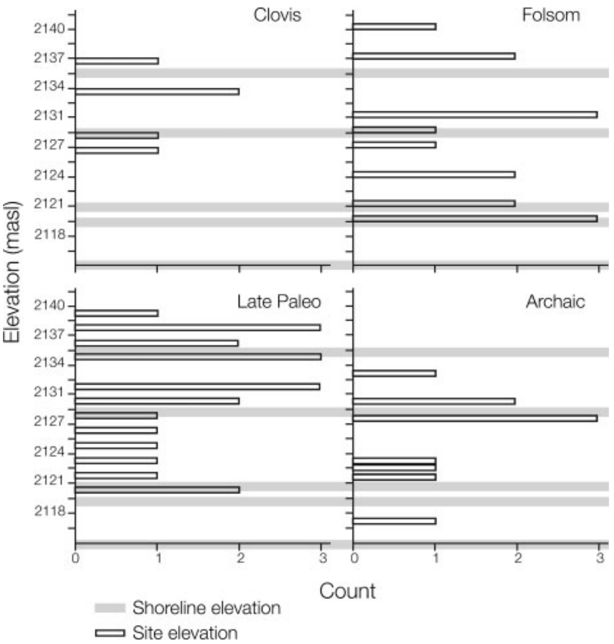

Figure 8 Bar graph depicting frequency of Clovis, Folsom, Late Paleoindian, and Archaic period components by elevations (masl) within the White Lake Basin. The gray bar represents the elevation of known shoreline features within the sub-basin.

probably dates to the LGM. However, playas or wet meadow conditions may have persisted well into the Holocene. Conditions were probably such that even Archaic foragers were able to use plant and animal resources along the playa margins. In the C-N Basin, the only potential direct association is seen with a series of Archaic and Folsom components located along a sandy beach ridge formation along the lake side at 2105 m (Holliday *et al.* 2006).

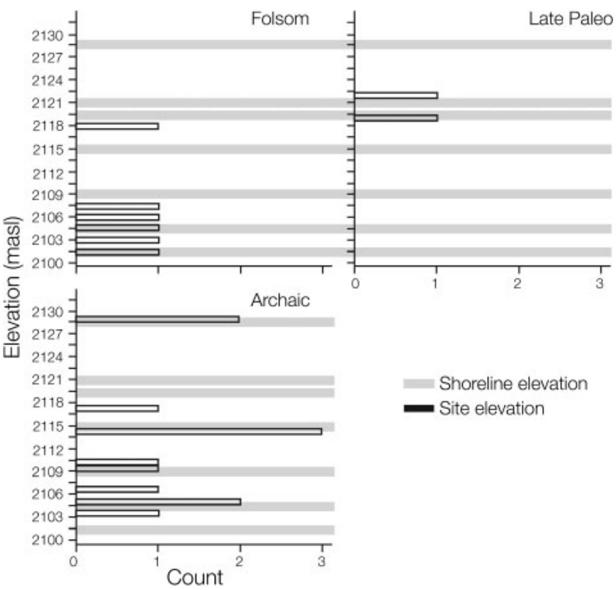

Figure 9 Bar graph depicting frequency of Folsom, Late Paleoindian, and Archaic period components by elevations (masl) within the C-N Basin. The gray bar represents the elevation of known shoreline features within the sub-basin.

Although all sites in C-N are lower than those in White Lake, we see there is no significant variation among the elevation of sites of different cultural components (C-N: Kruskal-Wallis $H = 3.5$, $df = 2$; $p = 0.17$; White Lake: Kruskal-Wallis $H = 3.9$, $df = 2$; $p = 0.26$). Comparison of different cultural components generally showed no variation in the elevation of sites among the range of cultural periods.

Conclusion

Archaeologists commonly assume that ancient populations express a single adaptive or land-use strategy. For example, archaeologists tend to argue that Paleoindians were either technology-dependent, highly mobile, specialized big game hunters or relatively sedentary broad-spectrum foragers. These perspectives suggest that climate-induced environment change can result in long-term shifts in adaptive strategies. The Paleoindian-Archaic shift is often explained as Holocene desication forcing foragers to adapt their settlement pattern and land-use strategies. Implicit in these discussions is that some cultural groups either do not or cannot utilize multiple strategies at the same time. Only recently have archaeologists developed a greater appreciation for how flexible the lifeways of foragers and low level horticulturalists were. If we want to understand the true nature of the adaptive variability of foragers, we need to focus our attention away from research areas that provide foragers with a homogenous environment, such as the Great Plains, and explore the archaeological record in environmentally diverse settings. We argue here that the high altitude basins of the western United States, such as the San Agustín Plains, are excellent areas for exploring the broader range of adaptive strategies used by foragers and to understand long-term processes of cultural change.

The San Agustín Basin is a good area to answer questions concerning adaptive change because it contains a rich archaeological record and we are developing a detailed paleoenvironmental history of it as well. Our study shows that regional variability and long-term changes in the hydrologic regime of the basin have played an important role in differences and long-term changes in the land-use patterns of prehistoric occupants of the basin.

Although we are in the early stages of work, preliminary conclusions can be drawn about the prehistoric occupation in the San Agustín Plains. First, most Paleoindian remains are isolated finds of diagnostic projectile points, and the sites with multiple artifacts are often palimpsests. This apparent low-density of early Paleoindian artifact scatters suggests a relatively low overall occupational intensity. The high frequency of isolated early Paleoindian finds in

White Lake basin suggests this area was primarily used for special-function activities, perhaps hunting. In C-N Basin, most Paleoindian sites produce multiple projectile points and fragments and byproducts (channel flakes, discarded tools, or bifacial thinning flakes) of tool rejuvenation and production. Perhaps conditions in the lower elevation playas to the south were better than in the north, and therefore human foragers found it a more attractive area in which to establish longer occupations. Second, the most intensive Paleoindian occupations date to the Folsom and Cody periods, measured either by the number of components or by diagnostic artifacts. Third, both limited-use (e.g. kill/butchery) and seasonal short-term residential localities (e.g. camps) are likely represented in the project area.

Finally, our initial raw material analysis suggests that while some distant chipped stone sources (e.g. Edwards, Chuska, Rancheria, and possibly Alibates) were used by site occupants, regional or nearby sources of tuffs, chalcedony, and rhyolites dominate Paleoindian chipped stone assemblages. Paleoindian foragers in the San Agustín Basin practiced a land-use strategy similar to that used elsewhere in the American Southwest, in which intermountain valleys were used as seasonal residences, and groups had moderate mobility and heavy reliance on locally available lithic raw materials (Amick 1994a, 1994b, 2002; LeTourneau 2000).

The changing hydrologic conditions in the San Agustín Basin greatly influenced the nature of human occupation. Because of the high frequency of isolated artifacts and early drainage of many of the paleolake features in the project area, there is little correspondence between shoreline features and areas of human occupation. It seems that soon after Paleoindian hunter-gatherers arrived in this part of New Mexico they began utilizing resources along the margins of the active playas or wetlands in the eastern/northeastern portion of the San Agustín Basin. As the permanent lake in White Lake Basin was gone before humans arrived in the project area, it should not, however, be expected that humans preferentially settled around shoreline features in this basin and the presence of isolates in White Lake probably indicates that while playas were present they were not large enough to support more than short-term use of this area. The occupation history of C-N Lake is slightly different. The presence of a series of large and dense Folsom and Archaic sites along the 2105 m shoreline suggests that foragers may have been drawn to resources of this lake.

With the shrinking and eventual disappearance of permanent water in White Lake and C-N Basins, late Paleoindian and Early and Middle Archaic foragers shifted their focus to habitats in the adjacent dune fields and foothill settings. The high density of lithic debitage and FCR associated with Archaic sites implies that overall residential mobility dropped and occupational intensity at particular sites increased, at least in C-N Basin. Most tools and artifacts associated with this later occupation and the occasional high density of thermally-altered rock concentrations indicates greater and repeated exploitation of plant resources and the beginning of use of upland habitats, which previously seemed to have been largely ignored. This occupation does not correspond to lower shoreline features in the valley bottom, either because a permanent lake was gone, or because of site preservation factors, or both.

The disappearance of the Horse Spring Lake in the middle Holocene might have led to significant changes in occupation. Compared to early periods, occupational intensity seems to decline gradually after this time. The frequency of diagnostic Late Archaic projectile points or ceramics is lower, a change corresponding to a decline in use in response to environmental conditions. Perhaps significantly, the period when a moderately high level of utilization occurred within the basin corresponds roughly to the Late Archaic when foragers begin to exploit domesticated maize. For Bat Cave, at least, the Late Archaic occupation represents a continued use of the cave as a seasonal (summer-fall) base camp (Wills 1988a, 1988b). It is possible that by the time Horse Spring Lake finally disappeared, conditions had become so marginal that human habitation was possible only when foraging of wild resources was supplemented with agricultural products.

By the Formative period, the occupants of Bat Cave no longer used the site as a seasonal camp and shifted toward a more low intensity use of the site as a bison-processing locality. In addition, our work and that of Bob Weber demonstrates a paucity of Formative period artifacts in either C-N or White Lake Basins. It would appear that the cultivation of agricultural products was not sufficient to support more utilization of the basin. This decline in occupation intensity is surprising because, as Wills (1988a, 1996) argued, this period witnessed an amelioration of climatic conditions resulting in a lowering of lower tree line elevation, an increase in effective precipitation, an increase in floral productivity, and the reintroduction of bison into the basin. Nonetheless, there is clearly a paucity of Formative period artifacts from the project area suggesting that human use of this area was for travel to other areas, or for short-term visits associated with special-function activities, such as hunting.

Acknowledgments

Funding for this research was provided by the Argonaut Archaeological Research Fund at the University of Arizona Foundation and the Department of Anthropology at the University of Iowa. This paper is dedicated to the memory of the late Robert H. Weber. Our work benefitted from the more than 50 years of fieldwork conducted by Bob. In addition, he graciously provided the authors access to his artifact collections and supporting documentation and offered many valuable insights about the human occupation of the project area. We also thank Dorothy Ake, Travis and Tammy Kiehne, Johnny Hand, Bill Ferranti, Lew Serna, Dave Finley, Dave Love, Philip Busker, and Margaret Beck for their assistance during the 2006 field season and sharing information about the San Agustín Basin. BLM archaeologists Brenda Wilkinson and Ann Sullivan were very helpful in our research of prior archaeological investigations in the San Agustín Plains. This manuscript benefited greatly from the comments and suggestions of Margaret Beck, Bruce Huckell, and three anonymous reviewers.

Matthew E. Hill, Jr (Ph.D. 2007, University of Arizona) is an Assistant Professor of Anthropology at the University of Iowa, and currently involved in research on prehistoric foraging behavior and human impacts on the environment in the Great Plains and American Southwest.

Vance T. Holliday (Ph.D. 1982, University of Colorado, Boulder) is Professor of Anthropology and Geosciences at the University of Arizona and Executive Director of the Argonaut Archaeological Research Fund. His research interests include Paleoindian archaeology and geoarchaeology of the Great Plains, Southwest U.S., and northwestern Mexico.

References

Alexander, L. E. 1997. "A Biography of Robert Harrison Weber," in M. S. Duran and D. T. Kirkpatrick, eds., *Layers of Time, Papers in Honor of Robert. H. Weber*. Albuquerque: The Archaeological Society of New Mexico, 1–12.

Alexander, R. K., and R. Behan. 1964. *The Highway Cultural Inventory Project: Final Report 1961–1964*. Santa Fe: New Mexico State Highway Department and Museum of New Mexico.

Amick, D. S. 1994a. *Folsom Diet Breadth and Land Use in the American Southwest*. Ph.D. dissertation, University of New Mexico, Albuquerque. Ann Arbor: University Microfilms.

Amick, D. S. 1994b. "Technological Organization and Structure of Inference in Lithic Analysis: An Examination of Folsom Hunting Behavior in the American Southwest," in P. Carr, ed., *The Organization of Prehistoric North American Chipped Stone Tool Technologies*. *Archaeological Series* No. 7. Ann Arbor: International Monographs in Prehistory, 9–34.

Amick, D. S. 1999. "Raw Material Variation in Folsom Stone Tool Assemblages and the Division of Labor in Hunter-Gatherer Societies," in D. Amick, ed., *Folsom Lithic Technology: Explorations in Structure and Variation*. Ann Arbor: International Monographs in Prehistory, 169–187.

Amick, D. S. 2002. "Regional Patterns of Folsom Mobility and Land Use in the American Southwest," *World Archaeology* 27: 411–426.

Bailey, G. 2007. "Time Perspectives, Palimpsests and the Archaeology of Time," *Journal of Anthropological Archaeology* 26: 198–223.

Bailey, G. 2008. "Time Perspectivism: Origins and Consequences," in S. Holdaway and L. Wandsnider, eds., *Time in Archaeology: Time Perspectivism Revisited*. Salt Lake City: The University of Utah Press, 13–30.

Bamforth, D. 2002a. "High-tech Foragers? Folsom and Later Paleoindian Technology on the Great Plains," *Journal of World Prehistory* 16: 55–98.

Bamforth, D. 2002b. "The Paleoindian Occupation of the Medicine Creek Drainage, Southwestern Nebraska," in D. C. Roper, ed., *Medicine Creek: Seventy Years of Archaeological Investigations*. Tuscaloosa: The University of Alabama Press, 54–83.

Bamforth, D. 2009. "Projectile Points, People, and Plains Paleoindian Perambulations," *Journal of Anthropological Archaeology* 28:142–157.

Bamforth, D., ed. 2007. *The Allen Site: A Paleoindian Camp in Southwestern Nebraska*. Albuquerque: University of New Mexico Press.

Bamforth, D. B., and M. Becker. 2000. "Core/Biface Ratios, Mobility, Refitting, and Artifact Use-Lives: A Paleoindian Example," *Plains Anthropologist* 45: 273–290.

Bamforth, D. B., M. Becker, and J. Hudson. 2005. "Intrasite Spatial Analysis, Ethnoarchaeology, and Paleoindian Land-Use on the Great Plains: The Allen Site," *American Antiquity* 70: 561–580.

Beck, C., and G. T. Jones. 1990. "Toolstone Selection and Lithic Technology in Early Great Basin Prehistory," *Journal of Field Archaeology* 17: 283–299.

Beck, C., and G. T. Jones. 1997. "The Terminal Pleistocene/Early Holocene Archaeology of the Great Basin," *Journal of World Prehistory* 11: 161–236.

Beckett, P. H., ed. 1980. *The Ake Site: Collection and Excavation of LA13423, Catron County, New Mexico. New Mexico State University Cultural Resources Management Division Report* 357. Las Cruces: Department of Sociology and Anthropology.

Bertram, J. B., G. R. Burgett, and K. Lord. 1989. *Cultural Resource Survey for the AT&T Fiber Optic Communications Line, Albuquerque to New Mexico/Arizona Border*. Albuquerque: Chambers Group, Inc.

Binford, L. R. 1982. "The Archaeology of Place," *Journal of Anthropological Archaeology* 1: 5–31.

Blodgett, D. D., and F. B. Titus. 1973. *Hydrogeology of the San Augustin Plains, New Mexico*. *Open File Report* 51. Socorro: New Mexico Bureau of Mines and Mineral Resources.

Bryan, K. 1926. "Ground Water Reconnaissance in Socorro County, New Mexico," *8th Biennial Report of the State Engineer, New Mexico*. Santa Fe: New Mexico State Engineer, 81–87.

Bussey, S. D., and P. Beckett. 1974. *An Archeological Survey of Portions of the National Radio Astronomy Observatory VLA Project*. Las Cruces: New Mexico State University.

Cannon, M. D., and D. J. Meltzer. 2004. "Early Paleoindian Foraging: Examining the Faunal Evidence for Large Mammal Specialization and Regional Variability in Prey Choice," *Quaternary Science Review* 23: 1955–1987.

Clisby, K. H., and F. Foreman. 1957. "Pleistocene Climatic Changes in New Mexico, U.S.A.," *Veroffentlichungen des Geobotanisches Institut Rubel* 34: 22–26.

Clisby, K. H., and P. B. Sears. 1956. "San Augustin Plains—Pleistocene Climatic Changes," *Science* 124: 537–539.

Dawson, J., and W. J. Judge. 1969. "Paleoindian Sites and topography in the Middle Rio Grande Valley of New Mexico," *Plains Anthropologist* 14: 149–163.

Dick, H. 1965. *Bat Cave*. *The School of American Research Monograph* No. 27. Santa Fe: The School of American Research.

Foley, R. A. 1981. *Off-Site Archaeology and Human Adaptation in Eastern Africa. BAR International Series* 97. Oxford: B.A.R.

Foreman, F., K. H. Clisby, and P. B. Sears. 1959. "Plio-Pleistocene Sediments and Climates of the San Augustin Plains, New Mexico," in J. E. Weir, Jr. and E. H. Baltz, eds., *West-central New Mexico. New Mexico Geological Society Guidebook, 10th Field Conference*. Socorro: New Mexico Geological Society, 117–120.

Frison, G. C., and D. N. Walker. 2007. *Medicine Lodge Creek: Holocene Archaeology of the Eastern Big Horn Basin, Wyoming*. Vol. 1. Avondale, CO: Clovis Press.

Hawley, J. W. 2005. "Five Million Years of Landscape Evolution in New Mexico," in S. G. Lucas, G. S. Morgan, and K. E. Zeigler, eds., *New Mexico's Ice-Age, New Mexico Museum of*

Natural History and Science Bulletin No. 28. Albuquerque: New Mexico Museum of Natural History, 9–93.

Haynes, C. V., Jr. 1993. "Clovis-Folsom Geochronology and Climate Change," in O. Soffer and N. D. Praslov, eds., *Upper Paleolithic-Paleo-Indian Adaptations*. New York: Plenum Press, 219–236.

Hill, M. E., Jr. 2006. *Preliminary Survey for Paleoindian Site in the San Augustin Plains, Westcentral New Mexico*. Tucson: Department of Anthropology, University of Arizona.

Hill, M. E., Jr. 2007. "A Moveable Feast: Variations in Faunal Resource Use among Central and Western North American Paleoindian Sites," *American Antiquity* 72: 417–438.

Hill, M. E., Jr. 2008. "Variation in Paleoindian Fauna Use on the Great Plains and Rocky Mountains of North America," *Quaternary International* 191: 34–52.

Hill, M. E., Jr., V. T. Holliday, and R. H. Weber. 2007. "Preliminary Evaluation of the Paleoamerican Occupation in the San Agustin Basin, Socorro and Catron Counties, New Mexico," *Current Research in the Pleistocene* 24: 97–100.

Hill, M. G. 2008. *Paleoindian Subsistence Dynamics on the Northwestern Great Plains: Zooarchaeology of the Agate Basin and Clary Ranch Sites. BAR International Series* 1756. Oxford: Archaeopress.

Hofman, J. L. 1997. "Changing the Plains Archaic," in M. L. Larson and J. E. Francis, eds., *Changing Perspectives on the Archaic on the Northwestern Plains and Rocky Mountains*. Vermillion, SD: The University of South Dakota Press, xi–xxvi.

Hofman, J. L., and L. C. Todd. 2001. "Tyranny in the Archaeological Record of Specialized Hunters," in S. C. Gerlach and M. S. Murray, eds., *People and Wildlife in Northern North America: Essays in Honor of R. Dale Guthrie. BAR International Series* 944. Oxford: Archaeopress, 200–215.

Holliday, V. T. 2000. "The Evolution of Paleoindian Geochronology and Typology on the Great Plains," *Geoarchaeology* 15: 227–290.

Holliday, V. T. 2005. "Ice-Age Peopling of New Mexico," in S. G. Lucas, G. S. Morgan, and K. E. Zeigler, eds., *New Mexico's Ice-Age, New Mexico Museum of Natural History and Science Bulletin* No. 28. Albuquerque: New Mexico Museum of Natural History, 263–276.

Holliday, V. T., B. B. Huckell, J. M. Mayer, S. L. Forman, and L. D. McFadden. 2007. "Geoarchaeology of the Boca Negra Wash Area, Albuquerque Basin, New Mexico," *Geoarchaeology* 21: 765–802.

Holliday, V. T., and R. D. Mandel. 2006. "Geoarchaeology of the Plains, Southwest, and Great Lake," in D. Stanford, ed., *Environment, Origins, and Populations, Volume 3 of the Handbook of North American Indians*. Washington, D.C.: Smithsonian Institution Press, 23–46.

Holliday, V. T., R. H. Weber, and J. H. Mayer. 2006. "Geoarchaeological Investigations at the Ake Folsom Site, New Mexico," *Current Research in the Pleistocene* 23: 112–114.

Huckell, B., B. V. T. Holliday, D. S. Amick, P. D. LeTourneau, M. E. Hill, C. V. Haynes, and M. J. Hamilton. 2008. "Remembering Robert H. Weber 1919–2008," *Mammoth Trumpet* 23: 8–9.

Huckell, B. B., and J. D. Kilby. 2002. "Folsom Point Production at the Rio Rancho Site, New Mexico," in J. E. Clark and M. B. Collins, eds., *Folsom Technology and Lifeways. Lithic Technology Special Publication* No. 4. Tulsa: University of Oklahoma, 11–29.

Hurt, W. R., and D. McKnight. 1949. "Archaeology of the San Augustin Plains, A Preliminary Report," *American Antiquity* 14: 172–193.

Jones, G. T., C. Beck, E. E. Jones, and R. E. Hughes. 2003. "Lithic Source Use and Paleoarchaic Foraging Territories in the Great Basin," *American Antiquity* 68: 5–34.

Judge, W. J. 1973. *Paleoindian Occupation of the Central Rio Grande Valley in New Mexico*. Albuquerque: University of New Mexico Press.

Kelly, R., and L. C. Todd. 1988. "Coming into the County: Early Paleoindian Hunting and Mobility," *American Antiquity* 53: 231–244.

Knell, E. J. 2007. "The Organization of Late Paleoindian Cody Complex Land-Use on the North American Great Plains," unpublished Ph.D. dissertation, Washington State University, Pullman.

Kornfeld, M. 2007. "Are Paleoindians of the Great Plains and Rockies Subsistence Specialists?" in R. B. Walker and B. N. Driskell, eds., *Foragers of the Terminal Pleistocene in North America*. Lincoln: University of Nebraska Press, 32–58.

Kornfeld, M., and M. L. Larson. 2008. "Bonebeds and Other Myths: Paleoindian to Archaic Transition on the North American Great Plains and Rocky Mountains," *Quaternary International* 191: 18–33.

Kuhn, S. L. 1991. ""Unpacking" Reduction: Lithic Raw Material Economy in the Mousterian of West-Central Italy," *Journal of Anthropological Archaeology* 10: 76–106.

Kuhn, S. L. 1994. "A Formal Approach to the Design and Assembly of Transported Toolkits," *American Antiquity* 59: 426–442.

LaBelle, J. M. 2005. "Hunter-Gatherer Foraging Variability during the Early Holocene of the Central Plains of North America," unpublished Ph.D. dissertation, Southern Methodist University, Dallas, TX.

Langford, R. P. 2003. "The Holocene History of the White Sands Dune Field and Influences on Eolian Deflation and Playa Lakes," *Quaternary International* 104: 31–39.

Larson, M. L. 1997. "Housepits and Mobile Hunter-gatherers: A Consideration of the Wyoming Evidence," *Plains Anthropologist* 42: 353–369.

LeTourneau, P. D. 2000. "Folsom Toolstone Procurement in the Southwest and Southern Plains," unpublished PhD. dissertation, University of New Mexico, Albuquerque.

LeTourneau, P. D., and R. H. Weber. 2004. "The Distribution of Edwards Chert Folsom Artifacts in Socorro County, New Mexico," *Current Research in the Pleistocene* 21: 60–62.

McFadden, L. D., R. P. Lozinsky, C. M. Menges, J. R. Miller, and J. Ritter. 1994. "Soil, Tectonic and Climatic Geomorphologic Investigations in the San Agustin Plains Area, NM," in R. M. Chamberlin, B. S. Kues, S. M. Cather, J. M. Barker, and W. C. McIntosh, eds., *Mogollon Slope, West-Central New Mexico and East-Central Arizona*. Socorro: New Mexico Geological Society, 12–16.

Markgraf, V., J. P. Bradbury, R. M. Forester, W. McCoy, G. Singh, and R. S. Sternberg. 1983. "Paleoenvironmental Reassessment of the 1.6-million-year-old Record from San Agustin Basin, New Mexico," in C. E. Chapin, and J. F. Callender, eds., *Socorro Region II. New Mexico Geological Society Guidebook, 34th Field Conference*. Socorro: New Mexico Geological Society, 291–297.

Markgraf, V., J. P. Bradbury, R. M. Forester, G. Singh, and R. S. Sternberg. 1984. "San Agustin Plains, New Mexico: Age and Paleoenvironmental Potential Reassessed," *Quaternary Research* 22: 336–343.

Nuendorf, K. K. E., J. P. Mehl, Jr., and J. A. Jackson. 2005. *Glossary of Geology.* 5th Ed. Alexandria, VA: American Geological Institute.

Phillips, F. M., A. R. Campbell, C. Kruger, P. Johnson, R. Roberts, and E. Keyes. 1992. *A Reconstruction of the Response of Water Balance in Western United State Basin to Climatic Change, Volume 1. New Mexico State University, New Mexico Water Resources Research Institute, Report* 269. Las Cruces: New Mexico State University.

Powers, W. E. 1939. "Basin and Shore Features of the Extinct Lake San Augustin, New Mexico," *Journal of Geomorphology* 2: 345–356.

Reeves, C. C., Jr. 1968. *An Introduction to Paleolimnology*. New York: Elsevier.

Sears, P. B. 1961. "Palynology and the Climate Record of the Southwest," *Annals of the New York Academy of Sciences* 95: 632–641.

Shott, M. J. 1997. "Stone and Shafts Redux: The Metric Discrimination of Chipped-Stone Dart and Arrow Points," *American Antiquity* 61: 86–101.

Smith, C. E. 1950. "Prehistoric Plant Remains from Bat Cave," *Botanical Museum Leaflets, Harvard University* 14: 157–180.

Sokal, R. R., and F. J. Rohlf. 1995. *Biometry: The Principles and Practices of Statistics in Biological Research*. New York: W. H. Freeman and Company.

Stiger, M. A. 2006. "A Folsom Structure in the Colorado Mountains," *American Antiquity* 71: 321–351.

Surovell, T. A. 2009. *Toward a Behavioral Ecology of Lithic Technology: Cases from Paleoindian Archaeology*. Tuscon: The University of Arizona Press.

VanPool, T. L. 2006. "The Survival of Archaic Technology in an Agricultural World: How the Atlatl and Dart Endured in the North American Southwest," *Kiva* 71: 429–452.

Waguespack, N. M., and T. Surovell. 2003. "Clovis Hunting Strategies, or How to Make Out on Plentiful Resources," *American Antiquity* 68: 333–352.

Waters, M. R., and T. Stafford, Jr. 2007. "Redefining the Age of Clovis: Implications for the Peopling of the Americas," *Science* 315: 1122–1126.

Weber, R. H. 1980. "Geology of the Ake Site," in P. H. Beckett, ed., *The Ake Site: Collection and Excavation of LA13423, Catron County, New Mexico. New Mexico State University Cultural Resources Management Division Report* 357. Las Cruces: Department of Sociology and Anthropology, 221–238.

Weber, R. H. 1994. "Pluvial Lakes of the Plains of San Agustin," in R. M. Chamberlin, B. S. Kues, S. M. Cather, J. M. Barker, and W. C. McIntosh, eds., *Mogollon Slope, West-Central New Mexico and East-Central Arizona*. Las Cruces: New Mexico Geological Society, 9–11.

Wessel, R. L., P. L. Eidenbach, L. M. Meyer, C. S. Comer, and B. Knight. 1997. *From Playas to Highlands: Paleo-Indian Adaptations to the Region of the Tularosa*. Tularosa, NM: Human Systems Research, Inc.

Wills, W. H. 1988a. *Early Prehistoric Agriculture in the American Southwest*. Santa Fe, NM: School of American Research Press.

Wills, W. H. 1988b. "Early Agriculture and Sedentism in the American Southwest: Evidence and Interpretations," *Journal of World Prehistory* 2: 445–488.

Wills, W. H. 1989. "Patterns of Prehistoric Agricultural Development in Western New Mexico," *Journal of Anthropological Research* 45: 139–157.

Wills, W. H. 1990. "Cultivating Ideas: The Changing Intellectual History of the Introduction of Agriculture in the American Southwest," in P. E. Minnis and C. L. Redman, eds., *Perspectives on Southwest Prehistory*. Boulder, CO: Westview Press, 319–332.

Wills, W. H. 1994. "Recent Evidence for the Introduction of Maize to the American Southwest from Mesoamerica," *Revista de Arqueologia Americana* 7: 87–97.

Wills, W. H. 1996. "The Transition from the Preceramics to Ceramic Period in the Mogollon Highlands of Western New Mexico," *Journal of Field Archaeology* 24: 335–359.

Wills, W. H. 1998. "Bat Cave," in G. E. Gibbon, ed., *Archaeology of Prehistoric Native America: An Encyclopedia*. Oxford: Taylor and Francis, 53–55.