

**BISON OF THE GRAND CANYON REGION, ARIZONA
AN OVERVIEW ASSESSMENT**

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INTRODUCTION AND SCOPE

Bison (*Bison bison* and its breeds and variants; Artiodactyla, Ruminantia, Bovidae, Bovinae) have now entered lands administered by Grand Canyon National Park (GRCA), including the higher elevations of the Kaibab Plateau (North Rim) from adjacent private and federal lands (Bison Management Team, 2002). Because of this, GRCA needs to determine the past history of bison in the Grand Canyon. That is the scope of this overview.

There are differing views of 'in the Grand Canyon.' Some administrators might want to define this term as the boundary to the entire park (Colorado River Miles 0 to 277). Some might want the definition to indicate just the Kaibab and Kanab plateaus, as these are the areas being directly affected with the current invasion (or likely to be affected if the introduction is to go unchecked). The boundaries of GRCA are political, and as such, the park is not a complete ecologic or physiographic unit. How do lands administered by Lake Mead National Recreation Area and Grand Canyon-Parashant National Monument relate to the ecological question/definition of 'in the Grand Canyon?' In reality it is important to understand the location of bison in both political and physiographic/ecologic perspective. That is the approach for this review. For the sake of discussion here, 'in the Grand Canyon' will refer to lands under the jurisdiction of GRCA. Lands adjacent to GRCA (such as Lake Mead NRA and Shivwits Plateau [GCPNM]) will be referred to as 'the greater Grand Canyon.'

This report will present what is known about bison history for GRCA and the greater Grand Canyon. This in effect will provide GRCA with a fairly complete background about its current incursion issue. As a preface – this report will not provide definitive proof for or against bison being found in GRCA during historic times because the data is so sparse and inconclusive. The caveat is that most of the areas in and adjacent to GRCA that would likely have been inhabited by bison have yet to be explored. The best that can be offered is to present what is known and provide logical or theoretical speculation about what it means.

The major questions being addressed in this report include:

- (A) Were bison ever present in GRCA?
- (B) Where did bison live or frequent in GRCA?
- (C) When did bison occur in the Grand Canyon? [i.e., Pleistocene, post-Pleistocene, late Holocene, historic]
- (D) Were bison ever present adjacent to the Grand Canyon?
- (E) Where and when did bison live adjacent to the Grand Canyon?
- (F) How reliable is the data set for the answers to the above questions?
- (G) What, if any, conclusions are there from the data set?
- (H) Can bison adequately inhabit GRCA lands as a viable 'wild' animal population, or will the species need to be cared for?
- (I) What options are there for GRCA concerning the data set?

DATASET

Paleontological, archaeological, and historical records are always 'snap-shots' of the past. There is no way to reconstruct complete records of past plant and animal communities for every square hectare of any region, let alone the rough country within GRCA and its adjacent plateaus and canyons. What makes the end results even sketchier for GRCA is that due to the remoteness of the park and nearby plateaus, much of the region has yet to be thoroughly investigated. Most of what has been inventoried in GRCA, has been within and nearby the river corridor region – areas relatively easy to access via rafts. To this extent, realistically only the eastern 150 river miles and the western most 5 river miles have been intensively investigated for questions relating to past plant and animal communities. This leaves approximately 125 miles in between and innumerable miles of canyon tributaries north and south of the corridor that are for all intent, unexplored for the sake of past community reconstruction.

This overview will include data from the following resources: paleontological, zooarchaeological, archaeological (cultural: rock art), and historical. It will also include personal communications with select researchers that are currently working on data that might be germane to this issue. Often it is pertinent to point out the various literature sources that do not contain reference to bison. In this way it illustrates what has been examined in an area which then allows some discussion as to how well particular areas are known and what it might mean if bison is not recorded from that region.

The classification, taxonomy, and identification issues of *Bison* are in the literature (McDonald, 1981). There is controversy as to how many species of bison have occurred in North America, if more than one. There is no indication that an extinct form has frequented the Colorado Plateau. This overview will work at the generic level, *Bison*, which is satisfactory for the issues of this report.

OVERVIEW OF BISON HISTORY

The Pleistocene (Quaternary) began approximately 1.8 million years ago (Ma; megannum, or millions of years ago), and in North America is divided into two Land Mammal Ages (NALMA; a biochronological unit independent of actual isotopic ages). The Irvingtonian NALMA dates from 1.8 Ma to about 260,000/150,000 years ago (0.26/0.15 Ma). The ending date is not precise (it is not well understood right now) – it probably sits sometime between 260,000 and 150,000 years ago and is likely time-transgressive. The Rancholabrean NALMA dates from this ending time to 10,000 years ago. *Bison* is the characterizing species to define the Rancholabrean (Lundelius et al., 1987); so, whatever the earliest date for bison is, that would become the end of the Irvingtonian and the beginning of the Rancholabrean. The dividing age between the two NALMAs is controversial and far from agreement. The most recent 10,000 years is not included within a NALMA but is named the Holocene or Recent.

Bison, as with all bovids in North America (e.g., bighorn and mountain goat), are immigrants from Asia, having entered via the Bering Land Bridge (Beringia; that area between Alaska and Siberia now predominantly inundated by the Bering and Chukchi seas). And, it is a matter of time perspective when one wants to classify an immigrant as an indigenous species. During the Pleistocene, climates radically fluctuated from glacial to interglacial regimes. Each species of plant and animal will independently react to

these climatic shifts. This results in an ever-changing community mosaic. The most recent glacial is the Wisconsinan Glaciation, which ended about 11,000 years ago. Since then we have been experiencing an interglacial climate. Each regime has its own micro-cycles of change which then furthers the constant community reshuffling. No species of plant or animal has a truly constant, stagnant distribution. With change, some species are early reactors while others are slow to change. As an example, the fossil record would imply that elk (wapiti, *Cervus*) arrived on the Colorado Plateau only in the past few hundred years, maybe 1,000 years, and the peccary (*Pecari*; sometimes *Tayassu* or *Dicotyles*) is a late arrival having invaded onto the Colorado Plateau only over the past few years to a decade in response to unusually warm winters. Land managers and ecologists should realize that the only constant is 'change.'

BISON OF THE COLORADO PLATEAU

PALEONTOLOGICAL RECORD

Bison are fairly common fossils in Arizona, as indicated in McDonald (1981) and Harris (1985), and are known on the Colorado Plateau (Mead, manuscript; Fig. 1). Agenbroad and Haynes (1975) produced a review about bison of Arizona. Examination of their map (Fig. 2) indicates that most of the known bison localities in Arizona are late Pleistocene in age (Rancholabrean). Also notice how few bison are recorded from northern Arizona as of 1975. This is more a reflection of how few methodical paleontological prospectings have been undertaken versus the actual distribution of bison. Comparison of the maps illustrates that with more prospecting for paleontological resources, the more bison and other species will be recovered. My thirty years of fieldwork on the Colorado Plateau has shown to me that new and unusual fossil discoveries are common, which only illustrates how little we really understand about the region.

The arid environments and the abundance of long-lasting caves and shelters on the Colorado Plateau provide the unique ability to preserve dung and perishable body remains of bison (as well as from other species). This resource has been discovered only since 1980. Bison dung is reported from a number of localities, predominantly in Glen Canyon National Recreation Area (GLCA; Table 1). Such remains are unprecedented for the quality of radiocarbon analysis, let alone their potential for DNA research. The fact that these perishable remains exist indicates the lack of contamination, which is typically introduced via percolating ground water.

Bison barely survived the late Pleistocene extinctions event/process (see review about extinctions in Mead and Agenbroad, 1992). Records from around the continent illustrate a crash in the number of bison occurred after about 11,000 years ago and that they did not rebound until after about 9,000 years ago, at which time they increased dramatically and were geographically reorganized. The reduction and then rebound is not fully understood, or agreed to, but the reorganization of plant communities in response to climatic change between 11,000 and about 4,000 years ago is certainly at the root of the issue. The role that humans played on the bison in the central plains is well documented but it is not known how, or if, they dramatically affected the bison of the Arid Southwest or Colorado Plateau.

FIGURE 1. Map of Arizona, Colorado Plateau, and surrounding region with generalized locations of late Pleistocene-age *Bison*.

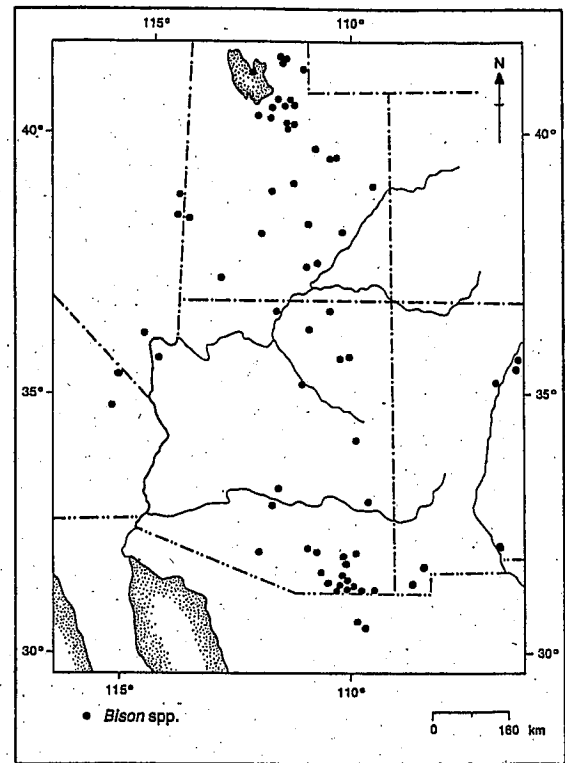
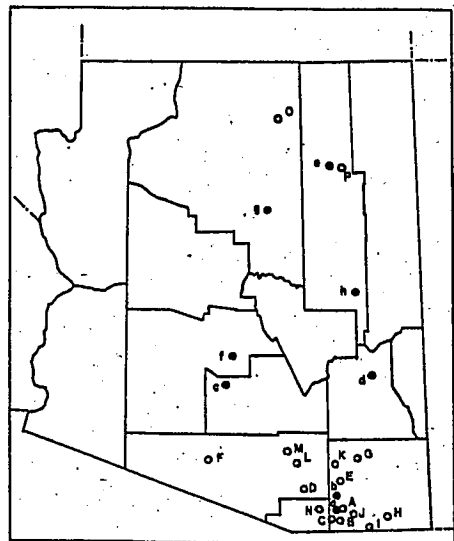


FIGURE 2. Map of Arizona with locations of known Bison site as of 1975. From Agenbroad and Haynes, 1975



- REPORTED BISON LOCALITIES IN ARIZONA**
- | ○ EXTINCT BISON | ● BISON bison |
|------------------------|-------------------|
| A: MURRAY SPRINGS | a: MURRAY SPRINGS |
| B: LEHNER RANCH | b: BABOCOMARI |
| C: HARGIS SITE | e: SNAKETOWN |
| D: GREATERVILLE | d: POINT OF PINES |
| E: LINDSAY RANCH | e: AWATQVI |
| F: VERTANA CAVE | f: LAS COLINAS |
| G: WILLCOX PLAYA | g: RIDGE RUIN |
| H: DOUBLE ADOBE | h: BEAR RUIN |
| I: NACO | |
| J: SAN RAFAEL | |
| K: FENN SITE | |
| L: TUCSON BRICKYARD | |
| M: WERNER SITE | |
| N: PARAGO SPRINGS CAVE | |
| O: CHARLEY DAY SPRING | |
| P: KEAMS CANYON | |

TABLE 1. Late Pleistocene *Bison* remains from Colorado Plateau localities (Mead and Agenbroad, 1992). *, no direct ¹⁴C determination assessed, but material exists to be analyzed; †, see discussion in Mead and Agenbroad (1992); ‡, from Emslie (1988).

<u>Locality</u>	<u>Direct ¹⁴C Date on Dung</u>	<u>Laboratory Number</u>	<u>Comments</u>
GLCA, UT			
Cowboy Cave	!13,040±440 –	A-1654	Dung
	11,810±140	UGa-636	Dung
Grobot Grotto	15,270±120	Beta-22999	Dung
Hooper's Hollow	18,840±350	Beta-23323	Dung
Mammoth Alcove	-	-	*
Oak Haven	-	-	!* ~11,000-9,000
Shrubox Alcove	-	-	*
Withers' Wallow	-	-	*
GRCA, AZ			
Sandblast Cave	-	-	Bone;>40,000 ‡
Stanton's Cave	12,790±70	Beta-166025	Keratin hoof

Bison dung has been recorded from seven sandstone alcoves in GLCA, with four radiocarbon dates indicating a late Pleistocene (late Wisconsinan Glaciation) age of deposition. Microhistological analyses (identification of the plant fragments left in the dung) indicate that these bison were predominantly grazers, but browse did play an important component, possibly seasonally (Table 2). Although the dung provide a menu of the bison's diet, it should not be used as an indicator of the carrying capacity of the land.

There is little question that the bison that produced the dung, did so in the alcove where it was recovered. Skeletal remains present a different dialogue about deposition. Pleistocene skeletal remains of bison are known in the Grand Canyon from two caves, both found in the Colorado River corridor in the Marble Gorge (Table 1). The question centers on if the skeletal remains imply that bison was actually at the cave area (i.e., outside of the cave or along the river) or if it died outside of the Marble Gorge. In this latter case, the skeletal remain either washed into the river corridor and became deposited in the cave via packrat collection, or, a scavenging bird might have 'airlifted' it to a nesting site within the corridor. Savaging birds such as the condor (*Gymnogyps*) and turkey vulture (*Cathartes*) do not have the ability to pick up carcass remains with their feet; they lack the grasping talons found on true raptors such as owls or eagles. One cannot omit the fact that bison phalanges (toe bones) or isolate teeth could be ingested by a condor and regurgitated as a stomach pellet at a river corridor nesting location. The keratinous hoof (over the third, distal phalanx) presents a different story as the preserved hoof shows no taphonomic markings that would imply stomach juice dissolution and breakage or pecking due to beak action. The preserved hoof is larger than would be ingested by a condor. Had the hoof been transported to the cave area by flood, it should

would show some battering and warping due to the water action – the specimen is near pristine. The hoof from Stanton’s Cave is a good example that a bison was actually in the river corridor of at least the Marble Gorge. The hoof was directly radiocarbon dated to the late Pleistocene (Table 1).

TABLE 2. Diet of Rancholabrean-age *Bison* on the Colorado Plateau reconstructed from microhistological remains recovered from preserved dung. Data for Cowboy Cave from Hansen (1980); data from other caves from Mead and Agenbroad (1989). Data expressed as percent value; T = trace value.

<u>Diet</u>	<u>Cowboy Cave</u>	<u>Grobot Grotto A</u>	<u>Grobot Grotto B</u>	<u>Hooper’s Hollow</u>	<u>Mammoth Alcove</u>
GRAZE					
<i>Agropyron</i>	1	2	-	-	-
<i>Bromus</i>	-	9	12	T	-
<i>Carex</i>	12	3	15	-	2
<i>Equisetum</i>	2	3	1	-	-
<i>Oryzopsis</i>	4	-	-	-	-
<i>Sporobolus</i>	74	74	72	93	47
<i>Stipa</i>	5	-	-	-	-
BROWSE					
bark	-	2	-	3	30
<i>Chenopodium</i> -type	T	-	-	-	-
<i>Clematis</i> -type	T	-	-	-	-
<i>Chrysothamnus</i>	-	5	-	-	-
<i>Ephedra</i>	-	-	-	T	-
<i>Lupinus</i>	-	-	-	T	-
moss	-	2	-	-	-
<i>Picea</i>	-	2	-	-	-
<i>Quercus</i>	-	-	-	2	2
<i>Yucca</i>	-	-	-	-	17

ARCHAEOLOGICAL RECORD

Skeletal and Organic Remains-Identifying skeletal remains of *Bison* can be confused with those of the introduced (post-contact) cattle (*Bos*), but there are characters that permit identification levels of certainty from ‘excellent’ to ‘probable’ (Balkwill and Cumbaa, 1992).

Some of the issues around the identifications are circular in reasoning and outcome. If a zooarchaeologist feels that bison probably were not in the area of the research, then the identifications will likely be *Bos* (if of post-Spanish contact age) or classified with a general term such as ‘Artiodactyla.’ This ‘data’ is then often used to

illustrate that bison were not in the region. Also, many zooarchaeological reports do not go into details as to how a particular identification was assembled. For instance, a fairly large number of artiodactyl remains were recovered from the 14th-century pueblo of Homol'ovi II, immediately east of Flagstaff, Arizona (Szuter, 1991). Most of the identifications indicate only 'Artiodactyla', along with a few *Antilocapra-Ovis* (pronghorn-bighorn), *Antilocapra*, and Cervidae (elk family containing the elk, wapiti, *Cervus*). Typically even a fragment of a metapodial (such as recovered at the locality) would permit the identification of a large artiodactyl, such as bison or cow, from the more slender forms found on deer, pronghorn, sheep etc.; however, conservatively these were labeled just as 'Artiodactyla.' Surely the researcher would have been able to distinguish the remains from other artiodactyls such as the peccaries (Suiformes) and camels (Tylopods). The point is that there may be more data in the collections but not in the literature. Accordingly, no *Bison* or *Bos* are recorded from the pueblo sites of Homol'ovi II or Walpi (Szuter, 1991).

Agenbroad and Haynes (1975) do illustrate that bison remains have been recovered from Awatovi, although Olsen (1978) does not include the bison in the zooarchaeological material from either the pre-hispanic occupation mound or the Hopi dwelling units.

Bison Alcove (informal designation for 42GR538) is a large rock shelter located in Arches National Park, Grand County, southeastern Utah (Mead et al., 1991). The dry, sheltered environment has permitted the preservation of numerous delicate paleontological and archaeological remains including the keratinous horn sheath, hoof, and bone remains. These specimens indicate the presence of a single, young adult. Direct radiocarbon dates were produced on the bison keratin. All dates can be considered a single event in time, having occurred between A.D. 1405 and 1420 in scenario 1 – just prior to Spanish contact in the region. Scenario 2 depicts an age between A.D. 1535 to 1605 – just prior, during, or just after Spanish contact on the Colorado Plateau (see discussion in Mead et al., 1991). The remains in the alcove (of any age) imply that bison were in the region and they were not a common element of the local animal community (see discussion below about historic records).

Dung attributed to bison was recovered in abundance in Stratum 1b in Cowboy Cave, Wayne County, Utah (Hansen, 1980). Hansen analyzed the dung for microhistological content and determined that these bison along the Orange Cliffs were consuming predominantly grasses and sedges (Table 2). Only one juvenile mandible fragment of bison was recovered, coming from Stratum 1b. Lucius (1980) indicates a polished edge on the bone but does not indicate if this refers to natural or human modification. Radiocarbon analyses from Stratum 1b indicate that deposition is consistently older than 11,020 years B.P. (Jennings, 1980). No hide and fur artifacts or animal skin bags removed from the cave were identified as belonging to bison (Hull, 1980a,b). These reports would imply that bison were in the region only during the late Pleistocene, not during the Holocene.

A report documents the results of archaeological inventory, excavation, and analysis of cultural resources within a 45-km long corridor of the Island-in-the-Sky district of Canyonlands National Park, Utah (Osborn, 1995). Radiometric dates for the archaeological sites range from 2990 to 120 B.P. (approximately 1400 B.C. to A.D. 1655-1950; Osborn, 1995). Faunal specimens were identified as *Bos/Bison*, *Bos*, and

Bison bison remains. Locality 42SA8502 dates from about A.D. 900-1205 to 1235-1415 and records *Bos/Bison* and *Bison bison* in fair percentages. The Alcove Spring locality (42SA8512) dates to about A.D. 1345-1650 and records *Bos/Bison* (in other words, it could be pre-Spanish and it could be post-contact; the precision of the date was not available to the researchers). Although the *Bos* could be present at the Alcove Spring locality, it is highly unlikely that this designation is correct for 42SA8502, based on its radiometric age assignment (Osborn, 1995).

No *Bison* or *Bos* remains were identified from the salvage excavations in lower Glen Canyon (Long, 1966), north and east of Navajo Mountain (Lindsay et al., 1968), or from the Prayer Rock District Basketmaker Caves (Morris, 1980) – areas with taphonomic scenarios that could have preserved remains of *Bison* of late Holocene age had they been available or utilized. Excavations were not conducted deep enough in the shelters to recover early Holocene or Pleistocene-age remains. As one might expect, no *Bison* were recovered in the narrow Colorado River corridor of the Grand Canyon (Fairley et al., 1994), although excavations and subsurface testings were not conducted in caves.

Pictographs and Petroglyphs-The creation of pictures on rocks to symbolically communicate an idea or concept appears to be a uniquely human characteristic. The broad domain of rock art comprises two generally recognized expressions: petroglyphs and pictographs. As Ekkehart Malotki has stated in Malotki and Weaver (2002) “Ideally, the intellectual challenge of interpreting rock art in a meaningful way would require an investigation of the art from the perspective of the individuals who produced it” (p. xii). The Grand Canyon region has had a number of prehistoric cultural traditions, including: Anasazi, Patayan, and Cohonina. Historic (and likely protohistoric) traditions in the same region include: Havasupai, Southern Paiute, and Hualapai. Any and all of these groups produced rock art in the Grand Canyon region. “To shed light on the function of a given rock art site, it is imperative that the site be placed in not only its cultural but also its temporal context. Establishing the age of rock art is an extremely challenging task and in many instances virtually impossible with the dating strategies available to researchers today” (p. xvi; see discussion within). “Most Colorado Plateau rock art-of both prehistoric and the historic periods-constitutes attempts to propitiate the gods and other supernatural forces to ensure individual or collective well-being” (p. xxiii). “Shamanism is rooted in animism... Animism, therefore, is regarded as the earliest and most fundamental underpinning of religious thinking” (p. xxiv).

With these statements, it is probably be safe to say that if bison were to be found in the Grand Canyon region at any time while people were hunting the same region (prehistorically, protohistorically, or historically), their existence would probably be recorded in one way or another as a rock art image. Bison rock art is found on the Colorado Plateau (see below), however, its record within the confines of GRCA are non-existent. Ekkehart Malotki (personal communication, July 8, 2002) has indicated that of all the areas of the Colorado Plateau, the Grand Canyon is the least understood and has received the least intensive field explorations. In other words, ‘who really knows what is out there in the Grand Canyon – who has systematically looked as they have done so methodically in the Glen Canyon, Canyonlands, Arches, and elsewhere?!’ Part of the reason is the remoteness of the eastern Grand Canyon, which is available, realistically

only via extended hiking in the backcountry and as day hikes from the river corridor. The vast plateau country of the western Grand Canyon (e.g., Shivwits and Uinkaret plateaus) is virtually untouched to methodical paleontological and zooarchaeological research. Given the inadequate record, here is what is known and is published.

What is depicted as bison, and what is recognized as bison, is typically a bovid-styled animal with short, recurved horns (versus the back-swept, curled horns of the bighorn sheep, *Ovis canadensis*) and has a distinct dorsal hump. Bison are clearly illustrated at Nine Mile Canyon (between Uintah Basin and Price, Utah) at sites 2, 4, 10, 15. Apparently these are likely produced by 'Fremont' culture and therefore date probably a few hundred years around A.D. 900-1100 (Castleton, 1984). A bison is also depicted on the Newspaper Rock in the Canyonlands National Park region. I am not certain if a bison is depicted on the Mobius Panel (KA3385) along the Escalante River area of GLCA (Tokioka, 1992). A more stylized bison is recorded as possibly Paleoindian in age for Upper Sand Island, San Juan County, Utah (Malotki and Weaver, 2002). A deeply varnished and darkened image (=fairly old; Paleoindian in age?) of a bison is found near Winslow, Arizona, in the Palavayu area (west of Petrified Forest NP, Arizona; McCreery and Malotki, 1994).

Probably the most intriguing bison rock art in its relation to the Grand Canyon region is a panel of images that have the same degree of patina (and therefore would presumably be the same age and therefore are assumed to be associated). The panel shows horses (some with riders) along side of a bison. Some viewers might be inclined to say that this is a historic depiction of riders herding a cow (*Bos*). Others might see the panel as depicting hunters going after a bison. The style of the horns implies to me that the animal is a bison. E. Malotki (personal communication July 8, 2002) has indicated that his opinion is that the animal represents a bison. The locality is at the base of the Grand Wash Cliffs (Weaver, 1992), north of Lake Mead Recreation Area, but I am not sure if it is on Grand Canyon-Parashant National Monument or on BLM lands.

SPANISH AND EARLY SETTLERS' DIARY ACCOUNTS

"The earliest written record of bison in Arizona is the sighting of a small herd in northern Arizona by a Spanish conquistador in the 1500s" (Bison Management Team, 2002). Similar statements have been used for years, however no precise reference has been provided as a source of proof, and given the difficulties of locating the translation of diaries, this is expected. I find that if one quickly scans the diary accounts, it appears that bison were encountered 'at' the Grand Canyon, especially if one reads just the chapter headings. However, with detailed reading it is apparent to me that no bison have been observed actually 'at' the Grand Canyon.

Bison are typically referred to as 'cattle,' often 'curly haired cattle' in the early Spanish diaries. Spanish accounts change early on and use the word 'cíbolo,' meaning bison, and sometimes they use the word 'Mexican bull' (in Francisco Fernández del Castillo's version of *Luz de Tierra Incógnita* by Captain Juan Mateo Manje during the years 1693-1721; see Karns, 1954). One can encounter any of these words for bison in the early literature. True *Bos* were not encountered or brought with the conquistadors during these early explorations.

Hammond and Rey (1940) published the *Narratives of the Coronado Expedition, 1540-1542*. This is proving to be a critical source and the likely basis for the implied 'conquistador encounters of bison at the Grand Canyon.' Don Pedro de Tovar was ordered to travel north and ultimately 'discovered' Tusayán' (or Tuzán, Tuçayán; meaning the Hopi land). He was told about a great canyon and river farther north but he returned to tell Coronado about his ventures. Don García López de Cárdenas was then sent to explore this canyon – now known to be the Grand Canyon. He explores much of at least one side canyon, with the help of Native Americans (yet never reaches the river), but the expanse and lack of water (even after some of the local Indian women cached water for them in gourds) forces them to return. No bison were actually observed either 'in' or 'approaching' the Canyon during this exploration.

Here is where I feel the error about bison slips into the account used by various researchers. When Don García López de Cárdenas leaves the Grand Canyon, he mentions observing bison; however, detailed reading indicates that by the time he and his men see the bison they have traveled to Cibola. Cibola (named possibly in response to the local occurrence of cibolo, the bison) is the name they use for the seven major Río Grande pueblos around Zuni (Hawiku), New Mexico. Based on the written account by Pedro de Castañeda of Nájera (or Najera), no bison were actually encountered 'at' or 'in' the Grand Canyon visited by the above conquistadors. Bison are found at Acuco (=Acoma, New Mexico), but as with Zuni, this is a logical distribution for bison and this locality does not equal the Grand Canyon. Captain Juan Jaramillo produced a narrative of his travels with General Francisco Vázquez Coronado during in the same years as those above and indicates that 'cattle' (bison) are common around Cibola. Zuni to Acoma are the western extension of grasslands from the prairies of New Mexico.

Padre Fray Francisco Silvestre Vélez de Escalante was a Spanish Franciscan missionary and explorer who with Padre Fray Francisco Atanasio Domínguez and party encountered one lone bison on September 11, 1776 (east of Snake John Reef, near K-Ranch) east of the Green River in Utah. The journal has no mention of bison while his group traversed the Kaibab Plateau, House Rock Valley, Vermillion Cliffs, and entered the Colorado River (called then the Río del Tizón and El Río Colorado) at what is now known as the Crossing of the Fathers in Glen Canyon. They did see near Moenkopi Wash evidence of 'Moqui cattle,' which are *Bos* that were being herded by people from various Hopi villages, having received them from earlier Spanish missionaries (Vélez de Escalante, 1792).

Haines (1970) indicates that 'buffalo' were encountered between the Great Salt Lake and the Wasatch Range, but this was predominantly north to the Bear River region. Some bison were reported to have been located south, being "...hemmed in on the west by the desert, on the south by canyons, and on the east by the Colorado mountain mass" (Haines, 1970:32). I am not sure what 'on the south by canyons' actually refers to but it could mean the Colorado River or the region around St. George, Utah. This aspect is difficult to pinpoint on a map but given the horse-bison petroglyph shown by Weaver (1992) along the base of the Grand Wash Cliffs, it would appear that some bison roamed that region immediately adjacent to the Grand Canyon. If so, in turn, bison could have traveled along the Colorado River floodplain in the Grand Canyon near Rampart Cave (River Mile 274.5), but not much farther up river than that – however, direct data for this scenario is lacking! I am not able to determine Haines source of data for the above.

Haines (1970) does mention that a small herd of bison was established on the 'good range country' in the valleys around Grand Junction, Colorado until the late 19th century.

As an aside, but I think ultimately relevant to this overview, Fray Marcos de Niza and Captain Juan Jaramillo (on separate journeys) from Culiacán, Mexico, up the San Pedro River of southeastern Arizona to Cibola did encounter people with bison cultural material (such as hide shields). When reading sections of the accounts the reader might jump to the conclusion that bison were in southern Arizona and elsewhere along the route during the years 1538 through 1542. However, again with detailed reading one finds out that upon questioning by the conquistadors, the bison material is not locally procured but traded from Cibola.

DISCUSSION AND CONCLUSIONS

THE MAJOR QUESTIONS BEING ADDRESSED IN THIS REPORT CAN NOW BE EXAMINED

Were bison ever present in GRCA?

Yes (see below).

Where did bison live or frequent in GRCA?

'Live' or 'frequent' is a hard to reconcile. Does the record represent a 'viable population/herd' or 'a lone explorer' – remembering that the fossil and archaeological records represent snap-shots of the past. It is here that we seem to put our own emotions or pet theories into the discussion and conclusion. For example, if we have an observation many years ago of a condor in or near the Grand Canyon region, we tend to say that this vulturid was there in the Grand Canyon, implying a viable population; this happens because most people want the condor there now. In contrast, it seems that many people do not want the bison in the park today. Does one record of a bison (one bone, one hoof, one petroglyph) represent a sample of a viable herd? If so, then allow the animal access today. Or, does that sample represent the lone explorer, and therefore the bison was never really an active part of the park? If so, then keep it out of the park today.

The two records of bison in the park are from Stanton's Cave and Sandblast Cave. The Stanton's Cave specimen is a hoof in prime condition. It is not a bird-preyed remain and it does not appear to be an example of a floated and transported carcass. It appears to me to be representing an animal that was alive outside of the cave, along the river. The Sandblast Cave specimens include a single tooth and a toe bone, both which could be accounted for by condor eating (i.e., a distance transport) or from packrat collecting (i.e., a local collection).

When did bison occur in GRCA?

The Stanton's Cave evidence of bison 'in' the Grand Canyon dates to 12,790 yr B.P. (a direct date on the keratin hoof). The date can be considered a very accurate analysis. The Sandblast Cave samples date sometime older than 40,000 years. In both cases, the bison are Pleistocene in age. No bison has been found and dated from within GRCA from Holocene or historic times.

Were bison ever present adjacent to the Grand Canyon?

Yes - there is evidence to suggest that bison were to be found surrounding the Grand Canyon at varying times.

Where and when did bison live adjacent to the Grand Canyon?

Bison dung is found in a number of sandstone alcoves immediately up-river from the Grand Canyon in the Glen Canyon region (Table 1). All of these remains are of late Pleistocene age, based on indirect and direct radiocarbon analyses. Bison subfossils were recovered from a sandstone alcove in Arches National Park, as well as at a number of archaeological sites in southern Utah. Bison are depicted on a petroglyph immediately outside of the lower Grand Canyon along the Grand Wash Cliffs. The age is assumed to be historic based on its association with horses and a horse rider (see discussion above for assumed association). Bison are also recovered elsewhere on the Colorado Plateau north and east of the Grand Canyon of varying Holocene ages. Bison herds, of varying size, are recorded in diaries as occurring along the west side of the Colorado Plateau at the Grand Wash Cliffs, along the plateaus north of the river (Grand Junction and Green River), and on the east side of the Colorado Plateau near Acoma and Zuni, New Mexico. The result seems to be that Holocene and even historic bison were around GRCA.

How reliable is the data set for the answers to the above questions?

The data set contains information that ranges from 'solid' to 'good' to 'of questionable use.' Overall it provides implications but the data set is small enough that it can be used to answer or 'prove' anything one wants. It points out to me that really we know precious little about the Grand Canyon proper (GRCA). Because so little has been studied actually 'within' the Grand Canyon (away from the river corridor) or on the expansive plateau country bordering the north and west end (e.g., Shivwits, Uinkaret, Kanab plateaus), I would say we could have had herds of bison (or camels, or peccaries or mammoths) on select regions and we just have not looked for them. There are many areas precisely suitable physiographically for bison, but we have not explored those regions to see if bison were or were not there.

What, if any, conclusions are there from the data set?

As far as I can determine from the various readings (Hammond and Rey, 1940; Karns, 1954; Haines, 1970; chapters within Snow, 1992) by the time the conquistadors are exploring Sonora, Mexico, north through Arizona to northwestern New Mexico in the mid-1500s, bison were not encountered and therefore were not established as a local population - until one reaches the western extent of the Great Plains and grasslands of Acoma, Zuni, and eastward from there. Bison were established as apparently isolate, small herds along the west side of the Grand Wash Cliffs north to the Great Salt Lake region, and east on the Colorado Plateau across Utah to the Grand Junction area of Colorado. There is no evidence that bison were observed on the rims of the Grand Canyon or within the canyon at any time in the historic past.

I have shown that bison did occur in and around the Grand Canyon, but we should not be using the known data set to imply expansive herds such as found on the Great Plains. The best data implies to me that bison were probably always part of the greater Grand Canyon region during the Pleistocene but typically a rare component – in the areas we have searched. But all of this dates to the Pleistocene, not the Holocene and not the historic. It appears that by the time the Spanish begin their conquest of the region, bison were extremely rare on the Colorado Plateau (either due to climate deterioration or over-hunting or both) and likely not 'in' the Grand Canyon – but again we have no data from the flat plateaus abutting the Canyon on the northwest end.

Can bison adequately inhabit GRCA lands as a viable 'wild' animal population, or will the species need to be cared for?

This all probably is related to the carrying capacity of the lands that bison are allowed to inhabit. It is likely that more bison were in the general region of the Grand Canyon during the Pleistocene due to the climate regime at that time.

Nests and middens (debris piles) produced by the cricetid rodent, *Neotoma* (packrat) have been used for years to reconstruct past environments of the arid Southwest (Betancourt et al., 1990). In the Grand Canyon, packrat midden studies have occurred predominantly in the eastern 70 river miles and the western-most, lowest, 5 river miles. Packrats are predominantly browsers, eating the more woody plant species and rarely and randomly sampling the graze plants. Because of this, shrubs and trees of the desert and woodland communities are probably accurately reconstructed, whereas grassland and related communities are likely not well portrayed – areas likely to be inhabited by bison and other grazers. Late Pleistocene packrat midden studies have shown that most of the alterations to the vegetational communities have been with elevational changes in distribution. For instance a juniper (*Juniperus*) and single-leaf ash (*Fraxinus*) open woodland occurred down to the Colorado River throughout the Grand Canyon (900 m below their common occurrences today); ponderosa pine (*Pinus ponderosa*) and pinyon pine (*Pinus edulis* and *P. monophylla*) were not present, or rarely so, in the Grand Canyon region throughout all of the Wisconsinan Glaciation (Cole, 1990; Coats, 1997; Mead et al., in press).

Today the Grand Canyon region is on the edge of receiving significant warm-season precipitation (often referred to as summer monsoon). Packrat middens studies determined that warm-season precipitation was not significant during the most recent glacial. However another data set has an alternative scenario.

C₄ plants are most common today in desert and subtropical regions, areas with warm-season precipitation. Warm-season grasses comprise the largest component of the C₄ plant cover in the arid Southwest and into northern Sonora (Cronnin et al., 1998). C₃ plants are considered more typical of a cool-season regime. Fossil packrat midden records from the arid Southwest imply that C₃ plants dominated the plant communities during the glacial regime and that C₄ grasslands formed only subsequent to a postglacial warming and a shift to summer-dominated precipitation (Van Devender, 1990).

More recent data and interpretations necessitate a different scenario. C₄ signatures recovered from fossil herbivore tooth enamel provide evidence that there was a C₄ plant dominance in the arid Southwest during the glacial, and that summer rainfall was actually significant (Cronnin et al., 1998). C₄ plants probably occurred in basin

grasslands, savannas, and wetland communities (see discussion in Cronin et al., 1998). The net result implies that a glacial climate regime, although overall cooler, was a richer mosaic of winter and summer precipitation than occurs today. Certainly the extreme high summer temperatures (and their drying effects) were not the dominating climatic factor as they are today in those same regions.

If the concept of Cronin et al. (1998) is correct for the Grand Canyon region, then it is likely the higher elevations and plateau lands (e.g., Marble Platform and Shivwits, Uinkaret, and Kanab plateaus) were significantly more grassy, if not a mosaic with sagebrush (*Artemisia*), and therefore ideal for viable herds of bison (among other herbivores). At this point, this is only speculation as these areas have not been satisfactorily studied for past community reconstructions (Fig. 3; Anderson et al., 2000).

The climate and plant and animal communities significantly changed during the latest Pleistocene and into the early Holocene (Van Devender, 1990). Probably the last major change in climate and vegetational communities began about 4,000 years ago. It is likely that these communities changed to a more hot and arid landscape around the Grand Canyon, eradicating the region of bison as viable herds.

It is also likely that the only places currently available for viable 'wild' populations of bison would be the higher plateaus where there is more available water from warm-season precipitation and therefore more grasslands. Such areas may include select areas of the Kaibab and Kanab plateaus, and maybe even areas of the Shivwits and Uinkaret plateaus.

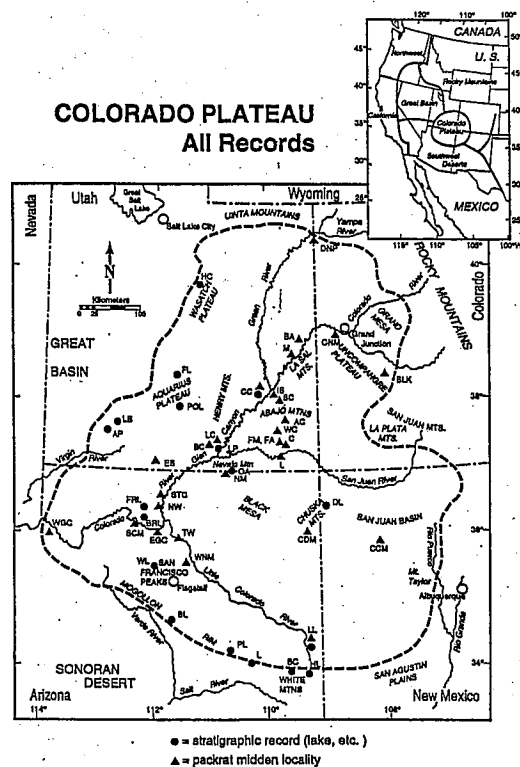


FIGURE 3. Location map of the general physical features of the Colorado Plateau and locations of major paleobotanical sites (from Anderson et al., 2002).

MY OPINION BASED ON THE AVAILABLE DATA

The scant facts dictate that any deductions drawn from the known data discussed above are at best **inconclusive**.

It is my opinion that bison were adjacent to and rarely within the Grand Canyon. They were probably fairly common (abundant?) only during the glacial regimes of the Pleistocene, at least for the Wisconsinan Glaciation. Due to major changes in climate (mainly the increase in summer temperatures) during the Holocene, especially the most recent 4,000 years, viable herds of bison have diminished over most of the Southwest, especially the southern Colorado Plateau around the Grand Canyon. What impact human populations had on the diminishing herds is not understood at all. It appears that by the time of Spanish contact (about A.D. 1540), bison were gone from the Grand Canyon proper and the immediate surrounding landscape. However, bison could be encountered occasionally a little farther north (central Colorado Plateau) and west as small, isolate herds and individuals, and abundantly to the east where the western extent of the Great Plains abut the Colorado Plateau near Zuni, New Mexico.

The major drawback that I see from the above conclusions is that key areas of the northwestern portion of the greater Grand Canyon (Shivwits and Uinkaret plateaus; regions that would appear to be highly suitable to bison as long as a carrying-capacity grassland was available) have not been adequately explored for bison remains – of any age. I would predict that bison remains should be found in caves and alcoves adjacent to flat plateaus abutting canyonlands in this region (hopefully a cave with dried dung for radiocarbon analyses and dietary reconstructions). Caves at these higher elevations should contain a record of bison, if it was there during the late Holocene or Spanish contact time. I would also expect to find rare remains of bison in the western-most portion of the Grand Canyon where the Colorado River begins to exit the Grand Wash Cliffs – areas where there was a narrow floodplain bordering the river. Much of this area is now under Lake Mead; however there are some potentially very important dry caves and shelters immediately above the lake level and close to the old river floodplain (e.g., Muav Caves). These caves and packrat middens may contain the rare remain of bison, although I would predict that they would all be of latest Pleistocene to earliest Holocene in age – not late Holocene or historic time.

I doubt that bison was ever an inhabitant of the steep, typical Grand Canyon scenario – its skeletal structure is not made for the talus slopes and cliffs. Given enough grassland, they should have been common on the rim-country. I think that bison would venture within the Grand Canyon proper anywhere a gentler slope would permit entrance. An example of this might be down Saddle Mountain and on to the plateaus above the Nankowear region. I have recovered the extinct shrub-ox (*Euceratherium*) and camel (*Camelops*) in dry caves of this region (Mead et al., in press). I believe bison could have been there if these animals made the trek, but the limited paleontological exploration has only discovered the shrub-ox and camel.

WHAT OPTIONS ARE THERE FOR GRCA CONCERNING THE DATA SET?

1. Use the data set as it is now understood. Bison were not 'in' GRCA during or since the initial Spanish conquest, therefore, 'bison are not native to the Grand Canyon.' With this scenario the NPS and GRCA would force an elimination of the currently invading bison.

2. Use the data set as it is now understood. Bison were in and adjacent to the Grand Canyon over the past 11,000 years and therefore can be considered 'native' to the Park. With this scenario the NPS and GRCA allow the invading bison to stay in the park. However, it must be established what carrying capacity GRCA lands have for bison. It must also be decided whether or not bison can exist on GRCA lands as 'wild' animals or if they will have to be supported. I personally see little reason to have an animal on NPS lands that must be cared-for in an un-natural way – they should not be forced to fit a landscape and community. If they have to be supported, then NPS has to determine if this fits what GRCA wants in its policy for native animal and plant communities. Although against NPS and GRCA policy, *Bos* are living in the more arid, desert lands of the far western landscape of the park. Can *Bison* live in this same niche if *Bos* were removed? I suspect not. Qualified range management specialists might examine this aspect.

3. Use the data set as it is now understood. Bison were observed and recorded from adjacent lands to the Grand Canyon and likely may have occurred on the flat plateaus rimming the Canyon. However, because these areas have not been assessed for bison remains, the NPS and GRCA will implement a contract(s) to evaluate these regions to determine when and where bison lived, and when they became eradicated from the immediate park landscape. Such a contract may conclude that bison were likely never a viable population within or on lands rimming the Grand Canyon. It may also conclude that bison were common as small herds in the grassy valleys of the Shivwits and Uinkaret plateaus right to the rim edges of Parashant, Whitmore, etc. canyons, only to be eradicated by people and the effects of changing climate of the most recent 2,000 years.

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