

THE FOLSOM (PALEOINDIAN) TYPE SITE: PAST INVESTIGATIONS, CURRENT STUDIES

David J. Meltzer, Lawrence C. Todd, and Vance T. Holliday

Research on the Folsom Paleoinian type site, involving renewed field investigations and an analysis of extant collections from the 1920s excavations, was undertaken between 1997 and 2000. The preliminary results of that research show that all excavations to date have been in the kill area, which took place in a small and relatively shallow tributary to the Pleistocene paleo-valley of Wild Horse Arroyo as well as in the paleovalley itself. Preliminary butchering of ~32 Bison antiquus took place near where the animals were dropped. The kill area is dominated by low-utility bone elements and broken projectile points; high-utility bones and tools for processing meat and hides are rare or absent, and either occur in another, as-yet undiscovered area of the site, or altogether off-site. Faunal remains are generally in excellent condition. Those in the tributary are mostly in primary context, and underwent rapid burial beneath fine-grained (dominantly aeolian) sediments, which in turn were subsequently armored by a shingle shale; those in the paleovalley experienced postdepositional transport and redeposition. The small lithic assemblage is dominated by projectile points and comprised of material mostly from two sources in the Texas panhandle, several hundred kilometers southeast of the site. It also includes stone obtained from sources at comparable distances north and northwest of the site. A series of radiocarbon ages is available for the stratigraphic units, nearly all from charcoal of non-cultural origins; radiocarbon dates on bison bone put the age of the kill at 10,500 B.P.

Entre 1997 y 2000 se llevó a cabo una nueva investigación en el sitio tipo paleoindio Folsom, que incluyó trabajos de campo y un análisis de las colecciones existentes de las excavaciones de la década de 1920. Los resultados preliminares de esa investigación muestran que todas las excavaciones hasta el presente fueron en el área de matanza, que tuvo lugar en un tributario pequeño y angosto del paleovalle del Arroyo Wild Horse, así como también en el paleovalle mismo. El descuartizamiento preliminar de aproximadamente 32 Bison antiquus se realizó cerca de donde los animales fueron lanzados. El área de matanza está dominada por elementos de hueso de baja utilidad y de puntas de proyectil fracturadas, huesos de alta utilidad e instrumentos para procesar carne y cueros son escasos o ausentes, es decir que se encuentran en otra área del sitio aún sin descubrir, o fuera del sitio. Los recursos faunísticos están en general en condiciones excelentes, los del arroyo están en gran parte en contexto primario, y fueron cubiertos rápidamente bajo sedimentos de grano fino (predominantemente eólicos), los cuales a su vez fueron cubiertos por una gravilla de esquistos; aquellos encontrados en el paleovalle fueron transportados y redepositados. El pequeño conjunto lítico está compuesto predominantemente por puntas de proyectil, incluye en gran parte materiales de dos recursos localizadas en el extremo oeste de Texas, a varios cientos de kilómetros al sudeste del sitio. También incluye piedra adquirida de recursos a cientos de kilómetros al noroeste y al norte del sitio. Se encuentra disponible una serie de fechamientos radiocarbónicos sobre las unidades estratigráficas, prácticamente efectuados todos sobre carbón sin aparente origen cultural, los fechamientos radiocarbónicos sobre hueso de bisonce ubican a la matanza en los 10,500 años a.p.

The Folsom (Paleoindian) type site (29CX1, LA 8121) is one of the best-known archaeological localities in North America. It is on the National Register of Historic Places, is a National Historic Landmark, and is a New Mexico State Monument (Murtaugh 1976:481)—all as a result of excavations there in 1926–1928, which ended a

long-standing and bitter controversy over human antiquity in North America (Meltzer 1983, 1994). Yet, because of the narrow goals of the original excavations, the field and analytical methods in place at the time, and the few publications that emerged from that early work, Folsom—at least in scientific terms—is also one of the least-known archaeologi-

David J. Meltzer ■ Department of Anthropology, Southern Methodist University, Dallas, Texas 75275-0336 (dmeltzer@mail.smu.edu)

Lawrence C. Todd ■ Department of Anthropology, Colorado State University, Ft. Collins, Colorado 80523-1787 (lctodd@lamar.colostate.edu)

Vance T. Holliday ■ Department of Geography, University of Wisconsin, Madison, Wisconsin 53706-1491 (vthollid@facstaff.wisc.edu)

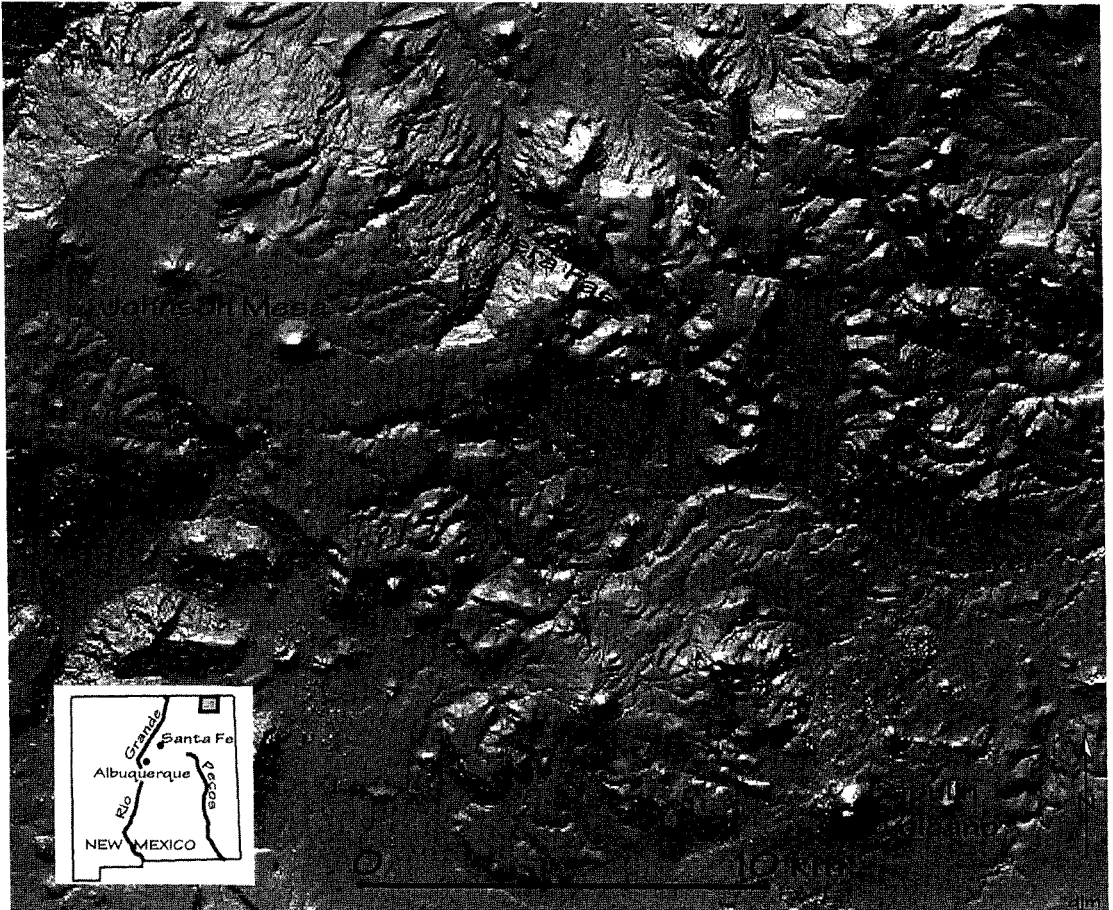


Figure 1. The Folsom site and surrounding region shown on a digital elevation model compiled from 7.5' USGS topographic quadrangles.

cal localities in North America. In an effort to enhance our understanding of the site, under the auspices of the Quest Archaeological Research Program at SMU, an interdisciplinary field project was initiated at Folsom in 1997, which continued over the next two field seasons and was followed by analyses of museum collections from the site.

Although analyses continue and additional results will be forthcoming, we provide here a summary to date, detailing the historical background, our current understanding of the site's geomorphic and stratigraphic context, its age and paleoenvironmental context, the structure and taphonomy of the bonebed, and the site's archaeological contents. A detailed monograph on the site is in preparation.

Site Setting

The Folsom site is located in the far northeastern corner of Colfax County, New Mexico, at an elevation

of ~2109 m (~6919 feet) above sea level. The site straddles Wild Horse Arroyo, a minor northwest-southeast trending tributary of the Dry Cimarron River. Both Wild Horse Arroyo and the Dry Cimarron have their headwaters on nearby Johnson Mesa, the eastern escarpment of which is just 1600 m west of the Folsom site and looms 228 m above the valley floor on which the site is situated (Figure 1). Johnson Mesa is a prominent regional landform (Meltzer 2000:Figure 1), but one of a series of extensive basalt mesas and scattered volcanic peaks and cones that characterize the Raton Section of the Great Plains province, extending from the Rocky Mountain Front Range to the Oklahoma Panhandle. Volcanic activity had ceased well before humans arrived in the area (Anderson and Haynes 1979; Hunt et al. 1987:51; cf. Baldwin and Muehlberger 1959), but the volcanic features dominate the landscape, topography, and drainages, and because of the consider-

able variability in elevation over short distances influence the local climate and biotic communities.

Based on data from weather stations within a ~.5 degree radius and ± 152 m elevation of the site, this is an area of relatively low annual precipitation (ranging from 38–44.5 cm—the higher amounts received at higher elevations), much of which falls during high-intensity summer thunderstorms. Save for atop Johnson Mesa and the area close to the site itself, winter precipitation is relatively inconsequential. Because of the elevation and the scarp effect of the mesa, snowfall near the site is much heavier than the surrounding, lower elevation areas. In general, this is a region of cool, seasonal temperatures with a relatively short (<145 days) growing season. Summers are cool, temperatures drop quickly and widely across the area by early fall (September), and winters are cold. Calculated Effective Temperature (ET) values for the weather stations in the area range from 12.05 to 12.97.

The Folsom site is situated in an open grassland/meadow, interspersed by oak and locust galleries (*Quercus gambelii*, *Q. undulata*, and *Robinia neomexicana*). Because of the topographic and climatic variability present over relatively short distances, the surrounding region is marked by diverse biotic communities, containing a range of warm and cool season plants (Anderson 1975:46–72; Huckell 1998). Vegetation communities include open grassland on the exposed uplands of Johnson Mesa; a zone of ponderosa pine/spruce/fir parkland mark the mesa rim; and on the talus slopes below, a scrub oak forest mixed with locust and occasional juniper and pine species. At lower elevations to the east/southeast (down the Dry Cimmaron Valley, which drops ~850 m in elevation in ~100 km), the predominant landscape form is relatively level, semi-arid grassland (dominated by C4 [warm-season] grasses).

Despite the floral diversity, primary productivity and standing biomass are relatively low (there are relatively few trees), and the vegetation experiences considerable annual turnover. Much of the biomass may not be edible by humans. Relatively few of the edible plants yield a significant return in fatty acids or carbohydrates that would have provided a viable subsistence base, particularly during the critical winter and spring months when game populations are low and fat-depleted (Speth and Spielmann 1983:18–21). Nonetheless, this area provides abundant forage for animals. Thus, the calculated sec-

ondary productivity for the region—a projection of expected ungulate prey based on empirically derived patterns of animal biomass (formulas in Binford 2001)—is relatively high, and even today this is a game-rich area, supporting large herds of elk, deer, pronghorn (atop nearby Johnson Mesa), and game birds (the richness perhaps enhanced by the fragmentation and loss of habitat elsewhere, the absence of a large local human population or urban center, and contemporary land use practices). Bison were present in the area in historic times (Findley et al. 1975; Fitzgerald et al. 1994), as they obviously were in the late Pleistocene.

Archaeological surveys in the area immediately surrounding the site (Anderson 1975; Meltzer 1998) have yielded a limited archaeological record, nearly all late prehistoric in age. Such finds suggest this has been an area in which human activities were rather ephemeral, consisting largely of hunting and other limited subsistence activities. As discussed below, this probably was the case for Paleoindian times as well.

History and Previous Work

The circumstances of the Folsom discovery are poorly known (Anderson 1975:43–44). The various accounts (e.g., Agogino 1971, 1985; Cook 1947; Folsom 1992; Hewett 1971; Hillerman 1971; Little 1947; Owen 1951; Preston 1997; Reed 1940; Roberts 1935; Steen 1955; Thompson 1967) are mostly secondary, based on the recollections of those who were not there, and are often contradictory—as one might expect. Most credit the initial discovery to Crowfoot Ranch cowboy George McJunkin; others, however, grant him only bystander status, belittle his role, or simply ignore him altogether (e.g., Cook 1947; Owen 1951; Roberts 1935; Thompson 1967). This, too, is not unexpected.

It seems reasonable to infer, based in part on independent geological evidence, that the event that set the discovery in train was an unusually heavy rain on Johnson Mesa, just above the Crowfoot Ranch, on August 27, 1908. The runoff from that storm triggered downcutting in the Dry Cimarron drainage and incised Wild Horse Arroyo more deeply than it had been before (Anderson 1975:43).¹ Sometime after (how long after, no one knows), McJunkin (or someone else) spotted large bones eroding out of the arroyo wall ~2–3 m below the surface—and must have recognized them as being something of

interest (otherwise, of course, the bones would simply have been ignored). Whether he (or whoever the finder) surmised the bones to be old or simply found artifacts with them has been the subject of much speculation, even some speculative history (e.g., Folsom 1992). But there are no facts bearing on the question, save that when excavations were begun in 1926, this was not considered an archaeological site.

The first secure record we have of the site comes from December 10, 1922 (after McJunkin died), when the locality was visited by Carl Schwachheim (a Raton, New Mexico blacksmith), Fred Howarth (a Raton banker), and several of their friends. Their visit was memorialized in Schwachheim's Diary and in a photograph of Howarth pointing to bison bone in place. How they learned of the site is also a matter of speculation. One engaging scenario has McJunkin stopping by Schwachheim's home to admire a fountain made with the antler racks of two bull elk that became entangled in a mortal contest (Folsom 1992; Steen 1955:5).

After an apparently unsuccessful attempt to interest the State of New Mexico in the site, in late January 1926 Schwachheim and Howarth visited Denver where they met Jesse Figgins, the Director of the Colorado Museum of Natural History² (hereafter, CMNH; Schwachheim Diary, January 25, 1926; Roberts 1935:4; Steen 1955:5–6). They told him about the bison remains and subsequently sent Figgins a package of the bones (Howarth to J. D. Figgins, February 4, 1926, DIR/CMNH³). The bones were identified as an extinct species of bison by Harold Cook (Honorary Curator of Paleontology at the Museum). Cook and Figgins visited the site March 7, 1926 (Schwachheim Diary), ultimately deciding to excavate with the aim of "supplying a mountable [bison] skeleton" (J. D. Figgins to Taylor, June 21, 1926, DIR/CMNH; Cook to Barbour, February 15, 1926, EHB/NSM). The hindsight claim that the Museum initiated excavations in search of human artifacts (Figgins 1927:232) is not corroborated by contemporary correspondence (Meltzer 1991; Roberts 1935:4).

Fieldwork began in early May 1926. The excavations started on the south bank of the arroyo and were conducted largely by Schwachheim (with help from several individuals, including Frank Figgins, the son of Jesse). The outlines of the excavation methods and the areas in which the excavation took place can be gleaned from archival clues. The exca-

vation worked into the south bank of the arroyo (Figure 2), in what came to be recognized as the western edge of the bonebed. J. D. Figgins instructed Schwachheim to remove the overburden to within a few feet of the bones over a large area, to "clear the ground for the recovery of the fossils in an orderly way" (J. D. Figgins to Howarth, July 24, 1926, DIR/CMNH). One particularly auspicious element of J. D. Figgins's strategy was to "carry . . . the dirt away from the creek, not into it" (J. D. Figgins to Howarth, July 24, 1926, DIR/CMNH). This was the procedure in 1927 and 1928 as well, and thus most of the overburden and back dirt was not washed down the arroyo but remains on site. No screens were used, not surprising given the times and the paleontological goals of the excavation.

By mid-June bison bones were being uncovered, and in mid-July the first artifact, the distal end of a Folsom fluted projectile point (Denver Museum catalog number 1391/3), was uncovered though not in situ (Schwachheim Diary, July 14, 1926). The discovery was reported to J. D. Figgins in Denver, who urged the crew to watch "for human remains and then in no circumstances, remove them, but let me know at once" (J. D. Figgins to Howarth, July 22, 1926, DIR/CMNH, also Meltzer 1991). While he instructed them to "scan every particle of dirt they remove" (J. D. Figgins to Brown, July 23, 1926, VP/AMNH), the crew found no in situ points over the remainder of the field season, although one additional broken point (a blade and tip) was found close to the end of the season. This point later proved to refit to a sliver of a midsection found adjacent to a rib—the sliver and rib having been removed from the field as a block and exposed in the laboratory (Figgins 1927:232–234, Figure 3 right, and Figure 4; J. D. Figgins to Cook, November 16, 1926, HJC/AGFO; Roberts 1935:4).

During the following field season (1927) the excavation area was expanded but the techniques remained the same. Only this time the crew—as a result of an exchange J. D. Figgins had with Ales Hrdlicka in Washington that spring (Meltzer 1983, 1994)—was explicitly instructed to watch carefully for artifacts and leave unexcavated any spotted in place. On August 29, 1927, a point was found in situ, J. D. Figgins was notified (Schwachheim to J. D. Figgins, August 29, 1927, DIR/CMNH), and he promptly sent telegrams to "several scientists inviting them to study the point in position." Meanwhile,

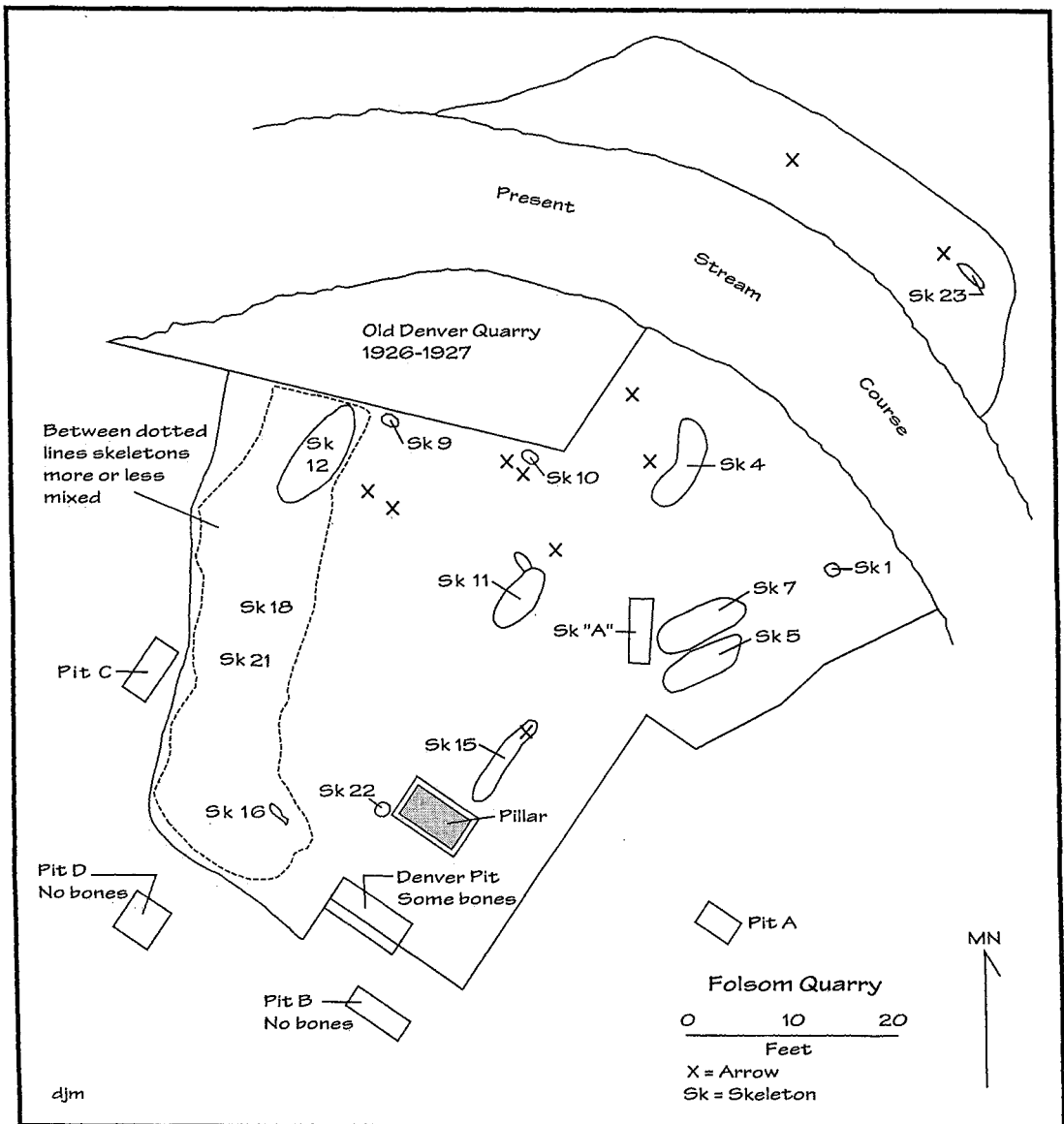


Figure 2. Facsimile of a plan map of the 1920s Folsom site excavations, based on an unpublished map made by the American Museum of Natural History in 1928. "Arrow" indicates the location of Folsom fluted projectile points. Because of discrepancies in the map and in the sparse field notes, it is not possible to specify with complete confidence which points (listed in Table 2) were found at which location. "Skeleton" should not be taken literally as the location of a complete bison skeleton, but instead as the presence of bison bone, which may include elements from one or more individuals.

Schwachheim was urged to keep his eyes on the point "every minute and do not let any one remove it or dig around it . . . regardless of who it is or what reason they give" (J. D. Figgins to Schwachheim, August 31, 1927, DIR/CMNH).

Schwachheim duly awaited the arrival of "Scientists, Anthropologists, Archaeologists, Zoologists, or other bugs" (Schwachheim to J. D. Figgins, September 4, 1927, DIR/CMNH), which began on Sep-

tember 4, 1927, when J. D. Figgins, Barnum Brown (vertebrate paleontologist at the American Museum of Natural History, who happened to be in Denver), and Frank Roberts (archaeologist at the Bureau of American Ethnology, Smithsonian Institution), came to the site. Brown examined the site stratigraphy and geology (B. Brown, unpublished fieldnotes, VP/AMNH) and had his picture taken with the in situ point (see Meltzer 1993:53). Roberts studied the

ground, was similarly convinced by the association, and thought it sufficiently important that he returned on September 6, and again on September 8 with A. V. Kidder (of the Carnegie Institution of Washington—both Roberts and Kidder had been attending the first Pecos Conference [Roberts 1935:5]). All agreed the point and the bones of the extinct bison were contemporaneous (Meltzer 1983:35–37, 1994; Roberts 1935:5) and provided the first unequivocal testimony that humans were in America by at least the late Pleistocene. That discovery, of course, profoundly changed American archaeology (for a thoughtful contemporary assessment of Folsom's implications, see Kidder 1936).

Altogether, the 1926–27 excavations of the Colorado Museum removed ~34.7 m² of the bonebed, in an area (Figure 2) that extended ~11 m along the south bank of the arroyo and 3.8 m into the south bank at its eastern end (Todd and Hofman 1991). Unfortunately, only rough sketch maps and photographs indicate the precise position of artifacts and bones (e.g. F. Figgins, unpublished fieldnotes, 1926, DIR/CMNH; Schwachheim to J. D. Figgins, September 4 and September 29, 1927, DIR/CMNH; Brown 1928). The archival materials present a basic picture of the deposits in which remains were found: the in situ point was found eight feet below ground surface (Schwachheim to J. D. Figgins, September 11, 1927, DIR/CMNH), and it—along with the bison skeletons—appeared to be “rest[ing] on a sloping bank” of a south-north channel (Brown, unpublished field notes, VP/AMNH).

In order to expand the sample of artifacts and bison remains and resolve more precisely the age of the site, the American Museum of Natural History (hereafter, AMNH) joined the excavations in 1928. They first dug four perimeter “test holes” (identified as Pits A–D in Figure 2) to establish the outer limits of the bonebed, then excavated the area within those boundaries. As before, mule-drawn fresnos moved the overburden onto the uplands south of the site, ultimately forming a semi-circular berm around its southern edge. As in previous years, much of the excavation close to the bonebed was done with picks and shovels, with not unexpected results: “We have found to date 9 broken points. Oh! Yes, one was a fine one, but Ernie struck it with a pick breaking it . . .” (Schwachheim to Brown, August 10, 1928, VP/AMNH).

Provenience was measured in Cartesian coordi-

nates relative to an earthen pillar left in the center of the excavations, and as depth below surface (the surface being the top of the earthen pillar). Provenience was recorded in this manner for individual artifacts and clusters of bone (not individual bone elements), then (apparently after the completion of the 1928 excavations) on a plan map of the site (Figure 2). Unfortunately, as noted below, that map contains some inaccuracies and is internally contradictory. The earthen pillar has long since disappeared, limiting the utility of the map and the measured provenience of the mapped items.

Ultimately, the 1928 AMNH excavations opened an area of ~233.7 m² (Todd and Hofman 1991), mostly on the south bank adjoining the CMNH excavations. A smaller excavation on the north bank included cleaning a vertical face along that bank for a distance of ~10.3 m. By late August, Peter Kaisen (in charge of the AMNH excavations) was convinced they had exhausted the bison quarry (Kaisen to Brown, August 29, 1928, VP/AMNH), a claim that would be repeated in later months and years (Brown 1928; also Howarth to J. D. Figgins, October 12, 1928, DIR/CMNH; Brown to J. D. Figgins, February 1, 1929, DIR/CMNH; but see Cook to Jenks, March 31, 1929, HJC/AGFO).

That same season, at the behest of the Smithsonian Institution, Kirk Bryan of the USGS and Harvard University visited the site and mapped the regional geology. He concluded “the age of the material containing *B. taylori* and the implements must be late Pleistocene or perhaps early Recent” (Bryan 1929:129). Brown reached a similar opinion based on the bison bones (Brown 1929).

By the end of three years of work at the site, the bonebed had yielded at least 14 Folsom fluted projectile points (see published photographs in Wormington 1957:28). More would subsequently appear during laboratory preparation of the plaster jacketed skeletal remains (e.g., J. D. Figgins to Brown, October 23, 1929, VP/AMNH). At least two fluted points (one from the Colorado Museum excavations, the other from the American Museum work) were recovered by the excavation crews in the back dirt (Schwachheim Diary). In fact, it was not uncommon in the years after the excavation for artifacts to be found eroding out of the back dirt. Brown found one there on a 1931 visit (Howarth to Cook, February 26, 1932, AHC/UWY), and in 1934 E. B. Howard found the base of one that he believed joined with a

tip found earlier (Howard 1943: 228). Several apparently were also found in the 1950s by Homer Farr, the longtime caretaker of Capulin Volcano (now Capulin Volcano National Monument). More recently (1994), a group from the Denver Museum recovered a point (Dixon and Marlar 1997). Altogether, perhaps two-dozen fluted projectile points have come from the site, although the current whereabouts of some are unknown; there may be unrecorded points in private collections.

Finally, the site yielded a considerable amount of bison skeletal remains (we have inventoried over 3,000 identifiable elements in the American and Denver museum collections). Brown believed they represented at least 30 bison and possibly as many as 50, which he and others referred to as the extinct species *Bison taylori* (and *Bison oliverhayi*, now synonymized with *B. antiquus occidentalis*; see Figgins 1933; Hay and Cook 1930; MacDonald 1981:85, 94). The herd consisted of “male, female, and yearlings . . . [all] killed at the same time” (Brown to Hay, January 10, 1929, VP/AMNH; also Brown 1928, 1936).

Other species besides bison were also found over the course of the 1920s excavations. These included “a deer midway between the size of a black-tail and an elk” (J. D. Figgins to Brown, July 14, 1926, VP/AMNH), as well as a variety of small mammals (Hay to Brown, undated, but ca. September 15, 1928, VP/AMNH; the fauna is reported in Hay and Cook 1928, 1930). All of the identified species, save the bison, occur in this area historically; several of the small mammals are burrowers, which occupy the site even today. Excavation techniques being what they were in the 1920s, the taphonomic history of those remains and their association with Folsom Paleoindian activities is unknown.⁴

Brown (1928) observed that the AMNH excavations—despite covering a larger area—yielded remains of only 14 bison, compared to 16 from the CMNH work the previous two seasons. Clearly, the density of skeletal remains was higher in the area excavated by the Colorado Museum.

The results of the three years of excavation at Folsom were not well published. The original papers by Cook (1927) and J. D. Figgins (1927) were largely polemical pieces, written before any fluted points had been found in situ, and which advocated other candidates for great antiquity besides Folsom. Later, there were a few brief papers on the fauna and geol-

ogy (e.g., Brown 1928, 1929, 1936; Bryan 1937; Hay and Cook 1928, 1930), as well as a couple of popular (and still somewhat polemical) pieces on the site (e.g., Cook 1928; Figgins 1928). However, detailed descriptions of the excavation data and results were never published—not unusual, given the contemporary standards.

There was no further fieldwork at the Folsom site for several decades. Later visits by various individuals added to the artifact inventory and led to the collection of a charcoal sample that produced the first radiocarbon date from the area—though not, as initially supposed, from the Paleoindian occupation at the site (Arnold and Libby 1950:10; Roberts 1951).⁵ Fieldwork at the site was renewed in the early 1970s when Adrienne Anderson, then a doctoral candidate at the University of Colorado, undertook an intensive archaeological site survey with the additional aim of developing a paleoenvironmental record for the region. Limited testing was also carried out at the Folsom site to determine: “(1) the remaining extent of the Folsom-bearing deposit, (2) the feasibility of additional excavation, and (3) the presence of diatoms, snails, pollen, and other information enabling paleoenvironmental reconstruction” (Anderson 1975:19). Samples were also collected for radiocarbon dating, partly with an eye on correlating the deposits with local volcanic events (Anderson 1975:39; Anderson and Haynes 1979; Haynes et al. 1992:83–84).

The fieldwork involved excavation of <10 small test pits and backhoe trenches in and around the site, though mostly on the south bank. In addition, the arroyo walls were cleaned, and pollen profiles were obtained from two sections near the site. Radiocarbon samples were also collected from the arroyo walls; these included bone fragments and a very small amount of charcoal flecks dispersed throughout the sediment in what appeared to be a secondary context (Haynes et al. 1992:87).

Anderson’s survey of the area surrounding Folsom yielded some 74 sites and 192 isolated artifact occurrences (Anderson 1975:14, 80), though only a very small number of those were Paleoindian in age. Despite the fact that at each site a “one hundred percent artifact collection was attempted” (Anderson 1975:79), the sum total of material recorded from all these sites was just 2,087 artifacts, of which 108 were projectile points, and 345 (16.5 percent) artifacts came from a single rockshelter (Anderson

1975:21 and Appendix B). Our own much less-extensive survey of the surrounding area in 1997 yielded even less material, confirming Anderson's results. Human use of this area in prehistory was evidently ephemeral and consisted largely of limited hunting activities (Anderson 1975:4, Table 23).

Aspects of the 1970s work at the Folsom site are touched on by Anderson (1975), though the attention there is primarily on the results of the survey. The Folsom site stratigraphic results are discussed in Anderson and Haynes (1979), which also addresses the age of the Folsom occupation relative to local volcanic activity. The outcome of the radiocarbon-dating efforts are summarized by Haynes et al. (1992:84), who report that analysis of bison bone collagen from the site yielded an age of $10,260 \pm 110$ B.P., while dated charcoal gave a mean age of $10,890 \pm 50$ B.P. (an average of six samples, five of which were individual charcoal flecks, the sixth a composite sample from the other five).

In the spring of 1972 Willard Loudon, other local avocational archaeologists, and a group from Trinidad State Junior College excavated a cranium of a relatively large bison cow, along with other skeletal elements (ribs and a thoracic vertebra, according to photographs taken at the time) on the north bank of Wild Horse Arroyo. The cranium and photographs are curated at the Loudon-Henritze Archaeology Museum at Trinidad State Junior College; the whereabouts of the axial elements are not known. None of this material was published.

Recent Investigations of the Folsom Site and Assemblages

We renewed field investigations at the Folsom site for several reasons: to assess its stratigraphy, geology, and paleoenvironmental history; to ascertain if any intact deposits remained and, if there proved to be portions of the kill area remaining, to see if we could gain an understanding of the spatial structure and taphonomy of the bonebed; and finally to go beyond the bonebed to seek other butchering and processing areas, or perhaps an associated camp. The latter is of particular interest, as ethnoarchaeological (e.g., Fisher 1992; O'Connell et al. 1992) and Paleoindian archaeological studies (Frison and Stanford 1982; Hofman 1996:56, 62, 1999b:394; Hofman et al. 1990; Jodry 1992, 1999b:73, 80; Jodry and Stanford 1992; Stanford 1999:302) have shown kill sites are often accompanied by camps, though the

latter are often less visible archaeologically and can be distant from the kill.

By the time we began fieldwork in 1997, the Folsom site had eroded significantly, perhaps in large part because the 1920s excavations were not backfilled, but also because of game and domestic animal traffic through the area. On the south bank, the old excavation area forms a semi-circular bowl, cut by gullies that run down to the arroyo (south to north). The upland, southern edge of the 1920s excavation area is still ringed by a semi-circular back dirt berm, though judging by archival photographs, it has diminished in height since 1928. While only a small amount of excavation took place on the north bank in the 1920s, the vertical face cut in 1928 has eroded and retreated considerably and now forms a $\sim 45^\circ$ slope (it remains an active erosional slope). No permanent datum markers exist from the 1926–28 work, and the earthen pillar used as a datum in 1928 has long since disappeared. In 1970, Anderson established a concrete datum on site, and it serves as the primary datum for our work as well; we have set four additional concrete datums.

Initial testing in 1997 focused on the west side of the south bank for two reasons: clues in the archival records indicated this was the mostly likely area where intact bonebed deposits might be found and, second, Kaisen observed there were "a lot of bones all along the west side," noting they were from "more or less mixed" skeletons (Kaisen to Brown, August 19, 1928, VP/AMNH; also, Figure 2). Among the mixed remains were several closely spaced crania (Kaisen to Brown, August 19, 1928, VP/AMNH). These hinted that this might be a possible bison-processing area.

In an effort to relocate that part of the bonebed as well as ground-truth the 1928 map, a series of shallow exploratory trenches were dug seeking the perimeter test pits excavated in 1928 (AMNH Pits A-D in Figure 2). Those test pits were sought on the assumption that since they were positioned outside the main excavation block and were discrete hand-dug units, their outlines might be better preserved and more readily recognized than the sloping and more irregular fiasco-dug walls of the main excavation block.

Ultimately, three of those pits (AMNH B, C, and D) were located. However, their locations on site and relative to each other do not match the positions as shown on the 1928 AMNH map. Pit C, for exam-

ple, instead of being within ~.5 m of the western edge of the main block excavations (note the scale in Figure 2), proved to be ~4 m distant. In effect, the area where the bonebed was removed in 1928 did not extend all the way to the edge of the excavation area as shown on the map. Thus, there were potentially unexcavated areas remaining between the edge of the 1928 bonebed excavations and the perimeter test pits (and perhaps outside the perimeter test pits).

Our excavations over the 1997–1999 seasons focused on a 17.5 m² area of the bonebed (within the 5-x-5 m M17 and N17 blocks in Figure 3). This area falls between the western edge of the 1928 excavations and AMNH Pit C—the outlines of which were found in the western half of the M17 block. Those excavations produced a concentration of bison bone (NISP = 259). Although all sediment from that excavation was water screened through nested 31.75-mm ($\frac{1}{4}$ -inch) and 15.875-mm ($\frac{1}{8}$ -inch) mesh, no points or tools were found. However, 25 tiny flakes (mean length = 4.6 mm) from use or resharpening were recovered in the water screens.

Several 1-m² units opened in the M15 block 5 m south of M17 (the outlines of AMNH Pit D were found within the M15 block) aimed at delimiting the southerly extent of the bonebed. Only a few bone fragments were recovered in this area of the site, indicating the bonebed does not extend to this point. In addition, several 1-m² test units were excavated on the uplands to the west ($n = 6$), southwest ($n = 1$) and east ($n = 3$) of the bonebed, in search of associated habitation areas; none yielded any hints of a Paleoindian presence. Limited testing and excavation also took place on the north bank in an effort to better understand the stratigraphic context of remains in this area.

Not all of our field efforts, results, and analytical interpretations can be discussed here, but will be detailed in a subsequent monograph. For the remainder of this paper, we will focus on the stratigraphy and geochronology of the site, the faunal remains recovered from the M17/N17 block, as well as those examined in the collections at the American and Denver museums, and the artifacts.

Stratigraphy, Geochronology, and Paleoenvironments

The geological history of the Folsom site has been reconstructed through stratigraphic mapping of the exposed arroyo and excavation walls, as well as

extensive Giddings machine coring and hand augering across the site (Figure 3). Electrical resistivity and seismic refraction surveys were also conducted to complement and enhance the coring and augering data on bedrock topography. This work has shown that the Paleoindian remains at Folsom extend from the lower portions of a small, two-pronged tributary into the deeper and wider adjoining paleovalley (the ancestral Wild Horse Arroyo).⁶ Because of the greater fluvial activity within the paleovalley, the stratigraphic histories of the tributary and paleovalley, although generally similar, also differ in important ways, as do the taphonomic histories of archaeological remains found in these different areas of the site.

Both the paleovalley and the tributary were incised into the local bedrock (Cretaceous-age Smoky Hill Shale [Scott and Pillmore 1993])⁷ and are filled with sediments of late-Quaternary age. The lithostratigraphic subdivisions and terminology we use in describing these sediments generally follow the tripartite scheme developed by Haynes on the basis of lithologic characteristics (Anderson and Haynes 1979) and includes three major stratigraphic units (Figure 4). From bottom to top, the Folsom formation (stratum *f*), the McJunkin formation (*m*), and the Wild Horse formation (*w*) (Anderson and Haynes 1979:Table 1). We have made some modifications to Haynes's terminology, however, based on the recognition of the differences in the stratigraphic histories of the paleovalley and the tributary. Nearly 50 radiocarbon ages, primarily on charcoal (which appears to be almost entirely noncultural in origin [also Bryan 1937:142]) but also on bison bone, provide chronological control for the stratigraphic sequence (ages are summarized in Figure 4, and are all in radiocarbon years B.P.). In-filling of the tributary and paleovalley began at least 12,400 B.P., with the accumulation of fluvial and colluvial deposits (the basal part of the Folsom formation, stratum *fl*) that by the time of the Paleoindian occupation had filled ~1–2 m of the lower reaches of these channels. The *fl* deposit is silty with layers of redeposited calcareous, angular shale fragments common along with occasional gravel lenses. Stratum *fl* represents episodic accumulation of shale fragments, derived from what were then relatively steep and high bedrock walls (varying from 5–10 m). Between periods of shingle accumulation, the valley filled with layers of silt clay. Locally, some time after burial, these basal

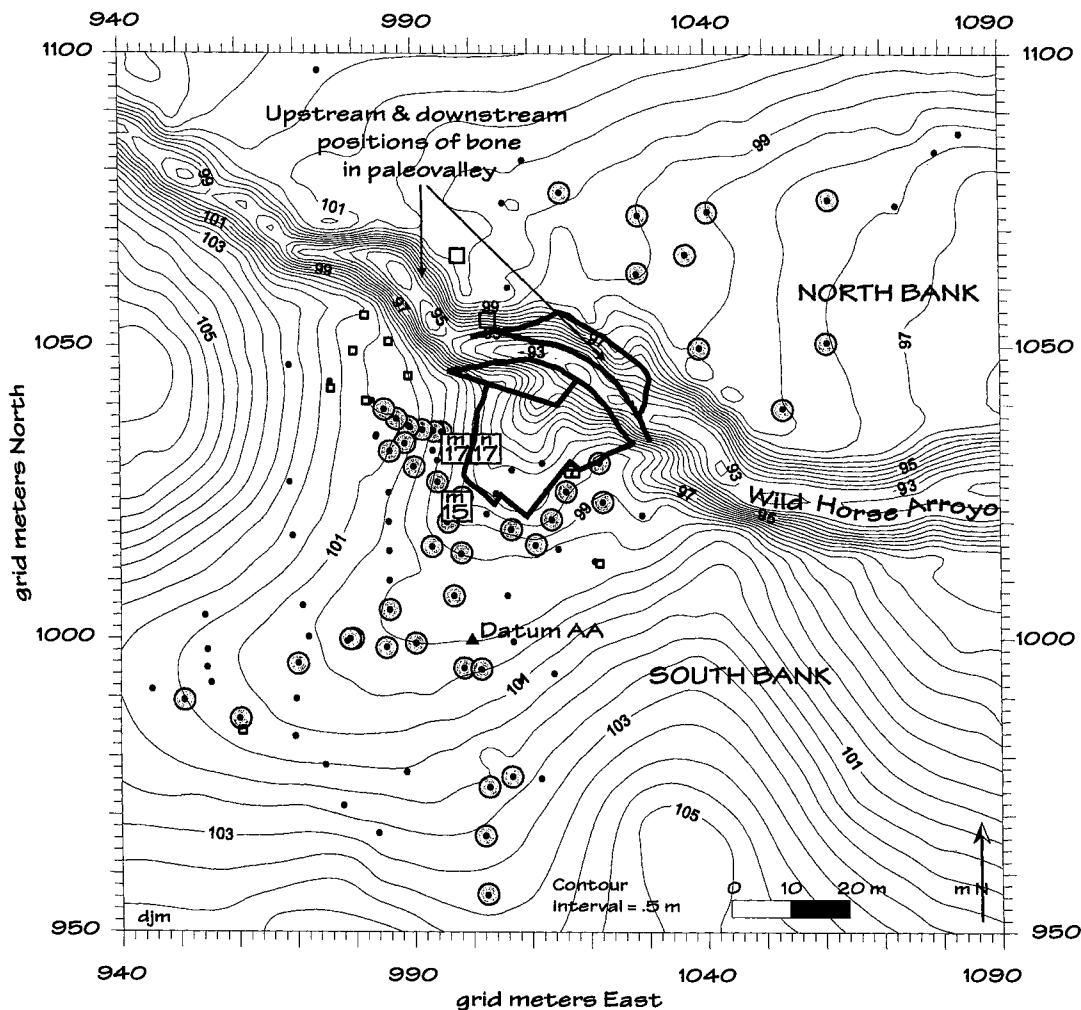


Figure 3. Topographic map of the Folsom site, showing the location of core/auger holes (black dots), select 5-x-5 m excavation blocks (M15, M17, M18), and smaller (1-m² and 2-m²) test units (open squares) from 1997–1999. Ticks along the edges mark the site grid. Black dots within gray circles identify core/auger holes where stratum *f*₂ was present, and also very roughly indicate the course of the two prongs of the tributary (which come in from the south and southwest on the south bank), and the location of the paleovalley, which is located beneath the north bank, in a course that approximately parallels the present arroyo. The plan map of the 1920s excavations is superimposed (in bold outline), although its position is at best an approximation, for reasons discussed in the text.

layers were subjected to a fluctuating water table that produced distinctive iron-oxide mottles.

Beginning around 11,500 B.P. and lasting until ~10,000 B.P. the tributary and the paleovalley filled with sediments of stratum *f*₂, fine-grained, calcareous, light yellowish brown silts (silt loam/silty clay loam) that are similar in physical characteristics to loess. Loess is not widely reported for the region, but its presence has been noted. In a study of volcanic rocks of the area, Collins (1949:1023) remarks that on some of the basalt mesas “Quaternary loess has been added to the decomposition products” but does

not elaborate. Allen (1959), in examining soils formed on the basalt uplands, observed that loess (and volcanic ash) is an important component of the parent material of some soils. Loess would not be out of place in the region given the site’s proximity to glacial and periglacial processes in the Southern Rocky Mountains during the late Pleistocene. The timing of *f*₂ deposition (Late Glacial) would also be appropriate for loess accumulation.

The *f*₂ may not be primary airfall loess, but rather a redeposited loess; evidence from thin sections shows fine bedding with stringers of clay, indicating

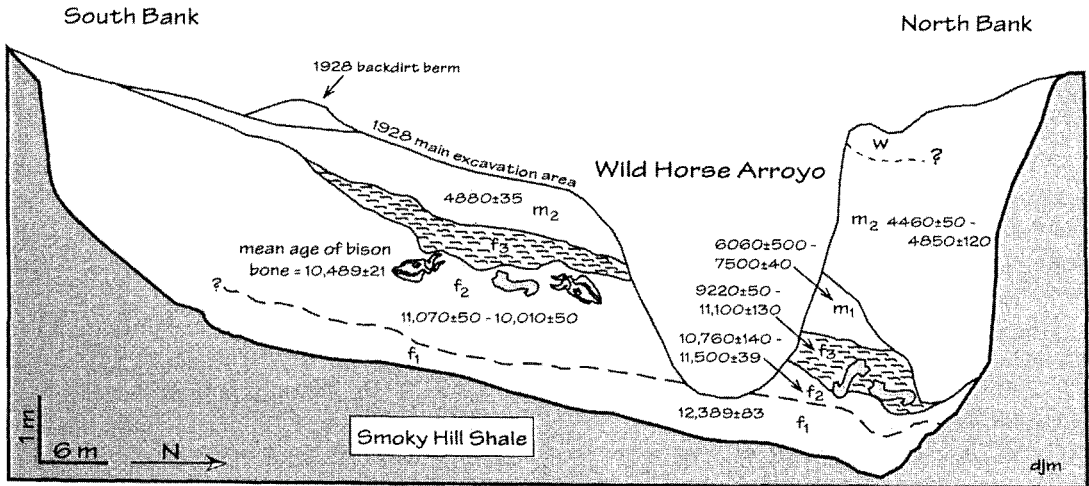


Figure 4. Generalized south-north geologic cross section of Wild Horse Arroyo at the Folsom site, showing major stratigraphic units and select radiocarbon ages and age ranges.

syndepositional reworking (Goldberg and Arpin 2000). Still, the absence of coarse clastics or pronounced bedding (except for several widely separated lenses of shale gravel) suggests the loess was not extensively reworked by fluvial/colluvial runoff or sheetflow and may have washed out of the air (“wash-out loess”) and accumulated in this topographic low.

Sediments are, at best, a coarse indicator of environmental conditions, but the presence of the *f2* loess or “wash-out loess” at the site suggests a cooler and drier landscape than at present. Support for that possibility is available in the preliminary results of the analysis of the isotopic chemistry of gastropod shell (from *Vallonia gracilicosta*, *V. parvula*, *Gastrocopta*, and *Succineidae*) recovered from the bonebed. These have more positive $\delta^{13}\text{C}$ and $\delta^{18}\text{O}$ values than occur among contemporary species. While this too suggests the environment at the site during the time of the occupation was marked by cooler and drier climates and greater amounts of C4 plants than at present, such a hypothesis needs to be (and will be) tested with ongoing isotopic analysis (as well as analysis of pollen extracted from a sediment core obtained from a nearby lake atop Johnson Mesa).

The *f2* deposition continued essentially uninterrupted through the time of the Folsom kill—the top of the bison bone (at least in the tributary) is covered, if thinly, in *f2* sediments. There are no distinct horizons within the *f2*, although there is evidence for weak pedogenesis, indicating periods of slower

aggradation and surface stability during the accumulation of this stratum.

Around 10,500 B.P. (five radiocarbon ages on bone average $10,489 \pm 21$), Paleoindian hunters killed a herd of ~32 bison, dropping the animals in both the tributary and in the adjoining valley. (Virtually all of the 1920s excavations were within the tributary, and not the paleovalley—even those excavations that in 1928 cut into the north bank, which then still was situated south of where the tributary and paleovalley merge.) It seems likely that the hunters would have maneuvered or otherwise disadvantaged the animals, thereby reducing their risks, by using the high bedrock walls of the valley and the tributary and perhaps a knickpoint within the tributary headcut. However, postdepositional colluvial movement of shingle shale off those valley walls has obscured the precise configuration of the land surface at the time of the kill.

The kill was made on a surface that was essentially dry underfoot—at least within the tributary. The *f2* within the adjoining, topographically lower valley may have had more moisture, but unfortunately we cannot be certain as we have virtually no evidence that bears on this question. In neither area do the bones occur on a distinct stratigraphic surface or unconformity, although in the tributary a backplot shows there is a well-defined archaeological surface on which the bones are resting, and there are subtle differences in soil texture and chemistry just below the bonebed. There is no stratigraphic evidence for

more than a single Paleoindian bison kill having taken place at this locality.

Erosion began in the drainage sometime around 10,000 B.P. and lasted until ~9800 B.P., at which point the depositional histories of the tributary and paleovalley began to diverge significantly. In the tributary, the eroded top of the *f2* and the Paleoindian bonebed were covered by a slopewash of angular, platy fragments of Smoky Hill shale (generally <5 cm in maximum length) that came off the nearby bedrock walls across the tributary basin. The shingle shale—which constitutes stratum *f3* in the tributary—is heaviest (but discontinuous) in the area of the bonebed; in the upper reaches of the tributary it thins and ultimately disappears. For the most part, the shingle shale flowed across the top of the *f2*; in just a few places it came to rest directly on bison bone. Otherwise, it forms a lens (sometimes sets of lenses) 10–30 cm thick, which effectively armored and protected the underlying bonebed from subsequent disturbance (e.g., erosion, rodent burrowing). This shale slope wash testifies to a scarcity of vegetation on the landscape. If the bedrock walls were overlaid by a vegetative ground cover, it would have been unlikely that the shingle shale could have moved so readily and en masse downslope.

In contrast to the relatively homogeneous shingle shale capping the bonebed in the tributary, the clasts comprising stratum *f3* in the paleovalley tend to be more rounded (i.e., gravel), show more size-sorting, and occur in multiple, complex lenses of gravels, secondary carbonate nodules (as Anderson and Haynes [1979] also observed), as well as silts—the latter appearing to represent continued deposition of fine-grained “wash-out loess.” The *f3* deposits also are substantially thicker (locally >100 cm) and tend to be more complexly bedded and finely laminated than those in the tributary; the laminated interbeds of silty clay mark repeated episodes of low-gradient fluvial erosion and redeposition.

Because of the action of these different geomorphic processes, the taphonomic history of the bone in the tributary differs from that found in the paleovalley. The bison remains in the paleovalley do not form—as they do in the tributary—a discrete archaeological horizon (or even a recognizable “bonebed”). Nor are they solely within *f2* sediments or protected by an overlying shingle shale. Instead, they tend to occur as isolated elements in secondary context and at high angles (a maximum of 79°, mean of 27.7°),

indicative of fluvial transport. These bones are situated in and among multiple, complex lenses of *f3* and gravel, including in some instances dispersed nodules of calcium carbonate, marking repeated episodes of low-gradient fluvial erosion and redeposition. The size of the gravels (packets of which range from coarse to very fine, i.e., <8 mm) suggest that water velocity and turbidity—here on the edges of the valley—was irregular, as was stream competence.

There are presumably some areas in the paleovalley where portions of the bonebed are in primary context (e.g., where the cranium and associated elements were found in 1972). Importantly, not all of the bone found in the paleovalley could have simply “washed out” from the tributary deposit, as bison remains have been found in the paleovalley at least 35 m upstream of the mouth of the tributary (Figure 3). Although the greatest concentration of bison bone was found in the tributary, this is not necessarily the main area of the kill (in fact, the density of carcasses here is relatively low in comparative terms [Hofman 1999a]). Indeed, it is quite possible that the kill was centered in the paleovalley, and a comparable or greater number of animals were dropped there where their traces were either moved/removed by subsequent erosion, or still remain buried and archaeologically invisible beneath the deep Holocene deposits of the north bank.

The erosion of *f2* sediment and its redeposition as *f3* complicates efforts to establish a precise chronological relationship between these units. In the tributary, where the *f2* was not extensively eroded, the youngest age from the unit is 10,010 ± 50 B.P. By contrast, in the paleovalley the youngest age on the *f2* (excluding the bison bone dates) is 10,760 ± 140 B.P., likely reflecting the removal of the upper, younger portion of that stratum. Charcoal from the *f2* in the paleovalley was apparently redeposited in younger, overlying *f3* sediments, which have yielded ages as old as 11,100 ± 130 B.P. (even older than the oldest radiocarbon age currently available on the *f2* in the tributary).

The majority of the ages on the *f3* in the paleovalley postdate 10,000 B.P. Stratum *f3* deposition continued until ~9200 B.P. The middle-to-late Holocene stratigraphic history of the site need not concern us here, save to observe that following the deposition of stratum *f3*, there were a series of cut-and-fill episodes. These produced the McJunkin

units, *m1* and *m2*: dark, organic- and charcoal-rich, massive silt loam/silty clay deposits ranging in age from ca. 7500–4400 B.P. The McJunkin filled and ultimately obscured the paleovalley and its bone-bearing tributary. The last major depositional episode in the valley is marked by sediments of the Wildhorse formation (stratum *w*), which are latest Holocene in age.

Bison Skeletal Remains from the Folsom Bonebed

A total of ~3,300 identifiable bison bone elements have been recovered from all the excavations in the Folsom bonebed. The aggregate tally and counts are given in Table 1, and the area of the bone bed as it appeared in our excavations is shown in Figure 5. As noted, *Bison antiquus* is the only species represented (MacDonald 1981:94).

Our estimates place the minimum number of animals at the site at ~32 (based on counts of astragali and fused 2nd and 3rd carpals; Brown, as noted, estimated 30 animals). Younger animals are well represented with calves and yearlings having a combined MNI of 7 (Todd et al. 1996:170). Based on measurements of distal humeri, nearly 60 percent of the skeletally mature animals are cows. Although many of the crania are very fragmentary, two are bull crania (one each at Denver and the AMNH) and four are cow crania (one at the AMNH, two from the QUEST excavations [Figure 5], and one from the Loudon excavation). With nearly two-thirds of the cranial remains and limb bones coming from sexually mature cows, and taking into account the fact that the bulls probably include both young (less than 7 years; Berger and Cunningham 1994:162) and a lower number of the more reproductively active and aggressive prime and old bulls, the age and sex evidence from Folsom seems to represent a cow-calf herd.

Based on the relatively uniform weathering of the bones examined in the extant collections, the within-cohort uniformity of eruption and wear patterns of mandibular molars, and the stratigraphic and depositional context of the faunal remains in the limited area of the bonebed we have been able to examine, we believe, as Brown did in 1928, that the remains all come from a single kill. This is typical of Folsom sites (Stanford 1999:301).

In general, the skeletal preservation is excellent. Elements not often preserved in Paleoindian con-

texts—for example, complete crania, including horn cores and tips of premaxillae, and extremely fragile hyoid bones—occur in the Folsom bonebed. A few of the remains collected in the 1920s, however, do show the damaging effects of contemporary excavation and laboratory preparation techniques, including pick and/or shovel cuts and breaks, shellacking, plastering, sanding, and carving of bone surfaces.

The preservation of the bone is attributable to several factors. First, surface weathering (using criteria in Todd et al. 1987) of the Folsom bone proved to be minimal, with over 75 percent ($n = 1141$) of the elements for which data are available ($n = 1488$) falling into weathering stage 1, and just over 99 percent in weathering stages 1–3. This suggests the carcasses were subaerially exposed for only a brief period of time prior to burial (perhaps no more than a few years). The bones were eventually buried by the fine-grained silts of unit *f2* and then in the tributary by the shingle shale. However, there is some variability in surface weathering across the bonebed. A few of the elements recovered in 1928 from the eastern side of the bonebed are in poorer condition (weathering stages 4–5, occasionally with substantial evidence of crushing or other damage). This spatial difference in bone preservation was observed by Kaisen in 1928, but he offered no explanation for the disparity (Kaisen to Brown, and Kaisen to Cook, both July 8, 1928, VP/AMNH). There are several possibilities (e.g., slightly longer initial exposure, re-exposure and weathering at a later time, an absence of the shingle “armor,” different moisture regimes, snowdrift locations, vegetation or shade differences), but we have been unable to resolve these as our test excavations in this area of the site did not yield any faunal remains.

Second, there is little or no evidence of carnivore modification or trampling. Only a very few ($n = 63$ or 2.9 percent) of the more than 2,100 specimens for which data are available show gnaw or tooth marks, and many of those in the 1920s collections are ambiguous and not securely referable to carnivore action. The low long-axis inclinations of the bone elements—at least in the tributary area—are also inconsistent with animal trampling (Fiorillo 1989).

Finally, there is evidence (including a lack of patterning in inclination or orientation) that the bone in the tributary was not moved or transported any significant distance by natural processes. In fact, we suspect the location of the bone piles in this area of the

Table 1. Summary Inventory and Element Counts of Folsom Site Bison Bone.

ELEMENT	CODE	NISP	MNE	MAU	MAU%
Axial Skeleton					
cranium	CRN	136	10	10.0	32.8
mandible	MR	144	57	28.5	93.4
hyoid	HY	12	7	3.5	11.5
atlas	AT	14	13	13.0	42.6
axis	AX	25	23	23.0	75.4
cervical vertebra	CE	122	84	16.8	55.1
thoracic vertebra	TH	276	184	13.1	43.1
lumbar vertebra	LM	114	88	17.6	57.7
sacrum	SAC	23	15	15.0	49.2
caudal vertebra	CA	38	33	2.2	7.2
rib	RB	459			
proximal rib	RB PR		240	8.6	28.1
costal cartilage	CS	11	9		
Fore Limb					
scapula	SC	37	26	13.0	42.6
humerus	HM	32			
complete humerus	HM CO		20	10.0	32.8
proximal humerus	HM PR		23	11.5	37.7
distal humerus	HM DS		29	14.5	47.5
radius	RD	59			
complete radius	RD CO		32	16.0	52.5
proximal radius	RD PR		39	19.5	63.9
distal radius	RD DS		35	17.5	57.4
ulna	UL	51	29	14.5	47.5
accessory carpal	CPA	41	41	20.5	67.2
fourth carpal	CPF	47	47	23.5	77.0
intermediate carpal	CPI	46	46	23.0	75.4
radial carpal	CPR	50	50	25.0	82.0
fused 2nd & 3rd carpal	CPS	53	53	26.5	86.9
ulnar carpal	CPU	45	45	22.5	73.8
metacarpal	MC	51			
complete metacarpal	MC CO		40	20.0	65.6
proximal metacarpal	MC PR		43	21.5	70.5
distal metacarpal	MC DS		43	21.5	70.5
5th metacarpal	MCF	18	18	9.0	29.5
Hind Limb					
os coxae	IM	47	27	13.5	44.3
femur	FM	42			
complete femur	FM CO		20	10.0	32.8
proximal femur	FM PR		23	11.5	37.7
distal femur	FM DS		22	11.0	36.1
patella	PT	13	13	6.5	21.3
tibia	TA	44			
complete tibia	TA CO		36	18.0	59.0
proximal tibia	TA PR		36	18.0	59.0
distal tibia	TA DS		36	18.0	59.0
lateral malleolous	LTM	32	32	16.0	52.5
talus	AS	61	61	30.5	100.0
calcaneus	CL	61	47	23.5	77.0
fused central & 4th tarsal	TRC	45	45	22.5	73.8
1st tarsal	TRF	9	9	4.5	14.8
fused 2nd & 3rd tarsal	TRS	38	38	19.0	62.3
metatarsal	MT	58			
complete metatarsal	MT CO		48	24.0	78.7
proximal metatarsal	MT PR		49	24.5	80.3
distal metatarsal	MT DS		48	24.0	78.7

Table 1. Summary Inventory and Element Counts of Folsom Site Bison Bone (continued).

ELEMENT	CODE	NISP	MNE	MAU	MAU%
2nd metatarsal	MTS	12	12	6.0	19.7
Feet					
1st phalanx	PHF	197	178	22.3	73.0
2nd phalanx	PHS	189	182	22.8	74.6
3rd phalanx	PHT	147	148	18.5	60.7
proximal sesamoid	SEP	249	249	15.6	51.0
distal sesamoid	SED	96	96	12.0	39.3
dew claw	DC	8	8	1.0	3.3
Miscellaneous					
unidentified metapodial	MP	12			
unidentified tooth fragment	TTH	22			
unidentified vertebra fragment	VT	23			
unidentified bone fragment	UN	331			
Total		3640			

site roughly approximates the position of the animals at the time of their death, with subsequent butchering and processing apparently having taken place close to where the animals were dropped. In contrast, and as noted above, skeletal elements found in the paleovalley show clear evidence of postdepositional transport—which in many cases led to breakage, loss of projecting articular ends, etc. Even so, the skeletal elements from the paleovalley do not show appreciably greater surface weathering, suggesting they too were rapidly buried even after reworking.

The butchering may have been thorough: bison remains uncovered during our excavations were from mostly disarticulated skeletons, save for a few articulated and/or conjoined skeletal elements. Yet, despite the apparent thoroughness with which the bison carcasses were taken apart, the recovered bones (including those in the museum collections) show few cutmarks on their surfaces. Obviously, given the (generally) excellent surface condition of the bone, butchering marks ought to be visible if present. We cannot yet determine whether the observed patterns of skeletal disarticulation and scattering resulted from dismemberment during butchering or through diagenesis.

For that matter, none of the elements recovered from the site were broken for marrow. There is virtually no evidence of bone impact fractures. Nor do any elements show signs of on-site processing for bone grease. In effect, the nutritional value of each carcass was not completely exhausted, in keeping with the general pattern seen at other Paleoindian kills (e.g., Bement 1999; Hill and Hofman 1997;

Hofman and Todd 1996; Todd et al. 1997), and in contrast with, for example, late prehistoric kills (e.g., Bartram 1993:121; Frison 1982; Todd 1991; Todd et al. 1997).

This herd of animals would have had considerable potential food value. The ~32 bison in this cow-calf herd were killed in the fall, based on patterns of dental eruption and wear (Todd et al. 1996:169–170), which indicate ages of .4–.5 years for the group 1 animals and 1.4–1.5 years for the group 2 animals. That time of year, fat reserves in cows are greater than they are at other times of the year (Speth 1983; Todd 1991:232–233).

The bison bone recovered from our excavations yielded disproportionately fewer long bones (femora, humeri, tibiae) and appeared to be dominated by skeletal parts traditionally considered low-utility (low meat-yielding) elements such as lower legs and mandibles (e.g., Wheat 1972:102–103; also Emerson 1993). These are parts generally discarded in the course of butchering. Subsequent statistical analysis of the assemblage indicated there was no correlation between ranking of element utility and recovered complete elements ($r_s = .217$, $t = 1.07$, not significant).

This preponderance of low-utility bones in our excavations was in apparent contrast to the results of the earlier excavations, which archival records implied yielded more or less complete skeletons (Kaisen, unpublished fieldnotes, VP/AMNH). That difference raised the question of whether our respective excavations had uncovered spatially distinct activity areas within the bonebed—despite their

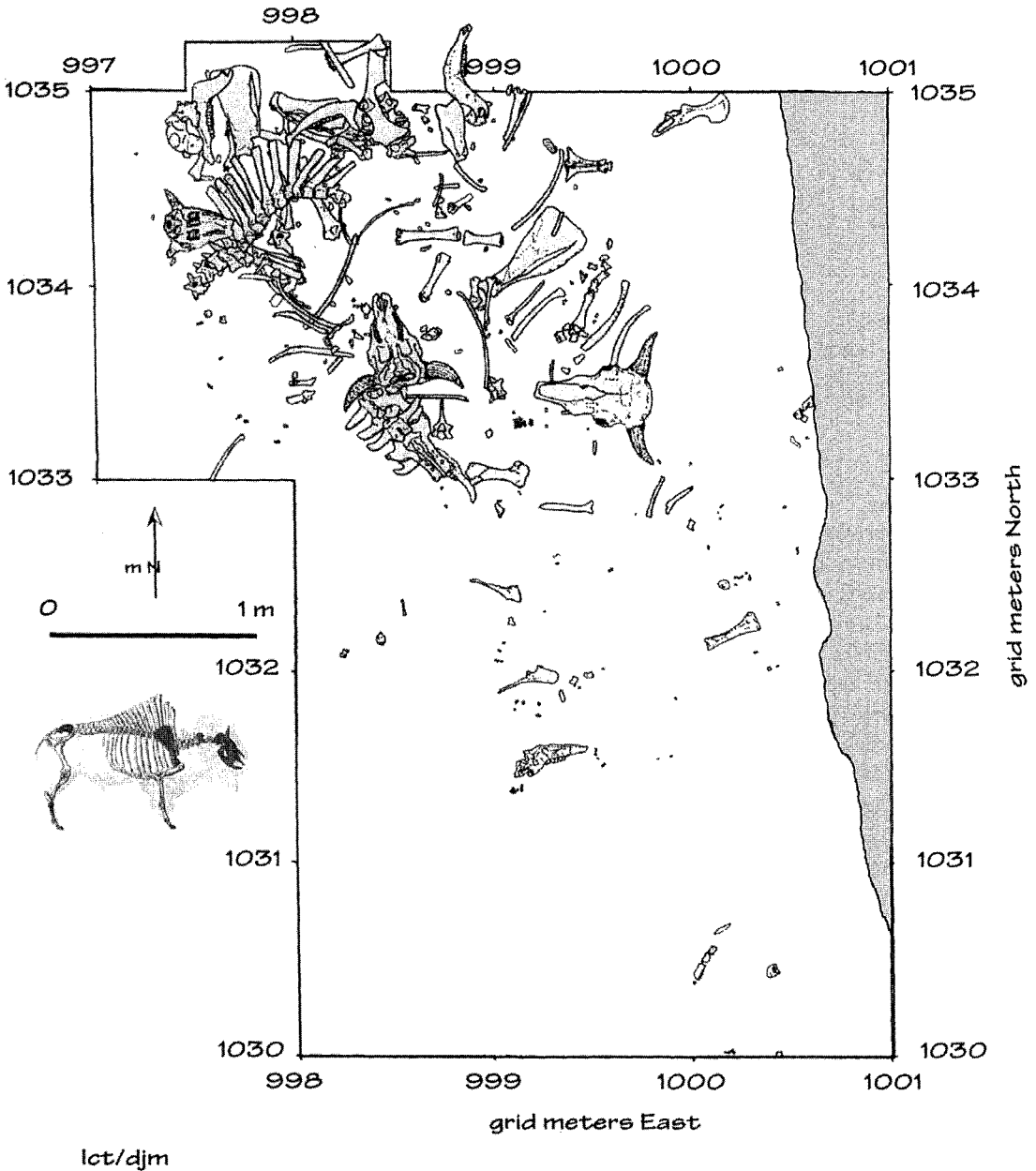


Figure 5. Composite map of the Folsom site bonebed, as it appeared in 1997–1999 within the M17/N17 block. This portion of the bonebed is situated in the area between AMNH Pit C and the western edge of the main block of the 1928 excavations (the latter, where it intersected our excavations, is shown in gray).

proximity—or, whether our results were actually the same but were only described differently. In the 1920s, the analytical focus was on skeletons rather than skeletal parts and their taphonomic history, with the result that a cluster of bones would commonly be referred to or mapped as “a skeleton,” rather than as individual elements.

No maps of sufficient detail exist from the earlier excavations that enable us to assess the spatial patterning of bone elements in those excavations. However, our inventory of the bone recovered by the CMNH and AMNH can be used to test whether differences exist in the elements recovered in these samples. When the number of identified specimen

(NISP) values from the CMNH, AMNH, and our own (denoted as QUEST) excavations are plotted and statistically compared, it is immediately clear the several assemblages are, in fact, quite similar (the Spearman's rank order correlation between the several assemblages range from $r_s = .69$ [CMNH x QUEST] to $r_s = .78$ [AMNH x QUEST] to $r_s = .87$ [AMNH x CMNH], $t = 6.45, 8.67,$ and 12.29 respectively, all significant at $p < .001$ [$n = 49$] [t test following Siegel 1956:202–212]).

The only significant difference among the recovery patterns of the various projects is one of sample size: the AMNH remains are from a much more extensive excavation area, producing a faunal assemblage 1.65 times larger (in terms of NISP, although as noted above, not in MNI) than the CMNH, and over 7 times larger than that from our excavations. Despite the apparently more destructive nature of the 1926–1928 excavations (which involved heavy picks, among other tools), there was no appreciable difference in relative recovery rate of complete elements. It would appear that the 1920s excavations also recovered single elements rather than whole skeletons. It seems statistically appropriate, therefore, to combine the faunal assemblages from the various excavations to provide a fuller and perhaps more representative picture of the assemblage—with the explicit caveat that even this combined sample may represent only a portion of the total bonebed.

Plotting NISP against bone utility shows that the Folsom faunal assemblage, with the exception of a few highly fragmented outliers (ribs), fits a generalized low-utility curve; there was no correlation between element utility and NISP in the combined samples ($r_s = .002$, $t = .01$, which is not significant [$n = 24$]). Lyman (1985, 1994) and others rightly caution such curves may also reflect differential preservation of high-density elements (see also Rogers 2000). To test this, NISP and (separately) complete element counts were plotted against bison bone-density values (utility and density data from Kreuzer 1992, and Lyman 1994:Tables 7.3 and 7.6). Statistical analysis shows no correlation between the two (the Spearman's rank order correlation between NISP and average bone density is $r_s = -.048$, $t = -.23$, and between complete elements and average bone density, $r_s = .136$, $t = .65$ [$n = 25$ in both cases; not significant in either case]). In effect, element frequency varies independently of bone density (a conclusion not unexpected, given the excellent

preservation of fragile bone elements).

Accordingly, the Folsom faunal assemblage appears to be dominated by low-utility skeletal parts, having been stripped of the high-yield elements. This is a pattern characteristic of initial butchering and processing in a kill area (e.g., Jodry 1999a)—which, as noted below, also fits with the kinds of artifacts recovered (broken points and a few flake tools). We infer this initial round of processing took place essentially where the animals were dropped, on the assumption that heavy elements like crania (of which at least half a dozen complete specimens were found) would not be moved any significant distance. In the absence of bonebed maps from the 1920s, we cannot say whether there were more subtle differences in the character of this initial butchering across the kill area. That said, the 1928 map does indicate that the west side of the bonebed yielded skeletons “more or less mixed” and apparently a higher density of bison remains (Brown 1928). Given the overall structure of the faunal assemblage, and in the absence of additional spatial information, this can be interpreted as an area in which animals were simply more closely spaced (rather than an area in which different kinds of activities were taking place).

The observed patterns of butchering leave unanswered many details of the bison processing and indirectly raise questions about other aspects of the site and occupation—notably, whether there exists (or once existed) other areas to the Folsom site. Ethnographic and ethnoarchaeological evidence suggests the rough rule of thumb that it takes a minimum of 1–2 hours of processing time per animal (L. R. Binford, personal communication, 1999; Ewers 1955:160; Wheat 1972:109–110, 116; Wissler 1910:41). That figure varies, of course, depending on the size of the animals, the spatial scatter of the carcasses, the extent of the butchering, the size of the labor force working on the task, the skill of the individual doing the processing, the available tools, whether carcasses were processed serially or in parallel, and even temperature—among other factors (Frison 1991:141, 299–302). Still, taken as no more than a rough estimate, one can argue the initial butchering and processing of ~32 Folsom bison must have taken at least several days. Presumably, the group would have camped nearby during that time to protect the kill from scavengers (Frison 1991:301).

What activities might have taken place in an associated camp area depend on what followed the ini-

tial processing of the carcasses in the kill area. The relative scarcity of high-utility elements in the bonebed suggests those parts were removed, but to where is unknown. There are at least two possibilities, each of which has different implications for the kinds of activities that might have taken place and the amount of time that might have been spent on site:

(1) the high-utility elements were not processed on site, but transported off site in meat/bone packages (e.g., rib racks) for subsequent processing. This implies that only the minimum amount of time and activities (those necessary to the initial butchering and processing) were spent on site; or

(2) the meat stripping/drying of the high-utility elements took place on site, in an as-yet undiscovered nearby area. This implies more activities and a longer period of time spent in the area, but how much more and how much longer would depend on whether the group stayed only for the time it took for meat stripping and drying, or whether they chose to make an extended stay in the area.

Which strategy might have been taken depends on many variables, several of which attend to the costs of transport such as the size of carcasses, the number of carcasses, the number of available carriers, the distance to the next camp(s), and the climate/season when the kill took place (Bartram 1993:121; Emerson 1993:139–140, 150; see also Roberts 1936:15; Wissler 1910:41–42). The number of animals killed and their size are relevant insofar as large-animal kills permit transport decisions based more on body-part utility than do small-animal kills (i.e., one can afford to be selective in regard to what is transported when the animals are large and abundant [Emerson 1993:139]). The climate/season is relevant, since temperature and precipitation may have influenced how easily groups could have butchered the animals and dried the meat (removing the meat from bones and drying it significantly reduces its weight and makes it easier to carry [Bartram 1993:121, 131–132]), and/or whether the area would be suitable for an extended stay. Resolving which of these possibilities might be correct would be helped by locating an associated camp or habitation area, but none has been found.

Based on our work and information from the 1920s notes and map, it appears the bonebed extended over a north-south distance of as much as

40 m, and an east-west distance of just under half that, suggesting the carcasses may have been scattered over a total area of ~800 m². At best, however, that is a ballpark figure and makes some assumptions (about the accuracy of the 1928 map and the spatial extent of carcasses) that ultimately may not be supportable. Nonetheless, a bonebed of this extent is not unlikely: indeed, O'Connell and others (1992) show it may even be on the small side—even for a kill of over 30 large mammals (and, of course, were there additional excavations across the entire area, the total number of bison might be larger). At this scale, and given the current estimated number of animals, the bison carcasses were very widely dispersed.

Skeletal elements on the north bank of the arroyo, as Kaisen observed in 1928, were at a much deeper elevation than the material on the south bank. According to archival data, the bonebed was within 1.5 m of the surface at the upper (southern) end of the tributary, and nearly 3.65 m below the surface some 25 m distant at the lower (northern) end where the tributary joins the paleovalley—a vertical difference of just over 2 m. Our recent evidence supports this: on average, the elevation of bone on the north bank was 2.5 m below the level of the bonebed on the south bank (some 15 m away).

Elevations recorded on skeletal remains recovered in 1928 suggest the surface was relatively level over a large area and began to drop off only as it neared the junction with the paleovalley. As our recent excavations on the south bank have been on the higher and more level areas of the site and exposed the bonebed over a north-to-south distance of less than 6 m, most of the skeletal material recovered by us has been at nearly the same elevation.

Artifacts from the Folsom Site

Like the faunal remains, the artifact assemblage from Folsom is consistent with that of a kill and initial butchering locality, as opposed to a camp or more intensive processing area (Jodry 1999a:273–276). The majority of the artifact assemblage is comprised of projectile points, while formal tools from more intensive butchering, meat and hide preparation, or other activities—such as end and side scrapers, graters, ultrathin bifaces, preforms, channel flakes, etc.—are absent. A few flake tools have been recovered over the years but, unfortunately, none in situ.

While the artifact assemblage at the Folsom site is dominated by projectile points, precisely how

many have been recovered from the site is uncertain, partly because of sometimes-lax curation procedures over a half-century ago, the rumored finding of points at the site by later site visitors, and because of confusion in counting broken specimens that were subsequently refit. Contemporary sources record only 14 points (Schwachheim Diary), or 16 points (Brown 1928:128; Figgins 1929:9) from the 1920s excavations at the site. Less than a decade later, Roberts (1935:17; see also Wormington 1939:6) put the total at 19 points, which apparently included specimens recovered from the back dirt in 1931 and 1934 by Brown and E. B. Howard, respectively (Howarth to Cook, February 26, 1932, HJC/AGFO; Howard 1943; Roberts 1935:17).

Our total, based on what we believe is a reasonably complete inventory of points from public and private collections, comes to 23 or 24 points (Table 2; many of the points are illustrated in Figgins 1927; Howard 1935; Wormington 1957). Our total depends on whether the base found by Howard in 1934 actually joins the tip found in 1928 (UM34-30-1), and if two of the points (CAVO-115 and CAVO-116) accessioned as coming from “near the original Folsom site” actually came from the site. Three of the points recorded from the site are now missing; these include one specimen found in 1927 and two in 1928 (AMNH A and AMNH J). Casts and photographs of two of those are available (Wormington 1957: Figure 7, top row, third from right, and bottom row, third from right). As it happens, two of the specimens curated at the Denver Museum (catalog numbers 1391/2 and 1262/1A) do not have secure provenience or match descriptions or sketches in Schwachheim’s Diary. To complicate matters, they do not appear to correspond to the two specimens missing from the 1928 excavations.

Roberts (1935:5) considered the point found in situ at Folsom in 1927 to be the type specimen, although there is no “type” description for this form. Nonetheless, he and others (e.g., Howard 1935:112) used this point’s attributes as the standard against which others were deemed Folsom or not. Of course, this specimen is not “typical” in any meaningful sense (Roberts himself did not even see it as being typical of the points from the site [1935:16]), nor is the type well defined (for a full discussion of the consequences of this, see LeTourneau 1998a). More recently, Ingbar and Hofman (1999:99) have identified one of the Lindenmeier specimens as “the com-

mon standard” for these points. But, in fact, within any assemblage of Folsom points, and the ones from Folsom and Lindenmeier are no exceptions, there is considerable morphometric variability about a “typical” form, as a result of variation in manufacture, raw material availability, point reworking, the number of kill or retooling events, the temporal/spatial distance from the last (or to the next) quarry visit, etc. (Amick 1995:34; Hofman 1992:193; Ingbar and Hofman 1999; LeTourneau 1998a) a matter anticipated by Figgins (1934:4).

Given the relatively small size and fragmented condition of the sample from Folsom, detailed metric analyses are not especially informative. That said, descriptive statistics on this assemblage of projectile points (data not shown) indicate this sample is well within the quantitative range of other Folsom projectile-point assemblages (comparative data from Amick 1995; Bement 1999; Hofman 1991; Hofman et al. 1990; Jodry 1999a; Judge 1973; Wilmsen and Roberts 1978:111). Not surprisingly, measured attributes in the haft area—e.g., basal width and flute thickness—show the relatively low coefficients of variation ($CV < 15$) evident in other Folsom fluted-point assemblages (e.g., Amick 1995:31–32; Judge 1973:261–264; in other Folsom assemblages, CV values for basal width dip as low as 5.42). These suggest a standardization in manufacture (Eerkens and Bettinger 2001), which is argued to be a consequence of knapping these tools to fit their hafts, and not vice versa (Judge 1973:264).

Virtually all of the points for which data are available are fluted—generally on both faces. The high incidence of fluting, arguably, marks a circumstance where lithic raw material was available in sufficient quantity that the potential cost of production failure while fluting was mitigated (Amick 1999a:3; Hofman 1992; Ingbar and Hofman 1999:103). There is no evidence for point production; no preforms, manufacturing failures, or channel flakes have been recovered, although again this might reflect the portion of the site excavated (the kill area).

Only four of the points are complete (one of those was refit from fragments, as the point was broken during excavation). The remainder of the assemblage is comprised of tips, midsections, and bases, with distal (tip) and proximal (base) portions of the points represented in about equal frequency ($n = 10$ and 9 , respectively). In keeping with Hofman’s (1999a:122) argument, there is no isomorphism between point

Table 2. Summary Data on Projectile Points from the Folsom Site.

Specimen	Maximum length	Maximum width	Maximum thickness	Basal width	Flute thickness	Lithic raw material	Comments (published photographs)
DMNS 1391/3	56.07	23.50	4.75	-	4.10	Black Forest petrified wood	Found July 14, 1926. Lacks base, but includes a portion of haft area, as indicated by presence of small amount of edge grinding (Figgins 1927, Fig. 3 left; Howard 1935:top row, 2nd from right; Wormington 1957:Figs. 6 & 7, top row, 2nd from left)
DMNS 1261/1A	52.96	24.90	4.71	-	2.97	Alibates agatized dolomite	Found October, 1926. Lacks base; edge grinding absent. Blade portion was 'refit' to small midsection wedge in CMNH laboratory (Figgins 1927:Fig. 3 right, Fig. 4; Howard 1935:top row, 3rd from right; Wormington 1957:Fig. 5)
DMNS 1262/1A	45.43	21.42	3.77	18.88	2.83	Flattop chert	Found August 29, 1927. Reworked, and complete except for missing corner. This is the specimen examined in situ in September, 1927. Data from cast (Howard 1935:top row, 1st on left)
missing	25.76	23.13	3.66	20.59	2.67	Alibates agatized dolomite	Found August 29, 1927. Base only, with missing corner. Whereabouts of original unknown. Data from cast (Howard 1935:bottom row, 2nd from right; Wormington 1957:Fig. 7, bottom row, 3rd from right)
DMNS 1391/2	40.13	25.77	4.22	-	3.19	Tecovas jasper	Found 1927. Lacks base, but includes a portion of haft area, as indicated by presence of small amount of edge grinding (Howard 1935, top row, 3rd from left; Wormington 1957:Fig. 7, bottom row, 2nd from left)
DMNS 1263/1A	17.71	21.37	3.44	-	2.37	Alibates agatized dolomite	Found 1927. Point tip, with only small part of flute visible on one face (Wormington 1957:Fig. 3 incorrectly shows this tip refit to midsection Denver 1391/1)
missing							Found June 25, 1928. Whereabouts of original unknown; no cast exists. Schwachheim Diary sketch is the only record. Sketch shows a point mid-section, perhaps longitudinally split
AMNH 20.2.5871	31.39	19.99	3.59	-	2.29	Tecovas jasper	Found June 27, 1928. Lacks base and tip shows signs of reworking and impact fracture (Wormington 1957:Fig. 7, bottom row, 1st on left)
AMNH 20.2.5865	56.20	24.15	3.91	19.17	3.08	Tecovas jasper	Found July 13, 1928. Complete, but with excavator breaks. Data from cast (Howard 1935: top row, 1st on right; Wormington 1957:Fig. 7, top row, 1st on left)
AMNH 20.2.5867	27.52	25.67	3.93	22.43	3.89	Tecovas jasper	Found July 16, 1928. Base only, with lateral snap occurring just beyond haft area. Found in backdirt in 1928 (Howard 1935:bottom row, 3rd from right; Wormington 1957:Fig. 7, bottom row, 2nd from right)
AMNH 20.2.5866	35.51	22.44	3.78	17.12	2.83	Black Forest petrified wood	Found July 17, 1928. Nearly complete, but impact fractured and burinated tip, and slight damage to base. Data from cast (Howard 1935:bottom row, 3rd from left; Wormington 1957:Fig. 7, bottom row, 3rd from left)
AMNH 20.2.5868	30.06	20.89	3.65	19.82	2.16	Alibates agatized dolomite	Found July 23, 1928. Reworked, but otherwise complete. Impact fractured tip. Data from cast (Howard 1935:bottom row, 1st on left; Wormington 1957:Fig. 7, top row, 2nd from right)

Table 2. Summary Data on Projectile Points from the Folsom Site (continued).

Specimen	Maximum length	Maximum width	Maximum thickness	Basal width	Flute thickness	Lithic raw material	Comments (published photographs)
UM 34-30-1 (tip)	26.62	22.69	5.20	-	3.06	Dakota? quartzite	Found July 27, 1928. Point tip, found by AMNH and later refit to base found by Howard in 1934 (Howard 1935: bottom row, 1st on right; Wormington 1957: Fig. 7, bottom row, 1st on right)
AMNH 20.2.5872	35.31	28.22	3.87	-	3.25	Alibates agatized dolomite	Found July 27, 1928. Lacks base and tip (which is impact fractured), but includes a portion of haft area, as indicated by presence of edge grinding. Excavator breaks (Howard 1935: top row, 2nd on left; Wormington 1957: Fig. 7, top row, 1st on right – but shown upside down)
DMNS 1391/1	19.57	24.42	3.49	-	2.5	Alibates agatized dolomite	Found July 30, 1928. Midsection only (Wormington 1957: Fig. 3 incorrectly shows this midsection refit to point tip; Denver 1263/1A)
missing	34.99	21.68	3.73	18.4	2.99	Tecovas jasper	Found August 28, 1928, on North Bank. Tip broken, and apparently reworked, but otherwise complete; whereabouts of original unknown. Data from cast (Howard 1935: bottom row, 2nd from left; Wormington 1957: Fig. 7, top row, 3rd from right)
AMNH 20.2.5869	35.03	21.57	3.37	-	2.76	Alibates agatized dolomite	Found August 29, 1928, on North Bank. Point tip and blade; point broke above the haft area; fluted on one face only. Excavator breaks (Wormington 1957: Fig. 7, top row, 3rd from left)
AMNH 20.2.5870	28.94	18.95	4.3	-	-	Flattop chert	Found in 1931 by B. Brown on backdirt pile. Lacks base and tip, but includes a portion of haft area, as indicated by presence of small amount of edge grinding. Possibly reworked. Remnant flute visible on one face only.
UM 34-30-1 (base)	36.2	22.83	4.19	17.72	3.96	Dakota? quartzite	Found in 1934 by Howard. Point base, refit by Howard to tip found by AMNH in 1928 (Howard 1935: bottom row, 1st on right)
Burchard collection	32.32	18.74	4.59	16.24	3.22	Tecovas jasper	Found in 1950s? Complete, but reworked point. Given to father of present owner; said to be from the site.
CAVO-115	56.42	23.24	4.38	-	3.31	Tecovas jasper	Found in 1950s? Provenience uncertain. Accession records only indicate point found "near original Folsom site." Lacks base, but includes a portion of haft area, as indicated by presence of grinding.
CAVO-116	35.05	21.49	4.01	17.48	3.24	Alibates agatized dolomite	Found in 1950s? Provenience uncertain. Accession records only indicate point found "Near original Folsom site." Complete but heavily reworked.
Brown collection	47.53	26.77	4.52	-	3.35	Tecovas jasper	Found in the 1970s on the backdirt at the site. Lacks base, but includes a portion of haft area, as indicated by presence of edge grinding.
DMNS A2006.1	31.08	24.18	5.16	20.32	4.07	Alibates agatized dolomite	Found in 1994 on the backdirt at the site. Point base, with impact damaged tip; missing corner (Dixon & Marlar 1997: Figs. 1 and 2).

Notes: all measurements are in millimeters; AMNH = American Museum of Natural History; CAVO = Capulin Volcano National Monument; DMNS = Denver Museum of Nature and Science; UM = University Museum, University of Pennsylvania).

tips:kills and point bases:camps—all of the points in this assemblage came from the kill area (cf. Roberts 1936:20). Relying just on the material from the kill could skew interpretation of the “site” assemblage (Hofman 1999a:123).

Reworking, which took place in advance of the kill at Folsom, is evident on seven of the points, including both complete ($n = 3$) and broken ($n = 4$) specimens, while impact fractures are present on five of the points (including one of the complete specimens). It should be noted that only two specimens that were reworked also had impact fractures. In several instances, the impact fractures are accompanied by what may have been end shock (which snapped the point while still in the haft). While one might expect reworking to be more common in lithic raw material from sources distant in time/space and late in their use-lives (e.g., Ingbar and Hofman 1999:103), there is no apparent correlation between the occurrence of reworking and types of lithic raw material, or for that matter between material type and impact fractures or other breakage patterns (see below).

Hofman has argued that the proportion of “complete (lost) points” will be positively correlated with the density of carcasses at the kill, reasoning that widely dispersed carcasses indicate a “less accessible herd where the use of atlatls was required resulting in a higher loss of projectile points per animal” (Hofman 1999a:128). As the carcasses at Folsom tend to be widely dispersed (perhaps as much as ~1 animal per 25 m², if our current estimate [800 m²] of the size of the kill area is correct), he suggests this accounts for the loss of weaponry at this site. It seems reasonable to assume in this instance that the carcasses were not moved significantly from the spot where the animal collapsed (though certainly this assumption might not hold true in other cases). But the spot where the animal collapsed may not be the same spot where the animal was struck by the weapon. Hence, it might not be reasonable to assume that the relative dispersal of the carcasses necessarily informs on whether atlatls or thrusting spears were necessary to bring the animals down.

It also seems reasonable to argue that hunters who held onto their thrusting spears had a better chance of recovering their weapons, to the degree those weapons remained hafted and attached to the spear shaft. Yet, it might not be the case that the recovery of projectile points is solely a function of whether

they were thrust or thrown, or the degree of carcass dispersal. After all, if dispersed carcasses and, presumably, the cool weather and extended occupation at Folsom (as Hofman 1999a:128 infers) enabled more thorough processing and the recovery of most of the useable artifacts, then the recovered material should also include complete projectile points. To be sure, butchering tools may be more easily retrievable, since they start out in the hands and not embedded in the animal. So we would add to Hofman’s argument the suggestion that the recovery (or loss) of projectile points may have as much or more to do with factors such as where in the animal the projectile points were embedded, the degree of butchering, whether the point-bearing parts of the animal were removed from the kill area and further processed, and perhaps whether there was a need to recover the artifacts.

Unfortunately, the position within the skeleton is known for only three projectile points from Folsom, all of which were adjacent to ribs. Two of those points lack bases (Figgins 1927:Figures 3 and 4) and may have been detached from their hafts, and thus perhaps were invisible when butchering began. However, these two are among the largest specimens in the assemblage and certainly could have been reworked into useable points if spotted and needed (Hofman 1999a:124). That these points were not recovered may indicate that the rib units associated with these points were not processed.

Even if they were, there are circumstances under which points were visible and recoverable but were not—that is, were not lost but instead were abandoned. The latter would likely occur when groups had sufficiently abundant lithic raw material or anticipated soon refurbishing their supply. In such cases, it would not be necessary or economically worthwhile to spend the time or effort to locate spent points, or if located invest the time and cost in cleaning or reworking them for re-use and transport. In contrast, groups low on stone may have gone to considerable lengths—even if the points were not readily visible—to find broken pieces and ascertain whether they might still be serviceable. That large specimens were not recovered, therefore, may say as much (or more) about the supply of stone as about the dispersal of the carcasses (which in this instance seemingly allowed a greater recovery potential of useable stone).

In addition to the projectile points, four tools have been found at the site. Roberts (1939:534, 1940:59)

reported on two of them: a “nondescript flake knife, and . . . a generalized type of scraper.” Unfortunately, their current whereabouts are unknown and the only record we have found is a 35-mm slide. Both appear to be expedient flake tools. One is apparently made of an orange-brown, mottled chert—perhaps Black Forest silicified wood, which principally outcrops north and east of Colorado Springs (Jodry 1999a:88). The other specimen seems to be made of chert from the Hartville Uplift area of eastern Wyoming. While silicified wood is not out of place in this assemblage, Hartville Uplift chert would be; however, given the poor quality of the slide colors, and the absence of this material among the other specimens from the site, this identification of Hartville Uplift should be taken with considerable skepticism.

The other two specimens are extant: one is a large (maximum length 95.55 mm) gray quartzite specimen found eroding from the face of the north bank in November 1936 by Ele Baker. Identified as a “side-scraper,” the specimen has bifacial usewear indicative of having functioned primarily as a knife. Its rounded edges (from grinding and use), and lack of evidence for damage from hitting bone, raise the possibility this specimen was used for skinning. Such large quartzite tools are not uncommon in Folsom-age sites, given their ability to hold an edge (Frison 1991:324; Frison and Bradley 1980; Jodry 1999a:109). The other specimen is a flake tool (maximum length 27.76 mm) made of Black Forest chert, found in 1999 just downslope of the 1920s back-dirt berm. Minor edge damage from use and slight retouch is present along one edge, while a burination blow is present along the opposite edge.

None of these tools shows evidence of formal preparation and manufacture but appear to have been used without modification in an expedient manner, dulled or broken in use, and then discarded. This is in keeping with the pattern seen in other Folsom kill/initial butchering localities (e.g., Jodry 1999a). More formal, complex, and substantially modified tools tend to be characteristic of assemblages from more intensive processing or habitation localities (Amick 1999a:3–4; Jodry 1999a).

The scarcity of tools—formal or otherwise—may result from one of several factors. Hofman (1999a) argued tools ought to be rare at the Folsom site, on the assumption that the relatively dispersed carcasses and cool weather at the time of the kill permitted more thorough processing and greater recovery of

tools by the hunters. While this seems a reasonable argument, the absence (or scarcity) of tools may also be a function of the size of the excavation area, the lack of screening in the 1920s excavations, and the fact that excavations to date have been concentrated in the kill area where tools might be expected to be rare. We have not located any areas of the site (if such remain) where more intensive processing of high-utility elements and short-term habitation may have taken place.

The Folsom lithic assemblage—and particularly the projectile points—is dominated by high-quality exotic raw materials (Table 2), in keeping with patterns seen in Folsom sites elsewhere (Amick 1999b:181; Hofman et al. 1991; LeTourneau 2000). This pattern is partly related to the technological demands of point production and the distance to quality stone sources (Amick 1999b; Hofman 1991, 1999b; Hofman et al. 1991; Ingbar and Hofman 1999:100). These particular sources testify to movement of raw material on the order of several hundred kilometers (Hofman 1991:341; Hofman et al. 1991:302; LeTourneau 2000:Appendix A) and provide some hint as to the direction of movement and range of this group, which appears to have been across an area trending southeast to west/northwest. This is in keeping with the general pattern seen on the Southern High Plains and roughly mirrors the overall trend in the drainages (Hofman 1999b:387, 406). Given the dominance of stone from Texas Panhandle sources, it would appear their last gearing up (or most recent occupation) prior to arriving at Folsom took place in that area.

That said, caution is appropriate, given the possibility the stone was not procured at the well-known primary sources (outcrops), but in secondary cobble sources (in river gravel trains [Wyckoff 1993; also Kraft 1997]), or from lesser-known look-alike sources in other areas (Banks 1990), either of which would potentially skew the distances and directions noted (also Hofman 1999b:396–397). In general, however, the use of secondary sources and look-alikes in Folsom assemblages is relatively rare (LeTourneau 1998b:78). Alternatively, it is possible the stone was acquired via exchange (e.g., Hayden 1982). For a variety of reasons (Meltzer 1989), we discount this possibility in favor of the suggestion the bulk of this exotic raw material was procured directly at the source by the groups who used it (also Hofman and Todd 1996).

It is noteworthy that all of the stone used at Folsom is from sources east of the Rocky Mountains (though including the Front Range) and that it lacks Edwards Formation chert, which outcrops in a large area of central Texas. The latter is often present in Folsom assemblages of the Southern Plains (e.g., Amick 1999b; Bement 1999:75, 97, 115; Hofman 1991, 1999b:398; Stanford 1999:303).⁸ The Folsom site also has a very different complement of stone than that used in the several Folsom sites in the San Luis valley just 200 km to the west (but separated by the spine of the southern Rocky Mountains), sites which also include low levels of Alibates and Edwards in their assemblages (Jodry 1999a:86–88, 115, 128, Table 10; Jodry 1999b:75, 78; Stanford 1999:303).

In order to gain a better measure of the use lives and attrition of the kinds of raw material at the site, the assemblage of projectile points was partitioned by raw material, and metric variables were grouped by the two materials (Alibates and Tecovas) for which there were sufficient sample sizes (>5 specimens). Statistical analyses failed to demonstrate any significant difference in these attributes by raw material type. Furthermore, there was no significant statistical relationship between raw material and breakage patterns (chi-square = 5.139, $df = 6$, $p = .526$).

However, raw material patterns apparent among the tools differ from that of the projectile points (we use the term “apparent” because two of the tools could not be examined firsthand). Specifically, none of the high-quality raw materials from the Texas Panhandle was used in the production of the flake tools at the site. From this, one might suggest that artifacts from more distant (time/space) sources that had already reached the end of their effective use lives were, as the need arose, reworked and pressed into service as flake tools—along with tools made of local stone (also Amick 1999b:181). Testing this model will require examining lithic debitage, but to date that has been comprised only of microdebitage ($n = 25$), which is not especially useful in this regard.

Looking for the Folsom Camp

Finding a camp associated with the kill area at Folsom would be desirable for many reasons, not the least that such might yield important site features, such as hearths, bone piles from processing of high-utility elements, and point resharpening and retool-

ing areas, the latter possibly including more tools, flakes, and debitage (see Amick 1999a:2; Hofman 1996, 1999a:123; Hofman et al. 1990; Jodry 1999a). Such evidence would potentially provide a more representative measure of the different types and quantities of tools and raw materials brought onto the site, and how, where, and in what form they were used. It might also help to resolve the intensity of bison carcass use by showing, for example, whether bones were removed from the site as “complete limb units rather than as segmented subsets,” and where high-utility skeletal parts may have ended up (Todd 1991:224, 229). Finally, it might also give a broader picture of Folsom diets, as any smaller-bodied prey and plants are unlikely to be present in kill sites and bonebeds, though may occur in associated camp areas (O’Connell et al. 1992:341; see, for example, Davis et al. 1997).

The search for a “habitation site of the Folsom bison hunters” (A. E. Jenks to H. J. Cook, April 29, 1929, HJC/AGFO) began soon after the initial discovery of the site. Clark Wissler hired Gerhard Laves (then a graduate student at the University of Chicago) in 1928 to accompany the AMNH paleontologists to Folsom and survey the region for a Folsom-age camp (Wissler to Laves, April 17, 1928, ANTH/AMNH). Laves was unsuccessful, reporting to Wissler that local collectors (including Schwachheim) described the area as “barren” of artifacts (Laves to Wissler, July 3, 1928, ANTH/AMNH).

Our archaeological surveys and limited testing yielded no traces of any Folsom-age activities on the interfluvial area and uplands surrounding the site. Rather, they confirmed Anderson’s (1975) observation that archaeological material of any age is scarce in this area. This suggests that if a camp is to be found, it will likely be closer to the kill—areas where Paleoindian groups would have had easier access to water and ability to protect the bison carcasses from scavengers. Scale is relevant here: camps may be situated 10–70 m from kills (Fisher 1992:73; Jodry 1992; O’Connell et al. 1992). The original excavations did not extend any distance away from the kill, so an associated camp may yet be found.

Moreover, one might exist in areas that are currently archaeologically invisible, such as within the paleovalley. Were it relatively cool at the time of the kill, the group may have elected to camp within the broad, low-lying channel that would have afforded some protection from the wind. The Folsom-age sur-

face in the paleovalley, however, is now buried 4–6 m beneath the present surface. Of course, a camp either in the paleovalley or on the uplands may have eroded away. Further fieldwork will be necessary to determine if (or where) an associated camp or habitation area is to be found.

Summary Notes and Concluding Thoughts

The fieldwork conducted at the Folsom site in the 1920s was directed toward very specific goals: to recover bison skeletons for museum display and, once the site's archaeological significance became known, to document the association of the artifacts with the bison skeletons and determine the site's Pleistocene antiquity. That was done well. In the decades that followed, knowledge of Folsom Paleoindians grew considerably with the discovery of additional Folsom-age sites, yet knowledge of the type site lagged behind. The Folsom site did not tell us very much about Folsom-period adaptations, and there was some question whether it ever would, given the ostensibly exhaustive excavations that took place in 1928.

Although the areas excavated in the 1920s are now badly eroded, portions of the site still exist in both the tributary headcut area where skeletal remains are in primary context and in the paleovalley where much of the skeletal remains appear to have been reworked. Bone preservation was very good to excellent (especially in the tributary headcut), owing to a combination of factors—notably, minimal postdepositional movement; a lack of carnivore or rodent activity; rapid burial by fine-grained, predominantly aeolian sediment (stratum *f2*); a sheet-wash shale shingle (stratum *f3*) that subsequently covered and armored the bonebed; and, finally, burial by middle-to-late Holocene pond sediments, which filled the valley and diverted the channel of Wild Horse Arroyo away from the bonebed until (we infer) the 1908 flood reopened the channel.

Having parts of the bonebed in both the tributary area and the paleovalley raises the interesting but possibly unanswerable question of whether the bison were initially attacked in the channel and tried to escape via the tributary, or whether the animals were corralled in the tributary and a few tried to flee down and out the channel, or some combination thereof. In either case, it seems likely that the hunters took advantage of the natural topography, which—based on our mapping of the deep and steep valley walls—

could have readily been used to maneuver and trap the animals.

We have further established that the material recovered to date has come entirely from the kill area, which limits the archaeological window we have into the range of activities that may have taken place at this locality. There is a reasonably representative sample of faunal remains and artifacts marking the initial butchering and processing of the carcasses. The faunal assemblage is comprised largely of low-utility elements; the lithic assemblage consists of broken projectile points, a few flake tools, and tiny retouch flakes from tool use. We can only speculate from this sample about any additional activities related to the kill that may have taken place—either on site or offsite.

There is reason to suspect the group making the kill would have stayed in this area for at least a few days, the time it would take for initial butchering and processing. As yet, we have no evidence they would have stayed longer. In fact, there are reasons to hypothesize they would not. Given the elevation of the Folsom locality (~2100 m above sea level), the season of the kill (fall), and our current, preliminary knowledge of the climate and environment at the time of the Folsom occupation (cooler and possibly drier than at present), it is not likely that human foragers would have stayed for extended periods.

That said, Amick (1996) has raised the interesting hypothesis that Folsom groups may have followed bison into protected foothills and intermontane basins and wintered there. Historically, bison in some parts of their range—primarily the northern Plains—did abandon the open plains in winter in favor of areas where vegetation cover and/or topographic features provided shelter from the elements. But they did not do so every winter, and not in predictable ways (Bamforth 1988:83–84; Hanson 1984:110; Malainey et al. 2001; Moodie and Ray 1976:49–51; Morgan 1980:156; Roe 1951:194, 533). Moreover, bison may not have favored the Folsom area as a wintering locality. Physiological and anatomical studies show that bison can cope with extremely cold temperatures (down to -30°C ; see Christopherson and Hudson 1978; Christopherson et al. 1976; Telfer and Kelsall 1984). However, they can do so only as long as there are not also high winds that can disrupt the winter hide's insulating properties (Christopherson and Hudson 1978:41). Moreover, bison do not fare well in areas that receive heavy snow—as Folsom does

today. When compared on a series of morphological attributes and behavioral characteristics with other large North American ungulates, bison rank near the bottom of the list in their ability to cope with snow (Telfer and Kelsall 1984:Table 3; see also Guthrie 1990:200–202, and historical evidence detailed in Roe 1951:180–203).

Of course, we have no direct evidence whether this was an area that received heavy snow during winter in the late Pleistocene. But we do know that because of the effects of nearby Johnson Mesa on local air mass and climate (an influence that would have been present in late Pleistocene times), winter snowfall is much heavier in this area today than it is in the surrounding region. A priori, then, we hypothesize this would not have been an area suitable for bison to over-winter.

In the absence of bison, human foragers intent on staying in the area for an extended period would have to rely on other animals and plants. In regard to the latter, we would again observe that edible plants, and particularly ones that provide a significant return in fatty acids or carbohydrates during the critical winter and spring months, are presently rare in this region. If plant foods exploitable by humans were also rare in Folsom times, it suggests Paleoindians would not have had sufficient food resources to linger beyond the period necessary to prepare the meat from their kill—let alone winter over in the area.

There is evidence of only a single kill at this locality, made by groups whose range (based on their stone sources) extended from the panhandle of Texas into the plains of northeastern Colorado. It is perhaps not irrelevant to observe that traveling up any one of several rivers and streams out of the panhandle (such as the Canadian and its tributaries or the Dry Cimarron) would have brought groups into the general vicinity of the Folsom site (major river courses, in addition to possibly serving as corridors of travel, may—along with other distinctive topographic features—have served as boundaries of traditional areas of exploitation, based on raw material use patterns [Stanford 1999:303]). This is not to say that following these drainages would inevitably deposit foragers at the Folsom site. Rather, unlike Paleoindian sites that occur, for example, at springs or small lake basins on the High Plains where there are no obvious topographic features to guide movement across the landscape (but

which, of course, may have had long-vanished game trails pointing arrow-like toward them), coming to or through the Folsom area need not (and may not) have been a random movement with respect to topography (as it could be on the featureless and open plains).

Indeed, there are only a few places where Paleoindian groups following those regional drainages would have been able easily to traverse the mountainous and broken terrain and high mesas that extend from the eastern flank of the Sangre de Cristo Mountains across a 200-km stretch of the border between Colorado and New Mexico. While hardly an obstacle on the scale of the Rocky Mountains, this was a barrier to easy north-south movement, and historically much of the movement of animals and people through the area was channeled through one of several passes, including Trinchera Pass. This saddle between Johnson and Kelleher Mesas is just 8 km north of the Folsom site. Of course, the speculation that the Paleoindian group that made the kill at Folsom may have been headed toward Trinchera Pass, and encountered and killed a herd of bison in Wild Horse Arroyo en route, will likely remain safely untestable.

Finally, unlike, for example, the San Luis Valley to the west (Jodry 1999a), the Folsom area does not show repeated use by Paleoindian groups—or, for that matter, by later groups (Anderson 1975). Why that should be so is not altogether clear, since the area is well watered and presents abundant game resources (at least today and, judging by the scanty archaeological record, in the past as well). Further clues to the local environment of the late Pleistocene may help resolve this matter and test the hypothesis that plant foods were simply not sufficient to support repeated or prolonged occupations.

We now have a clearer view of the Folsom site: its extent, history, bison bonebed, stone-tool assemblage, and geology. While each of these contributes to the basic inventory of data on the Folsom period, none approaches the significance of the basic question answered by the 1926–1928 excavations. Why is that? At this point it would be easy to use the shopworn (but legitimate) excuse that the “best parts of the site” were removed by the previous generation. As with most easy answers, this one would probably not be the most useful or interesting, and we suggest that a more relevant and productive conclusion may be that few of the contemporary central ques-

tions about Folsom archaeology can be answered from any individual site or assemblage.

Today's concerns with the ecological interactions of humans, bison, and other components of their physical and social environment will never be solved through a site-based archaeological discovery, no matter how spectacular. We definitely see the need for additional site-based investigations and re-investigations, but also are well aware that seeking solutions to questions about Folsom, or any other archaeological culture, requires us to tackle the difficult problems of scaling-up from sites to landscapes to regions. Having better information from Folsom, or any other of the landmark sites obviously has important, substantive implications. But the most exciting and challenging aspects of research questions current three-quarters of a century after the initial excavations in Wild Horse Arroyo require a more broadly focused perspective. Whether the Folsom site was used by peoples traveling toward Trinchera Pass may not be directly testable, nor may we ever be able to say how long the group remained near the kill, but our failure to answer such site-specific questions may be of less importance than the other sorts of research domains that can be addressed with the ongoing and future integrative regional studies (e.g., Holliday 1997). In isolation, no site will ever produce answers to today's questions.

That notwithstanding, there is much that can be learned from this re-investigation of the Folsom site, and our analysis continues. In the end, and despite the limitation of having to rely on materials excavated in another era for other purposes, the type site can ultimately shed new light on the cultural period that it named. The active, in-field collaboration of archaeologists, vertebrate paleontologists, and geologists in the original excavations at Folsom helped to make this site one of the hallmarks of North American archaeology. Even though the scale of questions has changed, the interdisciplinary focus initiated for this type site of Paleoindian studies continues to provide the most likely avenue for yielding interesting answers. The relevance of our site-scale work at Folsom will come from having a much better understanding of the site with which to examine, re-evaluate, and refine existing regional-scale models of Folsom-period adaptation.

Acknowledgments. Work at the Folsom site was conducted under Archaeological Excavation Easement permits from the State of New Mexico to DJM (Permit Reference numbers AE-74 [1997]; AE-78 [1998], and AE-83 [1999]). For their help with the permit process, and discussions about the site and its preservation, we thank David Eck, Daniel Reilley, and Norman Nelson. Our fieldwork could not have been accomplished without the gracious hospitality and support of Leo and Wende Quintanilla, Fred and Jane Owensby, and Stuart and Sue Owensby. Additional local help was provided by Willard and Richard Loudon, who freely gave of their knowledge of the site and the history of archaeological work here and in the region. Tom Burch and Emily Burch Hughes generously shared the diary and photographs of their uncle, Carl Schwachheim.

Folsom-site material is scattered in various museums, and we are indebted to the many curators who have made access to that material possible. These include, at the American Museum of Natural History, David H. Thomas and Lori Pendleton (Anthropology), and Mark A. Norell and John Alexander (Vertebrate Paleontology); at Capulin Volcano National Monument, Abbie Reaves and Margaret Johnston; at the Denver Museum of Science, Ryntha Johnson and James Dixon (Anthropology) and Russell W. Graham and Logan Ivy (Paleontology); at the Loudon-Henrickson Museum, Loretta Martin; and, at the University of Pennsylvania Museum, Lucy Williams. We also would like to thank Tony Baker, Darien Brown, and Boyd Burchard for allowing us to examine material in their care from the site, as well as Fred Wendorf for providing the only known picture of the missing Folsom flake tools.

The fieldwork has involved many crew members over the several years, and while too numerous to mention we would be remiss in not specifically acknowledging the long hours, expertise, and efforts of Rusty Greaves and Jason M. LaBelle; Jemuel Ripley was the field assistant for all the stratigraphic work. We have also benefited from the aid of several colleagues who joined us at the site and offered help and advice, including Stephen Durand, Grant Hall, C. Vance Haynes, Bruce and Lisa Huckell, Bonnie Jacobs, Robert Kelly, and Richard Reanier. We are especially grateful to Haynes for graciously sharing his firsthand knowledge of the site, not to mention his fieldnotes and photographs. VTH and DJM would like to thank Adrienne Anderson for introducing us to the site.

Meena Balakrishnan, Todd Surovell, and Crayton Yapp provided important data and information on the site chemistry. Jim Theler analyzed the gastropod samples. Roger Phillips, Doug Weins, and Patrick Shore arranged and oversaw the seismic and resistivity surveys on the site. Donald Grayson, Jack Hofman, and Phil LeTourneau provided valuable advice on archaeological and zooarchaeological matters.

Very useful comments on a draft of this paper were provided by A. Anderson, P. LeTourneau, Diane Young Holliday, and an anonymous reviewer. Elizabeth Pintar provided a Spanish translation of the abstract.

The work at the site was supported by the Quest Archaeological Research Fund, and by the Potts and Sibley Foundation, and for that we are most grateful (respectively) to Joseph L. and Ruth Cramer, and Robert Bechtel.

References Cited

- Agogino, G.
1971 The McJunkin Controversy. *New Mexico* 49:41–47.
1985 The Amateur Involvement in the Discovery of the Folsom Type Site. *The Chesapeakean* 23:2–4.
- Allen, B.
1959 A Mineralogical Study of Soils Developed on Tertiary and Recent Lava Flows in Northeastern New Mexico. Unpublished Ph.D. dissertation, Michigan State University, East Lansing, Michigan.
- Amick, D. S.
1995 Patterns of Technological Variation Among Folsom and Midland Projectile Points in the American Southwest. *Plains Anthropologist* 40:23–38.
1996 Regional Patterns of Folsom Mobility and Land Use in the American Southwest. *World Archaeology* 27:411–426.
1999a New Approaches to Understanding Folsom Lithic Technology. In *Folsom Lithic Technology: Explorations in Structure and Variation*, edited by D. S. Amick, pp. 1–11. International Monographs in Prehistory, Archaeological Series 12. Ann Arbor, Michigan.
1999b Raw Material Variation in Folsom Stone Tool Assemblages and the Division of Labor in Hunter-Gatherer Societies. In *Folsom Lithic Technology: Explorations in Structure and Variation*, edited by D. S. Amick, pp. 169–187. International Monographs in Prehistory, Archaeological Series 12. Ann Arbor, Michigan.
- Anderson, A. B.
1975 “Least Cost” Strategy and Limited Activity Site Location, Upper Dry Cimarron River Valley, Northeastern New Mexico. Unpublished Ph.D. dissertation, Department of Anthropology, University of Colorado, Boulder.
- Anderson, A. B., and C. V. Haynes
1979 How Old Is Capulin Mountain? Correlation between Capulin Mountain Volcanic Flows and the Folsom Type Site, Northeastern New Mexico. In *Proceedings of the First Conference on Scientific Research in the National Parks, Volume II*, edited by R. Linn, pp. 893–898. U.S. Department of the Interior, NPS Transactions and Proceedings, No. 5. Government Printing Office, Washington, D.C.
- Arnold, J., and W. Libby
1950 *Radiocarbon Dates (September 1, 1950)*. Institute for Nuclear Studies, The University of Chicago.
- Baldwin, B., and W. R. Muehlberger
1959 *Geologic Studies of Union County, New Mexico*. State Bureau of Mines and Mineral Resources, Bulletin 63. New Mexico Institute of Mining and Technology, Socorro.
- Bamforth, D.
1988 *Ecology and Human Organization on the Great Plains*. Plenum Press, New York.
- Banks, L.
1990 *From Mountain Peaks to Alligator Stomachs: A Review of Lithic Sources in the Trans-Mississippi South, the Southern Plains, and Adjacent Southwest*. Oklahoma Anthropological Society, Memoir 4.
- Bartram, L.
1993 Perspectives on Skeletal Part Profiles and Utility Curves from Eastern Kalahari Ethnoarchaeology. In *From Bones to Behavior*, edited by J. Hudson, pp. 115–137. Southern Illinois University Press, Carbondale.
- Bement, L.
1999 *Bison Hunting at Cooper site*. University of Oklahoma Press, Norman.
- Berger, J. B., and C. Cunningham
1994 *Bison: Mating and Conservation in Small Populations*. Columbia University Press, New York.
- Binford, L. R.
2001 *Constructing Frames of Reference: An Analytical Method for Archaeological Theory Building Using Ethnographic and Environmental Data Sets*. University of California Press, Berkeley.
- Brown, B.
1928 The Folsom Culture. Paper presented at the 23rd International Congress of Americanists, New York.
1929 Folsom Culture and Its Age. *Geological Society of America Bulletin* 40:128–129.
1936 The Folsom Culture—An Occurrence of Prehistoric Man with Extinct Animals Near Folsom, New Mexico. *Report of the XVI Session, United States of America, 1933, International Geological Congress, Volume 2*:813.
- Bryan, K.
1929 Discussion of “Folsom Culture and Its Age,” by B. Brown. *Geological Society of America Bulletin* 40:128–129.
1937 Geology of the Folsom Deposits in New Mexico and Colorado. In *Early Man*, edited by G. G. MacCurdy, pp. 139–152. Lippincott, Philadelphia.
- Christopherson, R. J., and R. J. Hudson
1978 Effects of Temperature and Wind on Cattle and Bison. *Annual Feeder's Day Report* 57:40–41.
- Christopherson, R. J., R. J. Hudson, and R. J. Richmond
1976 Feed Intake, Metabolism and Thermal Insulation of Bison, Yak, Scottish Highland and Hereford Calves During Winter. *Annual Feeder's Day Report* 55:51–52.
- Collins, R. F.
1949 Volcanic Rocks of Northeastern New Mexico. *Geological Society of America Bulletin* 60:1017–1040.
- Cook, H. J.
1927 New Geological and Paleontological Evidence Bearing on the Antiquity of Mankind in America. *Natural History* 27:240–247.
1928 Glacial Age Man in New Mexico. *Scientific American* 139:38–40.
1947 Some Background Data on the Original “Folsom Quarry” Site: and of Those Connected with Its Discovery and Development. Manuscript on file, Agate Fossil Beds National Monument, Scottsbluff, Nebraska.
- Davis, L., M. Baumler, K. Bovy, M. Cannon, and D. K. Grayson
1997 Folsom Resource Use and Disposal Behavior, Indian Creek, Montana. *Current Research in the Pleistocene* 14:18–20.
- Dixon, E. J., and R. Marlar
1997 A New Discovery at the Folsom Type Site. *Plains Anthropologist* 42:371–374.
- Eerkens, J. W., and R. Bettinger
2001 Techniques for Assessing Standardization in Artifact Assemblages: Can We Scale Material Variability? *American Antiquity* 66:493–504.
- Emerson, A.
1993 The Role of Body Part Utility in Small-Scale Hunting Under Two Strategies of Carcass Recovery. In *From Bones to Behavior*, edited by J. Hudson, pp. 138–155. Southern Illinois University Press, Carbondale.
- Ewers, J.
1955 *The Horse in Blackfoot Indian Culture: with Comparative Material from Other Western Tribes*. Bureau of American Ethnology, Bulletin 159.
- Figgins, J.
1927 The Antiquity of Man in America. *Natural History* 27:229–239.
1928 How Long has Man Hunted? The Light Fossils Shed on the Question. *Outdoor Life* 61:18–19, 82.

- 1929 Report of the Director. *Annual Report of the Colorado Museum of Natural History for 1928*:9–19.
- 1933 The Bison of the Western Area of the Mississippi Basin. *Proceedings of the Colorado Museum of Natural History* 12(4).
- 1934 Folsom and Yuma Artifacts. *Proceedings of the Colorado Museum of Natural History* 13(2).
- Findley, J., A. Harris, D. Wilson, and C. Jones
1975 *Mammals of New Mexico*. University of New Mexico Press, Albuquerque.
- Fiorillo, A. R.
1989 An Experimental Study of Trampling: Implications for the Fossil Record. In *Bone Modification*, edited by R. Bonnichsen and M. Sorg, pp. 61–72. Center for the Study of the First Americans, Orono, Maine.
- Fisher, J.
1992 Observations on the Late Pleistocene Bone Assemblage from the Lamb Spring Site, Colorado. In *Ice Age Hunters of the Rockies*, edited by D. J. Stanford and J. S. Day, pp. 51–81. University Press of Colorado, Niwot.
- Fitzgerald, J., C. Meany, and D. Armstrong
1994 *Mammals of Colorado*. Denver Museum of Natural History and University Press of Colorado, Denver.
- Folsom, F.
1992 *Black Cowboy: The Life and Legend of George McJunkin*. Roberts Rinehart Publishers, Niwot, Colorado.
- Frison, G. C.
1982 Paleo-Indian Winter Subsistence Strategies on the High Plains. In *Plains Indian Studies: A Collection of Essays in Honor of John C. Ewers and Waldo R. Wedel*, edited by D. H. Ubelaker and H. J. Viola, pp. 193–201. Smithsonian Contributions to Anthropology No. 30, Smithsonian Institution, Washington, D.C.
- 1991 *Prehistoric Hunters of the High Plains*. 2nd ed. Academic Press, New York.
- Frison, G. C., and B. Bradley
1980 *The Hanson Site*. University of New Mexico Press, Albuquerque.
- Frison, G. C., and D. J. Stanford (editors)
1982 *The Agate Basin Site*. Academic Press, New York.
- Goldberg, P., and T. Arpin
2000 Micromorphological Study of Selected Samples from the Folsom Site. Manuscript on file, Department of Anthropology, Southern Methodist University.
- Guthrie, R. D.
1990 *Frozen Fauna of the Mammoth Steppe*. University of Chicago Press, Chicago.
- Hanson, J.
1984 Bison Ecology in the Northern Plains and a Reconstruction of Bison Patterns for the North Dakota Region. *Plains Anthropologist* 29:93–113.
- Hay, O. and H. J. Cook
1928 Preliminary Descriptions of Fossil Mammals Recently Discovered in Oklahoma, Texas and New Mexico. *Proceedings of the Colorado Museum Natural History* 8:33.
- 1930 Fossil Vertebrates Collected Near, or in Association with, Human Artifacts at Localities Near Colorado, Texas; Frederick, Oklahoma; and Folsom, New Mexico. *Proceedings of the Colorado Museum Natural History* 9:4–40.
- Hayden, B.
1982 Interaction Parameters and the Demise of Paleoindian Craftsmanship. *Plains Anthropologist* 27:109–123.
- Haynes, C. V., R. Beukens, A. T. Jull, and O. K. Davis
1992 New Radiocarbon Dates for Some Old Folsom Sites: Accelerator Technology. In *Ice Age Hunters of the Rockies*, edited by D. J. Stanford and J. S. Day, pp. 83–100. University Press of Colorado, Niwot.
- Hewett, J.
1971 The Bookish Black at Wild Horse Arroyo. How the Folsom Man Came to Light: *New Mexico* 49:20–24.
- Hill, M. E., and J. Hofman
1997 The Waugh Site: A Folsom-Age Bison Bonebed in Northwestern Oklahoma. *Plains Anthropologist, Memoir* 29:63–83.
- Hillerman, T.
1971 Or: How Folsom was Saved to History. *New Mexico* 49:25–27.
- Hofman, J.
1991 Folsom Land Use: Projectile Point Variability as a Key to Mobility. In *Raw Material Economies among Prehistoric Hunter-Gatherers*, edited by A. Montet-White and S. Holen, pp. 335–355. University of Kansas, Publications in Anthropology 19, Lawrence.
- 1992 Recognition and Interpretation of Folsom Technological Variability on the Southern Plains. In *Ice Age Hunters of the Rockies*, edited by D. J. Stanford and J. S. Day, pp. 193–224. University Press of Colorado, Niwot.
- 1996 Early Hunter-gatherers of the Central Great Plains: Paleoindian and Mesoindian (Archaic) Cultures. In *Archaeology and Paleocology of the Central Great Plains*, edited by J. Hofman, pp. 41–100. Arkansas Archaeological Survey Research Series, No. 48, Fayetteville.
- 1999a Folsom Fragments, Site Types, and Assemblage Formation. In *Folsom Lithic Technology: Explorations in Structure and Variation*, edited by D. S. Amick, pp. 122–143. International Monographs in Prehistory, Archaeological Series 12. Ann Arbor, Michigan.
- 1999b Unbounded Hunters: Folsom Bison Hunting on the Southern Plains, circa 10500 BP, the Lithic Evidence. In *Le Bison: Gibier et Moyen de Subsistance des Hommes du Paléolithique aux Paléoindiens des Grandes Plaines*, edited by J. Jaubert, J. Brugal, F. David, and J. Enloe, pp. 383–415. Editions APDCA, Antibes, France.
- Hofman, J. L., and L. C. Todd
1996 Plains Paleoindian Hunters and Bison Paleocology. Paper presented at the 23rd Alaska Anthropological Association Annual Meeting, Fairbanks, Alaska.
- Hofman, J., D. Amick, and R. Rose
1990 Shifting Sands: A Folsom-Midland Assemblage from a Campsite in Western Texas. *Plains Anthropologist* 35:221–253.
- Hofman, J., L. C. Todd, and M. B. Collins
1991 Identification of Central Texas Edwards Chert at the Folsom and Lindenmeier Sites. *Plains Anthropologist* 36:297–308.
- Holliday, V. T.
1997 *Paleoindian Geoarchaeology of the Southern High Plains*. University of Texas Press, Austin.
- Howard, E. B.
1935 Evidence of Early Man in North America. *The Museum Journal* 24(2–3).
- 1943 The Finley Site: Discovery of Yuma Points, in situ, near Eden, Wyoming. *American Antiquity* 8:224–234.
- Huckell, L.
1998 Appendix D in “Testing for additional Folsom-age components at the Folsom type site (29CX1), New Mexico. Report on archaeological fieldwork conducted under State of New Mexico Permit Number AE-74,” by D. J. Meltzer. Report on file, Office of Cultural Affairs, State of New Mexico, Santa Fe.
- Hunt, A., S. Lucas, and B. Kues
1987 Third-Day Road Log, from Clayton to Des Moines, Capulin, Capulin Mountain National Monument, Folsom, Raton and the Cretaceous/Tertiary boundary on Goat Hill.

- In *Northeastern New Mexico*, edited by S. Lucas and A. Hunt, pp. 41–54. New Mexico Geological Society Guidebook, 38th Annual Field Conference. New Mexico Geological Society.
- Ingbar, E., and J. L. Hofman
1999 Folsom Fluting Fallacies. In *Folsom Lithic Technology: Explorations in Structure and Variation*, edited by D. S. Amick, pp. 98–110. International Monographs in Prehistory, Archaeological Series 12. Ann Arbor, Michigan.
- Jodry, M.
1992 Fitting Together Folsom: Refitted Lithics and Site Formation Processes at Stewart's Cattle Guard Site. In *Piecing Together the Past: Applications of Refitting Studies in Archaeology*, edited by J. Hofman and J. Enloe, pp. 179–209. BAR International Series 578, Oxford.
1999a Folsom Technological and Socioeconomic Strategies: Views from Stewart's Cattle Guard and the Upper Rio Grande Basin, Colorado. Unpublished Ph.D. dissertation, Department of Anthropology, American University, Washington, D.C.
1999b Paleoindian Stage. In *Colorado Prehistory: a Context for the Rio Grande Basin*, by M. Martorano, T. Hoefler, M. Jodry, V. Spero, and M. Taylor, pp. 45–114. Colorado Council of Professional Archaeologists, Golden.
- Jodry, M., and D. Stanford
1992 Stewart's Cattle Guard site: An Analysis of Bison Remains in a Folsom Kill-Butchery Campsite. In *Ice Age Hunters of the Rockies*, edited by D. J. Stanford and J. S. Day, pp. 101–168. University Press of Colorado, Niwot.
- Judge, W. J.
1973 *Paleoindian Occupation of the Central Rio Grande Valley*. University of New Mexico Press, Albuquerque.
- Kidder, A. V.
1936 Speculations on New World Prehistory. In *Essays in Anthropology*, edited by R. Lowie, pp. 143–151. University of California Press, Berkeley.
- Kraft, K. C.
1997 The Distribution of Alibates Silicified Dolomite Clasts along the Canadian River. *Current Research in the Pleistocene* 14:106–109.
- Kreutzer, L.
1992 Bison and Deer Bone Mineral Densities: Comparisons and Implications for the Interpretation of Archaeological Faunas. *Journal of Archaeological Science* 19:271–294.
- LeTourneau, P.
1998a The 'Folsom Problem.' In *Unit Issues in Archaeology: Measuring Time, Space, and Material*, edited by A. Ramenofsky and A. Steffen, pp. 52–73. University of Utah Press, Salt Lake City.
1998b Folsom Use of Eastern New Mexico Look-Alike Cherts on the Llano Estacado. *Current Research in the Pleistocene* 15:77–79.
2000 Folsom Toolstone Procurement in the Southwest and Southern Plains. Unpublished Ph.D. dissertation, Department of Anthropology, University of New Mexico, Albuquerque.
- Little, C.
1947 The Folsom Man in Colorado. *Rocky Mountain Empire Magazine*. 2 February: 3–4. Denver, Colorado.
- Lyman, R. L.
1985 Bone Frequencies: Differential Transport, in situ Destruction, and the MGUI. *Journal of Archaeological Science* 12:221–236.
1994 *Vertebrate Taphonomy*. Cambridge University Press, Cambridge.
- MacDonald, J. N.
1981 *North American Bison: Their Classification and Evolution*. University of California Press, Berkeley.
- Malainey, M., R. Przybylski, and B. Sheriff
2001 One Person's Food: How and Why Fish Avoidance May Affect the Settlement and Subsistence Patterns of Hunter-Gatherers. *American Antiquity* 66:141–161.
- Meltzer, D. J.
1983 The Antiquity of Man and the Development of American Archaeology. In *Advances in Archaeological Method and Theory*, vol. 6, edited by M.B. Schiffer, pp. 1–51. Academic Press, New York.
1989 Was Stone Exchanged among Eastern North American Paleoindians? In *Eastern Paleo-indian Lithic Resource Procurement and Processing*, edited by C. Ellis and J. Lothrop, pp. 11–39. Westview Press, Boulder.
1991 Status and Ranking at Folsom. Paper presented at the 56th Annual Meeting of the Society for American Archaeology, New Orleans, Louisiana.
1993 *Search for the First Americans*. Smithsonian Books, Washington, D.C.
1994 The Discovery of Deep Time: A History of Views on the Peopling of the Americas. In *Method and Theory for Investigating the Peopling of the Americas*, edited by R. Bonnichsen and D. G. Steele, pp. 7–26. Center for the Study of the First Americans, Corvallis, Oregon.
1998 Testing for Additional Folsom-Age Components at the Folsom Type Site (29CX1), New Mexico. Report on Archaeological Fieldwork Conducted under State of New Mexico Permit Number AE-74. Report on file, Office of Cultural Affairs, State of New Mexico, Santa Fe.
2000 Renewed Investigations at the Folsom Paleoindian Type Site. *Antiquity* 74:35–36
- Moodie, D. W., and A. J. Ray
1976 Buffalo Migrations in the Canadian Plains. *Plains Anthropologist* 21:45–52.
- Morgan, R. G.
1980 Bison Movement Patterns on the Canadian Plains: An Ecological Analysis. *Plains Anthropologist* 25:143–160.
- Murtaugh, W. J.
1976 *The National Register of Historic Places*. U.S. Department of the Interior, National Park Service, Washington, D.C.
- O'Connell, J. F., K. Hawkes, N. G. Blurton-Jones
1992 Patterns in the Distribution, Site Structure and Assemblage Composition of Hadza Kill-butcher Sites. *Journal of Archaeological Science* 19:319–345.
- Owen, T.
1951 Tom Owen Describes Men Who First Uncovered Bones of Folsom Bison. *The Raton Daily Range*, 28 June. Raton, New Mexico.
- Preston, D.
1997 Fossils and the Folsom Cowboy. *Natural History* 106:16–22.
- Reed, E. K.
1940 Archaeological Site Report on Folsom, New Mexico (Theme I: Early Man). Manuscript prepared for the Historic Sites Survey, Region III, National Park Service. Santa Fe, New Mexico.
- Roberts, F.
1935 A Folsom Complex: Preliminary Report on Investigations at the Lindenmeier Site in Northern Colorado. *Smithsonian Miscellaneous Collections* 94(4).
1936 Additional Information on the Folsom Complex: Report on the Second Season's Investigations at the Lindenmeier Site in Northern Colorado. *Smithsonian Miscellaneous Collections* 95(10).
1939 The Folsom Problem in American Archaeology. *Smithsonian Institution Annual Report for 1938*:531–546.

- 1940 Developments in the Problem of the North American Paleo-Indian. *Smithsonian Miscellaneous Collections* 100:51–116.
- 1951 Radiocarbon Dates and Early Man. In *Radiocarbon Dating*, assembled by F. Johnson, pp. 20–22. *American Antiquity, Memoir 7*.
- Roe, F. G.
1951 *The North American Buffalo: A Critical Study of the Species in Its Wild State*. University of Toronto Press, Toronto.
- Rogers, A.
2000 On Equifinality in Faunal Assemblages. *American Antiquity* 65:709–723.
- Scott, G., and C. Pillmore
1993 *Geologic and Structure-Contour Map of the Raton 30' x 60' Quadrangle, Colfax and Union Counties, New Mexico, and Las Animas County, Colorado*. U.S. Geological Survey, Miscellaneous Investigations Series, Map I-2266.
- Siegel, S.
1956 *Nonparametric Statistics*. McGraw-Hill Book Company, New York.
- Speth, J.
1983 *Bison Kills and Bone Counts: Decision Making by Ancient Hunters*. University of Chicago Press, Chicago.
- Speth, J., and K. Spielmann
1983 Energy Source, Protein Metabolism, and Hunter-Gatherer Subsistence Strategies. *Journal of Anthropological Archaeology* 2:1–31.
- Stanford, D.
1999 Paleoindian Archaeology and Late Pleistocene Environments in the Plains and Southwestern United States. In *Ice Age Peoples of North America*, edited by R. Bonnichsen and K. Turnmire, pp. 281–339. Center for the Study of the First Americans, Corvallis, Oregon.
- Steen, C.
1955 *Prehistoric Man in the Arkansas-White-Red River Basins*. National Park Service, Washington, D.C.
- Telfer, E. S., and J. P. Kelsall
1984 Adaptation of Some Large North American Mammals for Survival in Snow. *Ecology* 65:1828–1834.
- Thompson, F.
1967 Folsom Find Claimed by Canadian Cowboy. *The Raton Daily Range*, 11 November:1, 4. Raton, New Mexico.
- Todd, L.
1991 Seasonality Studies and Paleoindian Subsistence Strategies. In *Human Predators and Prey Mortality*, edited by M. Stiner, pp. 217–238. Westview Press, Boulder.
- Todd, L., and J. Hofman
1991 Variation in Folsom Age Bison Assemblages: Implications for the Interpretation of Human Action. Paper presented at the 56th Annual Meeting of the Society for American Archaeology, New Orleans, Louisiana.
- Todd, L., D. Rapson, and J. L. Hofman
1996 Dentition Studies of the Mill Iron and other Early Paleoindian Bison Bonebed Sites. In *The Mill Iron Site*, edited by G. C. Frison, pp. 145–175. University of New Mexico Press, Albuquerque.
- Todd, L., R. Witter, and G. C. Frison
1987 Excavation and Documentation of the Princeton and Smithsonian Horner Site Assemblages. In *The Horner Site: The Type Site of the Cody Cultural Complex*, edited by G. C. Frison and L. C. Todd, pp. 39–91. Academic Press, New York.
- Todd, L. C., M. G. Hill, D. J. Rapson, and G. C. Frison
1997 Cutmarks, Impacts, and Carnivores at the Casper Site Bison Bonebed. In *Proceedings of the 1993 Bone Modification Conference Hot Springs, South Dakota*, edited by L. A. Hannus, L. Rossum, and R. P. Winham, pp. 136–157. Archaeology Laboratory Augustana College, Occasional Publication No. 1. Sioux Falls, South Dakota.
- Wheat, J. B.
1972 The Olsen-Chubbuck Site: A Paleo-Indian Bison Kill. *American Antiquity, Memoir 26*.
- Wilmsen, E. N., and F. H. H. Roberts
1978 *Lindenmeier, 1934–1974: Concluding Report of Investigations*. Smithsonian Contributions to Anthropology, Number 24. Washington, D.C.
- Wissler, C.
1910 *Material Culture of the Blackfoot Indians*. American Museum of Natural History, Anthropological Papers 5(1).
- Wormington, H. M.
1939 *Ancient Man in North America*. 1st ed. Colorado Museum of Natural History, Denver.
1957 *Ancient Man in North America*. 4th ed. Denver Museum of Natural History, Denver.
- Wyckoff, D.
1993 Gravel Sources of Knappable Alibates Silicified Dolomite. *Geoarchaeology* 8:35–58.

Notes

1. Immediately above the site, the channel is extremely narrow (~.5 m wide) with nearly vertical walls that follow a joint plane in the Smoky Hill Shale, all of which indicates little elapsed time of erosion. Moreover, water passing through that constriction in the channel would have emerged on the downstream end with considerable force (owing to the Bernoulli Effect). That the site is just downstream of that constriction, and yet was still largely intact at the beginning of excavations in 1926, suggests that the channel had not by then been in its present position long enough to cause substantial erosion—hence, the suspicion that it might first have been incised following the 1908 flood.

2. The Colorado Museum of Natural History was known by that name during the 1926–1927 work at Folsom. It later (the late 1940s) became the Denver Museum of Natural History, and more recently, the Denver Museum of Nature and Science. For historical accuracy and to avoid confusion, we will refer to the 1926–1927 fieldwork, results, and collections by the original name of the institution (or the acronym CMNH), though of course all such material is housed at what is now the Denver Museum of Nature and Science.

3. Archival sources consulted in the research are cited in this paper using the following acronyms: AHC/UWY—Harold J. Cook Papers, American Heritage Center, University of Wyoming, Laramie, Wyoming. ANTH/AMNH—Department of Anthropology Archives, American Museum of Natural History, New York, New York. DIR/CMNH—Papers of the Director, Colorado Museum of Natural History; Denver Museum of Nature and Science, Denver, Colorado.

EHB/NSM—Erwin Barbour Papers, Nebraska State Museum, University of Nebraska, Lincoln.

HJC/AGFO—Harold J. Cook Papers, Agate Fossil Beds National Monument, Gering, Nebraska.

VP/AMNH—Vertebrate Paleontology Archives, American Museum of Natural History, New York, New York.

4. At the Denver Museum, the Folsom faunal collection includes remains from 16 species in addition to bison; some

of those elements clearly are out of place in this site and collection (e.g., *Equus*). From this and other evidence we suspect that material from different sites has become mixed together and ended up in the Folsom drawers at the museum. Brown (1928) makes reference to non-bison species being found at Folsom, but whether he was referring to material found in 1926–1927, or during his excavations in 1928, is unclear. A query of the AMNH Collections database yielded no mammals other than bison from the Folsom site itself.

5. In July 1933, Cook collected charcoal hoping to obtain a dendrochronological age—radiocarbon dating, of course, not having been invented in 1933. Soon after the technique was invented, Cook submitted the sample to Willard Libby, explaining it came from “below the Folsom bison and artifact level, in the arroyo of the type site of that cultural group . . . just a little below, and downstream from the horizon in which the bones occurred” (Cook, in Arnold and Libby 1950:10). Using the original solid carbon method, two ages were obtained on the sample: 4575 ± 300 and 3923 ± 400 , which were averaged to 4283 ± 250 (C-377). Arnold and Libby (1950:10) observed the age was “surprisingly young,” and it apparently “caused considerable comment” when it was released (Roberts 1951:20). Cook then corrected the sample provenience, noting it came from a side arroyo “some hundred feet, plus or minus, to the westward” of the bonebed (in Roberts 1951:20). Based on his descriptions of the strati-

graphic context from which the charcoal was obtained, this age matches well with more recently obtained dates from what appears to be the same stratum. Obviously, however, the date has no bearing on the Paleoindian occupation.

6. The tributary entered from the south/southwest, and joined the paleovalley at approximately the present position of the 1926–1928 excavations. Knickpoints are common at the upper end of tributaries that drain into Wild Horse Arroyo today, and the Pleistocene tributary may have been similarly constricted at its upper end. At the lower end, where the tributary joined the paleovalley, it was ~35–40 m across.

7. The bedrock in the site was identified as Pierre Shale originally (Brown 1928). However, detailed geologic maps show that the closest Pierre Shale occurs on the west side of Johnson Mesa, some 50 km distant, and the geological descriptions of the Smoky Hill Shale match more closely the material observed at the site (Scott and Pillmore 1993).

8. Hofman et al. (1991) identify Edwards chert in the Folsom assemblage (specifically, Denver Museum specimen number 1262/1A), but for several reasons LeTourneau (2000:341) believes the specimen in question is made of Flattop chert from northeast Colorado. We follow LeTourneau in this matter.

*Received February 27, 2001; Revised September 5, 2001;
Accepted September 11, 2001.*