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# PALEO-INDIANS IN THE SAN JUAN BASIN: A PALEONTOLOGICAL PERSPECTIVE

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**Abstract**—A large gap exists in our knowledge of the Pleistocene and Holocene cultural and faunal record in the San Juan Basin. Information concerning the activities of Paleo-Indians in the basin is often based on inference from other areas. Evidence found elsewhere suggests that they exploited large migratory herds of now extinct megafauna (e.g., mammoth, horse, bison and camel). Additionally, the paleontological record of the Pleistocene and Holocene is virtually nonexistent. Some evidence suggests that mammoth, horse, elk, bighorn sheep, pronghorn antelope and muskox were the major herbivores present in the basin during this period. The physiographic and environmental nature of the basin allowed access and exploitation of the forage resources to these animals and apparently restricted access to bison. Traditional thinking about the lifeways of the Paleo-Indians that lived in the basin should be re-examined and founded on different research methodology before we can fully understand the story of these early human migrants and their relationship to the environment. Interdisciplinary and interagency cooperation is a critical factor in developing a basis for our understanding of past life in the San Juan Basin.

## INTRODUCTION

From recent prehistory to the present, the North American Southwest has been united by its dry climate, with water being the most critical resource for its people. This region has been described as extending from Durango, Mexico to Durango, Colorado, and from Las Vegas, New Mexico, to Las Vegas, Nevada (Cordell, 1984). Yet, despite the temperature extremes and aridity, the prehistoric people of the area developed a way of life dependent on native cultigens. It is this agricultural adaptation that defined the prehistoric Southwest as a cultural area. Cordell (1984) gave an excellent background and overview of the previous research in this region.

It is from this setting that we travel backward in time to the San Juan Basin in northwestern New Mexico, during the late Pleistocene and early Holocene, between about 20,000 and 8000 years ago. This marked a period when the climate was a little more equable, with more moisture and a more diverse vegetative regime; a period when the culture was defined by a highly mobile subsistence strategy dependent on the availability of wild plant foods and game animals, particularly a large, extinct megafauna with mammoth, horse, camel and bison, and the sophisticated hunting and utility tools used for killing, butchering and processing game for food and hides.

The San Juan Basin contains archaeological evidence of major significance to the history of New Mexico and the Southwest. This record of human occupation represents a continuum of approximately 12,000 years of gradual changes in prehistoric technology, which are largely the result of environmental fluctuations and the concomitant adjustments and migrations into and within the area. Much of our knowledge of the Paleo-Indian period comes from the Great Plains area, where sites are more numerous than in the Southwest. In New Mexico two of the best documented and authenticated stratified sites are the type site, Blackwater Draw (Locality No. 1) (Hester, 1972) on the southeastern plains between Portales and Clovis, and the Mockingbird Gap Site about 48 km southeast of Socorro (Weber and Agogino, unpubl. 1968; Cordell, unpubl. 1979, 1984). Additionally, the discovery of fluted projectile points associated with an extinct form of bison (*Bison antiquus*) at Folsom, New Mexico, holds a significant place in the history of American archaeology, because it initially verified the presence of humans in North America during the late Pleistocene.

The San Juan Basin also boasts a long and extensive geological and paleontological record of national and international significance. It contains a rich diversity of geologic structures and formations. Within this area lie rock formations ranging in age from almost two billion years to the present. Some of these formations contain fossils representing early forms of life to the complicated organisms we know and recognize today, from tiny invertebrates to huge reptiles and dinosaurs, and finally to the age of mammals, whose fossilized remains document the evolution of horses, camels, wild dogs, large cats, bears and many species that left no modern descendants.

The archaeological record in the San Juan Basin contains little information concerning the activities of the early human migrants into the area. Few Paleo-Indian sites of late Pleistocene age are documented for the basin, and sites with substantial intact or stratified deposits are not known (Delaney and Dosh, unpubl. 1981; Magers, unpubl. 1979; Huse, unpubl. 1978; Tainter and Gillio, unpubl. 1980; Stuart and Gauthier, 1981; and Cordell, unpubl. 1979). Similarly, the paleontological record contains embarrassingly little data about the animals that inhabited the basin at that time. In contrast, the eastern plains of New Mexico contain several sites exhibiting the rich faunal and cultural record of this period. Sites in Texas, Colorado and Wyoming of the same period and approximately the same depositional conditions produce a better record of the activities and behavior of Paleo- and early Archaic Indians and the animals they hunted. Why are sites such as these not present in the San Juan Basin?

The primary focus of this discussion is with the Paleo-Indian period (10,000 to 5500 B.C.) and the evidence of their activities, and to explore some of the reasons why there are unconformities in our knowledge of the prehistoric cultural and faunal record in this part of the Southwestern cultural region.

## DISCUSSION

### Is anybody home?

The term Paleo-Indian refers to late Pleistocene American Indians of Asian origin whose ancestors crossed the Bering Strait land bridge sometime during the late Wisconsin glacial period. Although there is much debate about when humans made their entrance into the New World (proposed early dates range from 40,000+ to 25,000 years B.P.), the earliest, most securely dated, cultural remains in New Mexico are within the 10,000 to 12,000 years B.P. time span, and are known as the Clovis or Llano Complex (Sellards, 1952). Artifacts associated with the Clovis culture and those of Folsom and some later Plano cultural complexes that followed are distributed throughout the San Juan Basin.

The majority of Paleo-Indian occurrences in the San Juan Basin are isolated surface finds, most of which yielded projectile points of only one type (Judge, 1982), or were mixed with or modified by later cultural phases. Outside the San Juan Basin, multicomponent surface sites of the Paleo-Indian period are more common (Judge, 1982). Clovis materials are known from along Chaco Wash in the central basin (Rehrer and Witter, 1977) and portions of the Navajo Irrigation Project (NIIP) area south of Farmington (Judge, 1982). Folsom points have been found by several surveys, including sites at Navajo Reservoir (Dittert et al., 1961), Chaco Canyon (Hayes et al., 1981; Judge and Dawson, 1972),

Block X of the NIIP (Judge, 1982), the Coal Gasification Project area (CGP) (Chapman, 1977), near Farmington (Hadlock, 1962), at Peach Springs (Stuart and Gauthier, 1981), and possibly in the Stark Lake–Bisti region (Huse et al., unpubl. 1978). A Midland point was recorded in the Black Lake area north of Chaco Canyon (Jan Biella, personal comm. 1991). Plano (lanceolate) points are known from the CGP area, Chaco Canyon, Bisti–Star Lake (Judge, 1982) and Blocks IV and V of NIIP (Elyea et al., unpubl. 1979). Cody points have been reported from the El Paso Coal Company (EPCC) survey (Sessions, 1979), Block X of NIIP (Judge, 1982) and Bisti (Wait, 1976). Last, but certainly not least, Jay points, which are usually defined as being early Archaic (ca. 7500 B.P.) (Irwin-Williams, 1973, 1979), but considered late Paleo-Indian by others (Stuart and Gauthier, 1981) have been found in the basin. Fig. 1 shows the general locations of these areas.

In addition, Paleo-Indian artifacts have been reported at Stone Lake on the Jicarilla Indian Reservation (Broster and Ireland, eds., unpubl. 1984) and on Cebolleta Mesa near Grants just outside the southern edge of the basin (Broster, unpubl. 1980; and Broster and Harrill, unpubl. 1982). These Paleo-Indian complexes span a period of about 5000 years and although it appears that there are many Paleo-Indian sites known in the San Juan Basin, this is misleading. The documented record of Paleo-Indian occupation in the San Juan Basin is surprisingly poor. Cordell (1984) provided the most recent and comprehensive synthesis of Paleo-Indian occurrences in the Southwest.

Most Paleo-Indian sites in the basin have been exposed in areas of substantial erosion. A popular supposition among many researchers is that the majority of Paleo-Indian sites in the basin may still be buried. Another suggests that because much of the basin consists of denuded badland areas, much of the Paleo-Indian record has already been eroded away. The question of erosional effects on the Southwestern landscapes and arroyo cutting and filling has been addressed and often debated among researchers (Cooke and Reeves, 1976; Hall, 1977; Love, 1980). To date, only a few archaeological sites exhibiting the potential of extensive stratigraphic profiles have been found in the San Juan Basin, and none have cultural horizons earlier than late Archaic (ca. 2000 to 3000 years B.P.) (Simmons et al., 1984). This could stem from the character of the basic physiography; caves, rock shelters and other sites of high potential are not abundant. It must be noted, however, that many buried sites of considerable antiquity found elsewhere (e.g., Murray Springs in southern Arizona, and the Folsom site in New Mexico) were discovered because of bones protruding from arroyo banks.

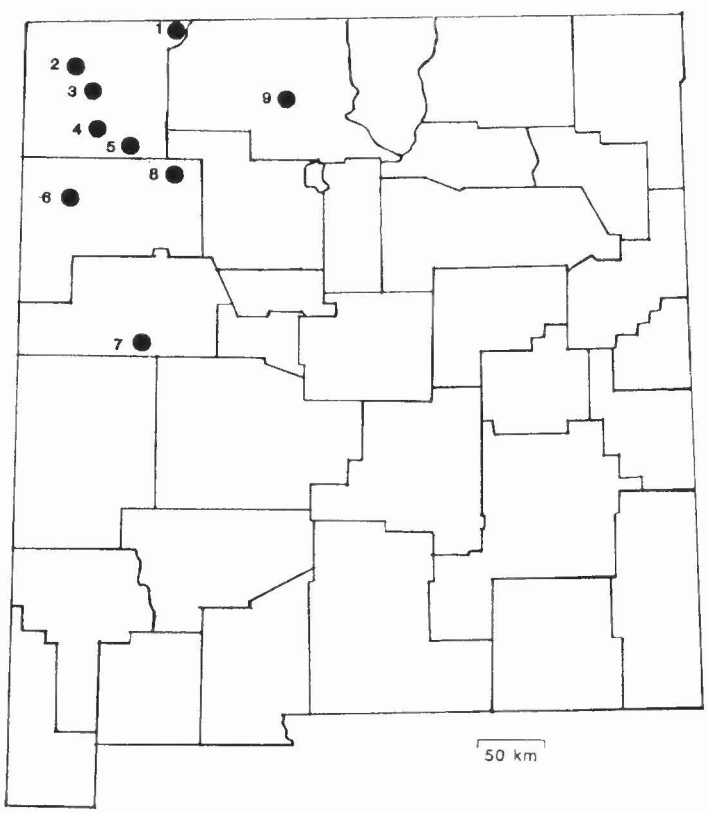


FIGURE 1. Map showing some representative areas where Paleo-Indian sites have been recorded in the San Juan Basin. Key: 1—Navajo Reservoir; 2—Navajo Indian Irrigation Project area; 3—Bisti; 4—Chaco Wash, Coal Gasification Project area; 5—Chaco Canyon; 6—Peach Springs, 7—Cebolleta Mesa; 8—Star Lake; 9—Stone Lake.

A situation bearing significant similarity exists with the Pleistocene and early Holocene faunal record for the San Juan Basin. The paleontological record of Pleistocene and early Holocene fauna is extremely poor. According to the paleontological literature, there are only three documented occurrences of Pleistocene fauna from the San Juan Basin: a portion of a skull attributed to a Pleistocene *Ovis canadensis* (bighorn sheep) reported by Stovall (1946) along with mention of teeth and bones of "*Elephas*" (=*Mammuthus*) *columbi* (mammoth), and another mammoth reported by Hay (1927) east of Zuni, New Mexico. *Symbos cavifrons* (extinct muskox) was also reported (Allen, 1913) by Harris (1985) near Black Rock, New Mexico. There are also unconfirmed third party reports of mammoth bones being uncovered during construction of a gas storage facility on the Quaternary terrace deposits above the San Juan River; however, no official reports or formal documentation exists.

## How do we know?

Most cultural resource surveys and excavations are conducted in response to land-use planning requirements on land administered by federal agencies such as the Bureau of Land Management, Bureau of Indian Affairs, U.S. Forest Service and National Park Service. The results of these surveys and excavations are then submitted to the appropriate agency in report form. Volumes of information have been collected concerning cultural artifacts reflecting human behavior, and environmental and ecological factors, including the faunal, floral and climatic histories of the San Juan Basin. However, there is no formal mechanism for reporting faunal remains of paleontological or zoological interest to the appropriate professionals or institutions who are responsible for the collection and protection of such data and material.

Archaeological archives are a source of information that add significantly to the late Pleistocene and early Holocene faunal record in the San Juan Basin. In many cases, paleontological material is collected, recorded and archived with the cultural resource document, but it often does not become a part of the paleontological data base. In many cases, out-of-state institutions are involved and the material and data leave the state permanently.

An example of this is the New Mexico Museum of Natural History, whose primary mission is to collect, store and disseminate to the public, information and material relating to the natural history of New Mexico. The museum receives little or no information from the archaeological community about the zoological and paleontological resources encountered during their investigations. For instance, archaeological excavations at a major new site in New Mexico have become a focal point of much interest in the scientific community. Significant data have been recovered that may shed more light on the antiquity of humans in North America. Also, a great many Pleistocene faunal remains are being recovered which should add significantly to the paleontological data base for the state of New Mexico. There is some concern about the final disposition of the data and material collected from this site, and how it will be made available to those entities in the state whose responsibility is to collect and disseminate to the citizens of New Mexico, and the visiting public, information about our cultural and natural heritage.

Other cases in the San Juan Basin can be cited. Excavations in the Chaco Canyon area at Atlatl Cave (Betancourt et al., 1983), Sheep Camp Shelter and Ah-shi-sle-pah Shelter (Simmons et al., 1984) all have produced faunal remains in levels predating human occupation zones. In addition to an environmentally diagnostic microfauna, remains

of some extinct large mammals have been reported. At Sheep Camp Shelter, skeletal elements assigned to *Equus* sp. and/or *Equus* cf. *conversidens*, *Bison* sp., and cf. *Platygonus compressus*, an extinct form of giant peccary, were recovered. At Ah-shi-sle-pah Shelter remains of *Bison bison* (vertebral process and rib fragment) were identified (Simmons et al., 1984). None of these remains were thought to be connected archaeologically to the sites. They do, however, have paleontological significance; these are the first records of *Equus* and *Platygonus* from within the San Juan Basin.

The *Bison* remains are significant for several reasons: (1) they are the first recorded *Bison* remains from the basin; (2) because their specific identification is uncertain, they could be an extinct form of *Bison;* or (3) the *Bison* material could have been misidentified and represents another genus of bovid, such as *Symbos* (extinct muskox), which has been reported from the northwestern and southwestern edge of the basin. This material was collected and reposited at an out-of-state university. Fig. 2 shows the known locations of fossil megafauna now documented in the San Juan Basin. This reflects an appalling lack of information on the Pleistocene and Holocene faunal assemblages in the San Juan Basin.

Unless investigating paleontologists examine the archaeological literature and reports submitted to federal agencies, or discoveries such as mentioned above are reported to qualified paleontologists, or reported in paleontologically oriented literature, much information will remain obscure and estranged from the paleontological data base upon which researchers must rely to ensure accuracy and completeness in their work.

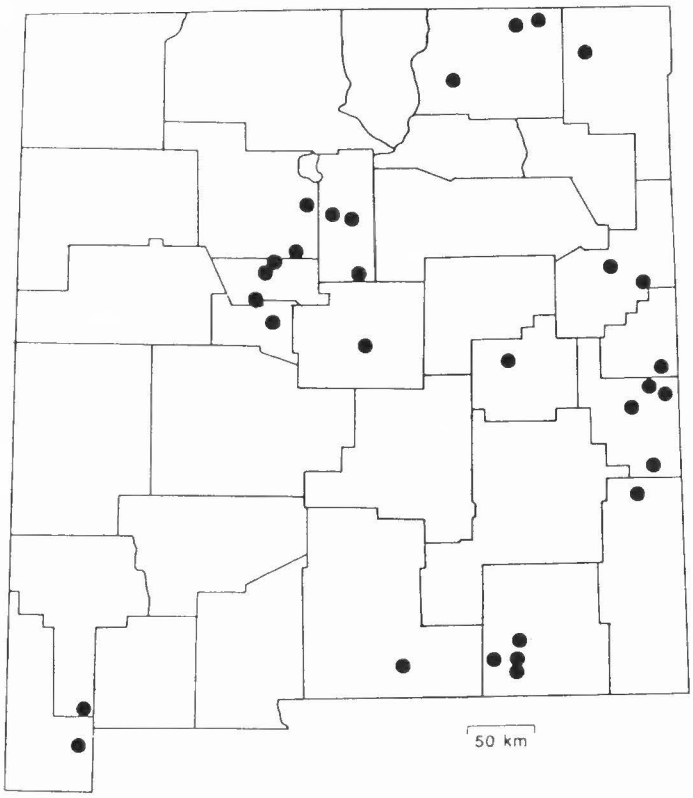


FIGURE 2. Known locations of Pleistocene/Holocene fossil megafauna in the San Juan Basin. Key: 1—Navajo Reservoir, Archuleta County, Colorado: cf. *Platygonus compressus* (Bertram, unpubl. 1988); 2—Bloomfield, San Juan County, New Mexico: *Mammuthus columbi* (Stovall, 1946; Lucas and Effinger, 1991), *Ovis canadensis* (Stovall, 1946); 3—Ah-shi-sle-pah Shelter, San Juan County, New Mexico: cf. *Cervus* sp. (Simmons et al., 1984); 4—Sheep Camp Shelter, San Juan County, New Mexico: *Equus* sp., cf. *Bison* sp., cf. *Platygonus* sp., cf. *Cervus* sp. (Simmons et al., 1984); 5—Black Rock, McKinley County, New Mexico: *Mammuthus columbi* (Hay, 1927; Lucas and Effinger, 1991), *Symbos cavifrons* (Allen, 1913; Harris, 1985).

There are exceptions to this, of course, such as the discovery and well written documentation of a partial skeleton of *Symbos* sp. (Clay et al., unpubl. 1987) during excavations by the Dolores Archaeological Program at Grass Mesa Village, below the earliest level of human occupation. The specimen was collagen dated to 15,970 ± 155 years B.P. Although not in an archaeological context, it is paleontologically important because it adds to the known dates for *Symbos*, and is the first documented occurrence in southwestern Colorado. Moreover, associated cranial and postcranial elements of a single individual are a rare find anywhere. The specimen was identified by paleontologists at the University of Colorado.

In another case, cf. *Platygonus compressus* (collagen dated to 12,060 ± 1780 years B.P.) was reported from the Oven Site in the Navajo Reservoir area (Bertram, unpubl. 1988) as a result of archaeological mitigation work by the Bureau of Reclamation. An analysis of this specimen is presently under way. Other specimens collected include an antilocaprid, a small bovid, a large bovid or cervid, and possibly a large canid. Together with specimens from Sheep Camp Shelter in the Chaco Canyon area, these are the only reliable records of *Platygonus* in the Four Corners Area, specifically the San Juan Basin, for the terminal Pleistocene. The paleontological material from the Oven Site may be transferred to the New Mexico Museum of Natural History for appropriate studies and inclusion in the published paleontological record. These cases illustrate one factor responsible for the gap in the Pleistocene/Holocene faunal data base for the San Juan Basin. Important paleontological data was collected, but was not in many cases curated into the paleontological archives.

Another contributing factor is that virtually all paleontological investigations in the San Juan Basin have concentrated in areas where Cretaceous, Paleocene and Eocene continental sediments are exposed. In these areas, the scientific focus has been primarily on problems surrounding the end of the age of dinosaurs, the beginning of the age of mammals, and rock-stratigraphic and biostratigraphic evidence concerning the Cretaceous/Tertiary boundary. For the most part, this work is being conducted in response to coal, or oil and gas development. Pleistocene deposits are largely overlooked by the paleontological investigators because of the generous expanse of badlands in the basin containing dinosaurs and early mammals. Although this situation still exists, research on the Quaternary is increasingly motivated by academic curiosity. Units of Quaternary sediments have been identified within the Chaco River drainage system. Data relating to the sedimentological and geomorphological processes that have shaped the San Juan Basin, and to the climatic regimes and environments that have occurred over the past several millennia are becoming more available (Betancourt and Van Devender, 1981; Betancourt et al., 1983; Gutierrez, 1980; Love, 1983; Schultz, 1983; Wells, unpubl. 1982; Wells et al., 1983).

## What was on the menu?

In general, there has been more speculation about Paleo-Indian subsistence economy in the San Juan Basin than actual documentation. Paleo-Indians are assumed to have been big-game hunters by inference, with large projectile points being the most diagnostic artifacts. Traditionally, Paleo-Indian subsistence economy has been regarded as almost exclusively based on the systematic hunting of extinct large mammals such as mammoth, horse and bison. Paleo-Indian projectile points have been found outside the basin in direct association with extinct megafauna; thus, it is assumed that they exploited this same fauna in the basin as well. Many researchers working in the basin speculate that Paleo-Indians, especially Folsom and later phases, concentrated on the large migratory herds of bison as a means of subsistence (Hewett, 1977; Huse, unpubl. 1977; Magers, unpubl. 1979; Tainter and Gillio, unpubl. 1980; Dulaney and Dosh, unpubl. 1981; and Stuart and Gauthier, 1981). However, there is no evidence to substantiate such speculation.

Based on information available in the paleontological literature, one can only question the presumptions made concerning the subsistence strategies of the Paleo-Indians in the San Juan Basin. This line of questioning bears directly on the data gap for this period in both the archaeological and paleontological record, two disciplines that have

actively conducted investigations in the San Juan Basin for more than a hundred years.

From the evidence at hand, it appears that Paleo-Indians may have occupied the basin as much as 12,000 years B.P. and that they might have lived off the land much as they did elsewhere. However, lack of any *in situ* evidence directly connecting human occupation with megafaunal exploitation in the San Juan Basin even as late as 3000 years ago leaves us with many unanswered questions about their subsistence economy.

Some astute observers recognize the fact that, although Paleo-Indians (particularly Folsom and later phases) were highly successful, mobile hunters and gatherers who sometimes focused on the exploitation of bison, there were other crucial components to their adaptive strategies (Simmons et al., unpubl. 1989; Judge, 1974). They also recognize the possibility that bison might not have been the focus of their subsistence economy, or even present in the San Juan Basin. It is entirely possible that there was a broad spectrum of game species which occupied the niche filled by bison elsewhere. However, because of the limited number and poor integrity of Paleo-Indian sites in the basin, it is difficult to characterize game species that could have been exploited as a subsistence base.

Reports of bison from the Chaco Canyon area should be treated with caution. Fragmentary postcranial remains of *Bison* do not readily lend themselves to accurate taxonomic diagnosis, and their presence in the San Juan Basin is considered to be speculative at best. The paleontological and zoological literature does not cite any record of bison in the San Juan Basin (Effinger and Lucas, 1990). On the contrary, sources report that bison did not inhabit the middle Rio Grande Valley or country to the west (Findley et al., 1975); and McDonald (1981) reported that bison were (due to lack of evidence) relatively rare throughout the region south and west of the Rio Grande—even in the early sixteenth century. More recently, Effinger and Lucas (1990) illustrated the distribution of New Mexico fossil *Bison*, with the western half of New Mexico essentially devoid of any reported fossil bison localities (Fig. 3).

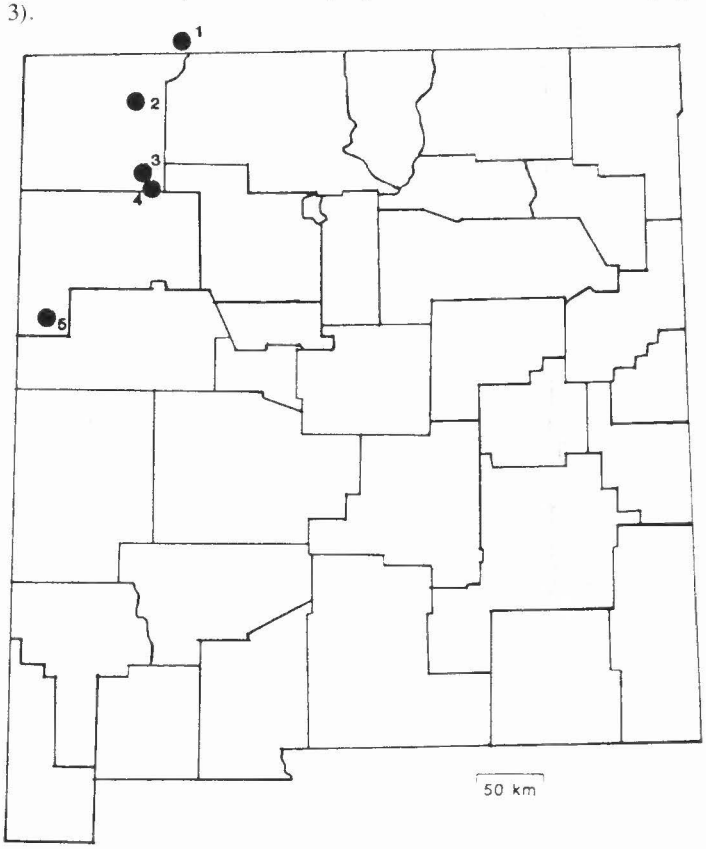


FIGURE 3. Distribution of fossil *Bison* localities in New Mexico. From Effinger and Lucas (1990).

The term "Basin" is somewhat misleading in this discussion because it seems to imply low elevation. Actually, the San Juan Basin is quite high. Its interior elevation averages 1800 m, largely accounting for the basin's variable climate and abbreviated growing season (Judge, 1982). Present knowledge of the zonal vegetation development from about 20,000 to about 6000 years ago suggests several episodes of subalpine pine–spruce forests and open woodland environments moving down from higher elevations such as the Chuska Mountains (Betancourt, 1987, 1990; Betancourt and Van Devender, 1981; Gillespie, 1985; Hall, 1977, 1985; Markgraf and Scott, 1981; and Wright et al., 1973). Between about 15,000 and 10,000 years B.P., these woodlands were dominated by limber pine (*Pinus flexilis*) and Rocky Mountain juniper (*Juniperus scopulorum*), with Douglas fir (*Pseudotsuga menziesii*) and Blue spruce (*Picea pungens*) possibly restricted to the shady canyon bottoms and walls (Betancourt, 1990; Markgraf et al., 1983). Big sagebrush occupied a mid-seral stage on the more open slopes and mesa tops with a productive understory of grasses and forbs. From about 10,000 to 5000 years B.P., Ponderosa pine (*Pinus ponderosa*), pinyon pine (*Pinus edulis*) and one-seed juniper (*Juniperus monosperma*) became dominant, with some Douglas fir persisting (Betancourt, 1990; Markgraf et al., 1983). As these woodlands retreated, particularly during the drier and hotter intervals around 4000 to 7000 years B.P. (West, 1978), the desert shrub/grass communities dominated by big sagebrush gradually became climax over areas formerly dominated by woodland (Young et al., 1979). A desert shrub grassland, similar to modern vegetation communities, appears to have become established in the central San Juan Basin by about 5000 B.P.

Today the upper Rio Puerco drainage in the San Juan Basin contains the largest population of the big sagebrush/grass ecotype south and east of the Continental Divide. This ecotype is estimated to cover 263 $km^2$ in this area but extends farther north, west and south from the Rio Puerco drainage and the Continental Divide. West of the Divide, the sagebrush/grassland ecotype comprises several thousand square kilometers with grass understories of galleta, blue grama, alkali sacaton, Indian ricegrass, squirrel tail, sand dropseed and forb species, such as buckwheat, penstemon and tansy mustard (Vincent, unpubl. 1991). Together these areas make up what can be considered the central San Juan Basin. Surrounding the basin are the gradational zones of pine/juniper woodland, ponderosa park and meadowlands and montane spruce/fir forests, which over the past 10,000 years or so have advanced and retreated into and out of this area.

It is proposed here that environmental conditions were such that bison probably did not utilize the sagebrush/grassland in the San Juan Basin during the late Pleistocene and Holocene epochs. Browsers such as camels, ground sloths, mammoths, horses (*Equus* sp.), and elk (*Cervus elaphus*) grazed on the grass understory while pronghorn antelope (*Antelocapra americanus*) browsed the forb and shrub understory. Deer (*Odocoileus* sp.) and bighorn sheep (*Ovis canadensis*) occupied the uplands and breaks where there was more cover and less danger from predators. The diverse topographical and vegetational features of the basin provided these animals with an excellent habitat in which to thrive.

Horses and cattle, which are considered modern analogues to bison, are predominantly grazers throughout the year, and grasses comprise around 88% of their pooled seasonal diets (McInnis and Vavra, 1987). Modern studies (McInnis and Vavra, 1987) estimate dietary overlap between horses and cattle averages around 70% on an annual basis and in a variety of vegetation types. Diets of feral horses in some areas have a higher sedge component than do diets of free-ranging cattle (Reynolds et al., 1982). In this respect, feral horse diets show greater similarity to diets of bison than to cattle diets.

Elk are known to have been present in the mountains of Arizona, New Mexico, Texas and Mexico at the end of the Wisconsin glacial stage (Bailey, 1905; Baker, 1956; Gilmore, 1947; Murie, 1951). Grasses comprise the largest percentage of forage for elk from May to December with browse being important from December through April (Bryant and Maser, 1982). This varies with forage availability dictated by physiographic constraints. Elk are very gregarious and aggregations appear to be related to vegetation, with the largest groups occurring in the

most open habitat (Knight, 1970). The availability of thermal cover, forage, or both, especially in winter is a critical limiting factor to elk distribution (Bryant and Maser, 1982).

Pronghorn antelope consume mainly forbs and shrubs, concentrating on diets containing higher levels of crude protein, resulting in little dietary overlap with horses or bison. Pronghorn select diets of higher nutritional quality than horses or bison because of their smaller size and higher metabolic rate (Hanley and Hanley, 1982).

Assuming that horses, elk and other ungulates utilized the forage in the central basin, where space and resource availability were limited, there would very likely have been strong potential for exploitative competition from bison, if they were present. In most situations, bison are the dominant herbivore and have been known to force elk out of desirable forage areas and have even displaced horses (Reynolds et al., 1982). It is recognized, however, that because elk are frequent browsers, they are not in direct competition with bison for forage under optimum conditions.

Mammoths probably concentrated in small family groups along the stream terraces and canyon bottoms, where the spruce/fir stands provided cover and refuge after foraging on the sagebrush grassland in the central basin. Dietary intake, recorded in dung remains, included predominantly graminoids and to a lesser extent various woody shrubs and trees that currently grow at higher elevations (Agenbroad and Mead, 1989). If present in the basin, mammoths may have been the dominant herbivore, and competition could have been a critical factor in the ecology of the central basin. The exact ecological relationship between mammoths and other large-bodied herbivores has not been established. The three known localities containing mammoth remains in New Mexico within the Colorado Plateau (Agenbroad and Mead, 1989; Lucas and Effinger, 1991) are Bloomfield (Stovall, 1946), Black Rock (Hay, 1927) and Datil (Hay, 1927, cited in Agenbroad and Mead, 1989). No direct association of *Mammuthus* and the Clovis hunters has been reported from the Colorado Plateau.

Although dietary overlap is not sufficient evidence for exploitative competition, competition may increase if resource availability is limited and is reduced by common utilization, as it might have been in the San Juan Basin. This could have occurred if bison were present. Under natural conditions, most ungulate populations are held in balance by habitat requirements and predator pressure. It seems unlikely that bison herd size was regulated by nonhuman predators, especially if resource availability was unlimited as it was on the more expansive great plains and prairies. However, the basin's geographic and physiographic position significantly influenced the potential for great numbers of large-bodied, migratory herbivores. If bison were present in the San Juan Basin, herd size would undoubtedly be reduced under conditions of limited space, limited forage availability and dietary overlap with other herbivores. Their migratory tendency would have been severely restricted compared to the vast herds and unrestricted movement on the open plains. Because of limited access through the physiographic barriers surrounding the San Juan Basin, it would not have been available as a point of migratory departure, stopover or destination for animals known to travel great distances in large numbers. Bison require large areas to exist as free-ranging, naturally regulated populations. Although small herds of bison could have manipulated their habitat altitudinally, there is no evidence for that conclusion. It is therefore highly unlikely that bison led a sympatric existence with other large ungulates in the San Juan Basin, or that they were present in any number as a dominant species.

Another large-bodied herbivore, muskox, could have occupied the "bison" niche in the San Juan Basin. Muskox remains (here the term "muskox" will be used to avoid the *Symbos/Bootherium* debate) are recorded from pine/spruce/fir environments just outside the physiographic boundaries of the San Juan Basin (the Gallup-Zuni sag in the southwest, and the Canyon Lands section of the Four Corners Platform in the northwest). From modern studies (Gunn, 1982), forage requirements and behavior of prehistoric muskox were somewhat similar to present-day muskox. The San Juan Basin would have been well suited to the habitat needs of the muskox. Although the habitat preference of *Symbos cavifrons* is disputed, it is known as the woodland muskox, inhabiting lake and forest margins in boreal forests and grassland and parklands as well (Harrington, 1968, 1975). Behaviorally, muskoxen do not congregate in great herds, but in smaller groups of 10 to 20 individuals with larger herd sizes being stimulated by the presence of predators. Herd fragmentation could have reduced competition for limited forage and space created by the presence of other species of ungulates. Muskoxen are relatively sedentary animals and their movements are usually limited between winter and summer ranges, about 50 to 80 km (Gunn, 1982). The dentition of muskoxen is similar to that of bison, but is less hypsodont and more adapted to succulents such as sedges and forbs but still suitable for exploiting the higher-fiber grasses in the central basin with its lower snow cover in the winter. During the cooler and wetter climate of the late Pleistocene and early Holocene this ecotype could have been established in the higher elevation subalpine grassland or mountain meadow grassland of the basin (Brown, 1971).

During this time, water was probably available in sufficient quantity to support animals living in small herds throughout the central basin. Drainages occupied approximately their present positions but the Chaco River was about 12 to 15 m above its modern base level, and streams were less deeply entrenched and the valley slopes more gradual. It is not known when initial incision, entrenchment and aggradation began in the basin, but from studies in the Rio Puerco Valley, it must have taken place in late Pleistocene time (Hawley et al., 1983).

## CONCLUSION

Although the San Juan Basin was subject to many environmental and climatic fluctuations throughout the late Pleistocene and early Holocene, and to severe erosional processes beginning about 6000 years ago (Wells, 1983), this does not entirely explain the absence in the record of the rich and diverse fauna that existed throughout the Southwest. The apparent lack of Paleo-Indian sites in the San Juan Basin has resulted in several proposed scenarios about Paleo-Indian demographic responses to geographic and environmental conditions in the Southwest.

Paleo-Indian archaeology in the San Juan Basin is burdened with several problems, including low site visibility, poor preservation, poor exposure of appropriate landforms, imprecise chronology, and a lack of known excavated stratified sites (Cordell, 1984). The resulting data gap can be attributed to several factors: (1) geomorphic processes create a data collecting and data base problem; (2) research design, training and methodologies are inadequate to address the problem; (3) some researchers assume that late Pleistocene and Holocene sediments are not within the realm of archaeological research; (4) a general lack of Quaternary paleontological research in the San Juan Basin; and (5) a general lack of communication and cooperation between the paleontological and archaeological communities, land managing agencies and other institutions, resulting in large information gaps in the data base of both disciplines.

While attempting to understand the complexity of the problems facing us about the Paleo-Indians, their environment and their lifeways in the San Juan Basin, several factors (some speculative) should be considered before any theories of "who, what, when, where and how" can be advanced.

1. Approximately 12,000 to 8000 years ago, the San Juan Basin was essentially an environmentally and physiographically isolated island, containing a high-diversity environment characterized by ecotonal zones reflecting the variable altitudinal and topographical features.
2. For the human newcomers, the basin was well suited for the manipulation of variation in altitude for subsistence options because of its high-diversity environment. Climatic and topographical variation in altitude could have provided an opportunity for seasonal and episodal movement to meet subsistence needs rather than through directional or lateral movements following large migratory herds, as on the Great Plains to the east.
3. The fact that there is so little evidence of Clovis and Folsom people in the San Juan Basin could mean that when, or if, they

entered the basin, an adaptation to a different lifestyle was beginning. Thus, groups trailing into the basin could have been small in number and possibly in search of their traditional subsistence economy. This is not to say that their economic spectrum was not broader based, but a search for specific kinds of megafauna, such as *Bison antiquus* or *Bison occidentalis*, which were becoming scarcer outside the basin, could have been the motivation for such a migration. The southern and northern edges of the San Juan Basin contain highly diverse topographic settings and may not have been previously attractive to small groups with focal economies emphasizing open-plains megafauna.

4. Although mammoths could have been present in the basin, their numbers were probably very small and they, too, were probably on their "way out," as a result of overhunting, environmental stress, or restricted genetic exchange that decreased species vigor. The paleontological record (Agenbroad and Mead, 1989; Lucas and Effinger, 1991) shows that mammoth were present in the outer edges of the central San Juan Basin. The vegetation zones from the central basin to its higher elevations were also available for altitudinal migration of mammoths as well.
5. Paleo-Indian activity sites (especially Folsom and later complexes) in other areas are known from large bison kill sites. Animals that lived together in large herds and are killed in large numbers (e.g., Agate Basin and Hell Gap sites in Wyoming), leave a better paleontological record for later discovery than animals living in smaller family groups or leading solitary lifestyles. So far, there are no "kill sites" recorded in the basin, or west of the Rio Grande for that matter.
6. Because of its isolation, the basin probably remained insulated against exploitation by large groups of Paleo-Indians. Indeed the record in the basin seems to suggest a Paleo-Indian "hiatus" between about 10,000 and 8000 years ago (Cordell, USFS & BLM rpt., 1979). This is noteworthy, because bison remains were becoming increasingly common elsewhere in the archaeological record about 11,000 to 10,000 years ago. It seems logical to assume that if there were no bison in the San Juan Basin, hunters whose strategies depended on bison ecology would not be present either.
7. Relative to the "hiatus" mentioned above, the possibility of a correlation between which bison species were being hunted by which Paleo-Indian cultural complex should be considered. According to McDonald (1981), there were distinguishable differences in the ecology of *Bison antiquus* and *Bison bison* with a possibility of *Bison occidentalis* filling in the transitional adaptation from an open woodland/savanna ecotype to the grassland ecotype that was developing in ever-wider expanses on the plains east of the basin where greater numbers of animals could be accommodated.
8. Because a case can be made for the absence of groups whose subsistence economy focused on the large migrating herds of bison, it does not mean that groups utilizing a broader spectrum of subsistence activities were not present. If the San Juan Basin were occupied by plains-based Paleo-Indian groups with a hunting economy focused on migrating herds of bison, they would have to modify their lifestyle and tool arsenal to adapt to a more diverse subsistence base. This should be reflected in changes of types and manufacture of weapons and tools, replacing types no longer appropriate for acquiring the different game species found in the basin.
9. Lastly, three alternative conclusions can be drawn: (1) lack of substantive evidence suggests that some Paleo-Indian complexes were not present in the San Juan Basin, or that they rarely exploited the basin, and that the basin was not a refuge for the extinct and modern megafauna; (2) the geomorphic processes within the basin during the past 18,000 years or so have disassociated and removed much of the archaeological and paleontological record; or (3) archaeological research in the San Juan Basin has been so focused on architectural and ceramic sites, and paleontological research focused on older geologic formations that the Pleistocene and early Holocene cultural and faunal records have been overlooked.

A new approach to the inquiry of the not-so-distant past is mandatory if we are to extract an accurate story of these early people and the environment they lived in. Before we can begin to understand their lifeway economics, we must learn more about the environment that shaped their relationship with nature and the adaptive response of one to the other. Training and methodologies should be modified and updated to improve geographic and remote sensing skills, and knowledge of the biological sciences. Research designs should include more participation of nonarchaeological specialists to help reconstruct past environmental conditions and assist in the analysis of biological remains, without which an accurate analysis of Paleo-Indian economy cannot be undertaken. A cooperative atmosphere should be created by formal agreement between appropriate entities to share information about the collection and storage of data and materials where the interest of the public is concerned.

In addition, paleontologists should acknowledge the gap in the Pleistocene and Holocene faunal record in the San Juan Basin, and address the questions surrounding the record of life during the past million years or so in general, and the past 12,000 or 13,000 years in particular. Additional interdisciplinary research is crucial if we are to begin to fill the gaps in the framework that earlier studies have defined. The primary concern now is simply to better understand, using the varied array of modern techniques available, the complex and intriguing story of one of the most fascinating areas in the American Southwest.

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Barber Peak southeast of Shiprock is seen here at mid-day with The Hogback (Upper Cretaceous strata) visible in right middleground. Barber Peak is composed of Oligocene intrusive rocks. Photograph taken 29 March 1992. 