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# Clovis Hunting and Large Mammal Extinction: A Critical Review of the Evidence

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*The North American archaeological phenomenon known as Clovis is famous for the fact that a number of sites that contain diagnostic Clovis artifacts also contain the remains of mammoth and perhaps other extinct genera. In the past, this has led many to assume that Clovis subsistence adaptations were organized around large, now-extinct mammals. It has also seemed to support the argument that the colonization of the Americas by hunters about 11,500 years ago caused the extinction, either directly or indirectly, of some 35 genera of primarily large mammals. Here, we review all sites known to us that have been suggested to provide evidence for the association of Clovis-age archaeological material with the remains of now-extinct Pleistocene mammals. Of the 76 sites reviewed, only 14 provide strong evidence that Clovis-aged people hunted such mammals. Of these sites, 12 contain the remains of mammoth, while two contain the remains of mastodon. Although the prime focus of the analysis we present is on Clovis-age archaeological associations with now-extinct mammals, we conclude that there is no evidence provided by the North American archaeological record to support the argument that people played a significant role in causing Pleistocene extinctions here.*

**KEY WORDS:** Clovis; Pleistocene extinctions; North America; mammoth; mastodon.

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# INTRODUCTION

The initial human colonization of North America took place in late Pleistocene times, although exactly when during the late Pleistocene has been a matter of longstanding debate. The recently reported evidence from the site of Monte Verde, Chile (Dillehay, 1997; see Meltzer *et al.*, 1997) makes it almost certain people were present in South America well before the appearance of Clovis groups far to the north at about 11,500 years ago (all ages in this paper are in radiocarbon years), but it remains unclear what, if any, historical relationship might obtain between the groups who left behind these very distinctive archaeological remains (Meltzer, 2002).

The apparent resolution of the question of whether there was a pre-Clovis occupation in the Americas throws Clovis itself into new light, and prompts a reevaluation of some of the traditionally accepted notions about that archaeological phenomenon. Much attention nowadays is focused on an exploration of its roots, whether in Siberia or within North America itself; on the means by which Clovis so suddenly appeared across North America at about 11,500 years ago (was it a rapid spread, or merely diffusion of a new and highly distinctive technology—fluted points—across an extant population?); and on just what this wide-ranging and apparently fast-moving people/technology reflects in terms of human adaptation (Anderson, 1995; Kelly, 1999; Meltzer, 1995, 1997, 2002; Surovell, 2000).

Two facets of the Clovis adaptation that have long been of particular interest relate to the apparent mobility of these people on the late Pleistocene landscape and to their subsistence strategies (e.g., Haynes, 1982). There is now little doubt that these groups had ranges that extended considerable distances, and that their mobility was on a scale generally far greater than what is to be seen during later prehistoric times. Although Clovis period mobility continues to be discussed, much of that discussion is focused on the details of what that mobility represents: whether frequent, small-scale moves, or fewer long-distance ones; to what degree mobility varied across the continent; and the factors that apparently enabled groups to move so rapidly across a landscape that seems to have been empty of other people (Anderson, 1990, 1995; Anderson and Gillam, 2000, 2001; Kelly, 1999; Meltzer, 1995, 2002; Moore, 2001; Moore and Moseley, 2001; Surovell, 2000).

Traditionally, it had been assumed that large mammals formed a primary component of Clovis-aged human subsistence, but that assumption is no longer commonly made (e.g., Johnson, 1977, 1991; Meltzer, 1993a; Stanford, 1999). Closely related to this issue is, of course, the larger question of whether Clovis predation led to the extinction of some 35 genera of primarily large mammals, as argued by Martin for many years (e.g., Martin, 1967, 1973, 1984;

Martin and Steadman, 1999). Yet, unlike the discussions of Clovis mobility, there is no consensus as to the nature of Clovis-aged subsistence. In part, this is for the simple reason that the empirical record currently remains inadequate to the task of deciphering subsistence patterns. In addition, however, there is a surprising lack of site-by-site systematic evaluation of the available data that are relevant to subsistence questions [Haynes (1991) is an exception, but he examines only Clovis-age proboscideans, and does not include all such occurrences]. Indeed, skeptical as we have been about the role of now-extinct mammals in Clovis subsistence (e.g., Grayson, 1984a,b, 1988b, 1993, 2001; Meltzer, 1986, 1988, 1993a,b), we are also well aware that we have not fully and systematically explored the data in question. The literature consists largely of impressionistic statements about Clovis subsistence, occasionally based on lists of species found at what are argued to be, or not to be, "kill sites" (e.g., Haynes, 1970).

We begin that evaluation here, focusing not on all possible subsistence remains from Clovis-aged sites, but on asserted associations between human activities and the remains of now-extinct Pleistocene mammals.

The question of Clovis subsistence is a critical one if we are to understand how groups may have moved across a landscape that seems to have been largely devoid of other people. If, as the traditional model had it, Clovis groups were big-game hunters, that adaptation may have reduced the time needed to translate subsistence-related knowledge appropriate to one landscape into a form appropriate for another (Kelly and Todd, 1988). In fact, it has been assumed by some that a diet focused on large mammals might provide the adaptive underpinnings for the observed mobility of Clovis-aged peoples (Kelly and Todd, 1988; Mason, 1962). Were this the case, such a dietary focus would also provide some measure of support for a human role in causing terminal Pleistocene extinctions. We do not address these issues here. What we do address is the evidence suggesting that Clovis people preyed on a diverse set of large mammals, mammals whose extinction they are argued by some to have caused.

## DERIVING THE DATA

The research question we seek to answer is simple. Which of the 35 genera of now-extinct Late Pleistocene North American mammals have been found in Clovis-age archaeological sites in such a way as to suggest that they had been hunted (Table I)? Even though the extinction of the seven genera of carnivores on this list has been attributed to the extinction of their prey (e.g., Martin, 1967, 1984), we include all genera in the review that follows.

**Table I.** The Extinct Late Pleistocene Mammals of North America

| Order | Family | Genus | Common name |
|---|---|---|---|
| Xenarthra | Pampatheriidae | *Pampatherium*[a] | Southern Pampathere |
| | | *Holmesina* | Northern Pampathere |
| | Glyptodontidae | *Glyptotherium* | Simpson's Glyptodont |
| | Megalonychidae | *Megalonyx* | Jefferson's Ground Sloth |
| | Megatheriidae | *Eremotherium* | Rusconi's Ground Sloth |
| | | *Nothrotheriops* | Shasta Ground Sloth |
| | Mylodontidae | *Glossotherium*[c] | Harlan's Ground Sloth |
| Carnivora | Mustelidae | *Brachyprotoma* | Short-faced Skunk |
| | Canidae | *Cuon*[b] | Dhole |
| | Ursidae | *Tremarctos*[b] | Florida Cave Bear |
| | | *Arctodus* | Giant Short-faced Bear |
| | Felidae | *Smilodon* | Sabertooth Cat |
| | | *Homotherium* | Scimitar Cat |
| | | *Miracinonyx* | American Cheetah |
| Rodentia | Castoridae | *Castoroides* | Giant Beaver |
| | Hydrochaeridae | *Hydrochoerus*[b] | Holmes's Capybara |
| | | *Neochoerus* | Pinckney's Capybara |
| Lagomorpha | Leporidae | *Aztlanolagus* | Aztlan Rabbit |
| Perissodactyla | Equidae | *Equus*[b] | Horses |
| | Tapiridae | *Tapirus*[b] | Tapirs |
| Artiodactyla | Tayassuidae | *Mylohyus* | Long-nosed Peccary |
| | | *Platygonus* | Flat-headed Peccary |
| | Camelidae | *Camelops* | Yesterday's Camel |
| | | *Hemiauchenia* | Large-headed Llama |
| | | *Palaeolama* | Stout-legged Llama |
| | Cervidae | *Navahoceros* | Mountain Deer |
| | | *Cervalces* | Stag-Moose |
| | Antilocapridae | *Capromeryx* | Diminutive Pronghorn |
| | | *Tetrameryx* | Shuler's Pronghorn |
| | | *Stockoceros* | Stock's Pronghorn |
| | Bovidae | *Saiga*[b] | Saiga |
| | | *Euceratherium* | Shrub Ox |
| | | *Bootherium* | Harlan's Musk Ox |
| Proboscidea | Mammutidae | *Mammut* | American Mastodon |
| | Elephantidae | *Mammuthus* | Mammoths |

[a] Recent authors see *Holmesina* as the only pampathere in North America, but disagree among themselves as to the systematics of this family (de Iuliis *et al.*, 2000; Edmund, 1996). In the apparent absence of a detailed reassessment of the Texas specimen originally assigned to *Pampatherium* (Edmund, 1985), we have left this genus on our list.

[b] Genus survives outside of North America.

[c] Harlan's ground sloth continues to be referred to as both *Glossotherium* (e.g., Yates and Lundelius, 2001) and *Paramylodon* (e.g., McDonald, 1995).

Providing that answer requires that we first amass as comprehensive a list as possible of Clovis-age sites claimed to provide evidence for the association between artifacts and now-extinct Pleistocene mammals. To amass that sample, and to insure that we did not inadvertently bias our analytical efforts by considering only those sites we knew about already, we turned to FAUNMAP, an electronic database that documents the distribution of mammal species in the continental United States during the past 40,000 years (FAUNMAP, 1994). Initially, we tallied all FAUNMAP sites designated either "Clovis" or "Paleoindian" from mid-latitude North America south of the late Pleistocene ice sheets. We did not include North America north of the ice sheets, since occupations in those areas may have been isolated from, and not had any particular bearing on, the Clovis colonization of the rest of the continent. We also did not include sites claimed to be pre-Clovis in age, since it is Clovis-age foragers whose subsistence activities are at issue here, and whom Martin (1982, p. 403) has explicitly targeted as the cause of large mammal extinctions.

Sites designated as Folsom, Plainview, Late Paleoindian, or any other recognizably later Paleoindian occupation were also not included in the initial sweep through FAUNMAP, again because we are interested in the potential subsistence-related faunas of colonizing groups of Clovis age. We knew that using the generic "Paleoindian" in our initial sweep would potentially net post-Clovis occupations as well. Nonetheless, we chose to incorporate all of the sites identified in FAUNMAP as "Paleoindian" to ensure that all sites of the relevant age would be included in our sample. There is, for example, no Clovis *sensu stricto* in northeastern North America or in the Great Basin, but the users of Clovis-like fluted points there are arguably the region's first human colonizers and thus of interest in this study. In effect, we erred on the side of caution by casting our sampling net as widely as possible, so as to reduce the number of FAUNMAP sites that might slip through.

We are also aware that although FAUNMAP provides a large and relatively complete list of Clovis and Clovis-age sites, it is not comprehensive. Some localities were missed in the compilation (e.g., McLean, Texas), while others have only been discovered and reported since. We included as many of those additional localities as we could identify. On the other hand, some sites once thought to be archaeological but now convincingly rejected as such are correctly listed in FAUNMAP as paleontological [e.g., Gypsum Cave, Nevada (Heizer and Berger, 1970), Whitewater Draw, Arizona (Waters, 1986)]. Such sites are not considered here.

Proceeding in this manner produced an initial list of 76 sites in which extinct mammal remains of any kind were found in what appeared to be a Clovis or Paleoindian archaeological context (see Fig. 1 for site locations). Those sites are individually listed in Table II, which includes source information. While we are reasonably certain this is the most comprehensive list published to date, we are equally certain there are sites we have missed. However, there cannot be many of those, and their absence from our sample should not significantly affect the outcome of the analyses we present.

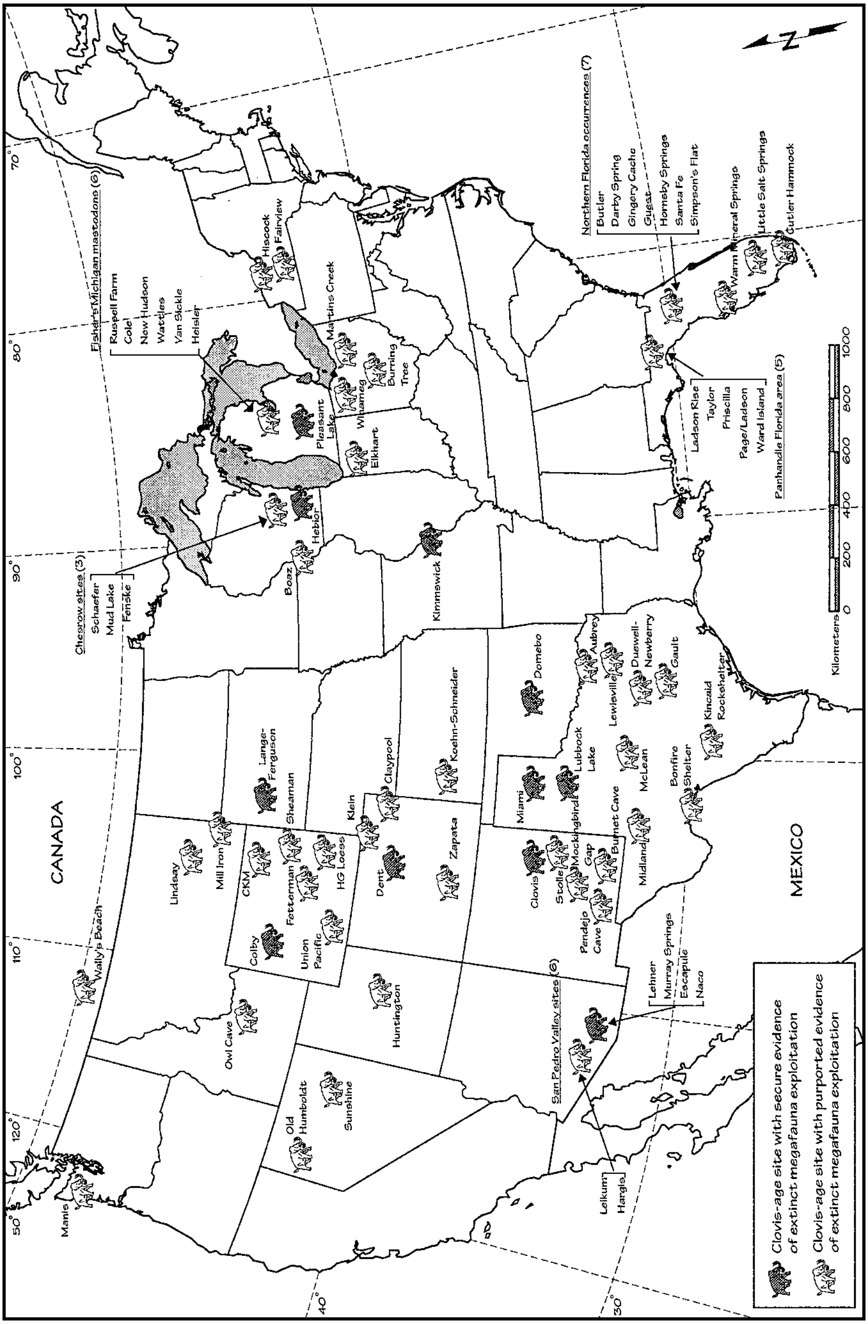

**Fig. 1.** The location of sites discussed in the text.

**Table II.** FAUNMAP Sites Identified as "Clovis" or "Paleoindian," With Additional Non-FAUNMAP Fluted Point Sites

| | Site | State | FAUNMAP machine number or reference if not in FAUNMAP |
|---|---|---|---|
| 1 | Agate Basin / Sheaman | Wyoming | 175 |
| 2 | Aubrey | Texas | 1933 |
| 3 | Blackwater Locality 1 | New Mexico | 6 |
| 4 | Boaz | Wisconsin | 925 |
| 5 | Bonfire Shelter | Texas | 122 |
| 6 | Burnet Cave | New Mexico | 1163 |
| 7 | Burning Tree | Ohio | Fisher *et al.*, 1994 |
| 8 | Butler | Florida | 1633 |
| 9 | Carter-Kerr-McGee | Wyoming | 196 |
| 10 | Claypool | Colorado | 559 |
| 11 | Colby | Wyoming | 181 |
| 12 | Cole | Michigan | Fisher, 1987 |
| 13 | Cutler Hammock | Florida | 1614 |
| 14 | Darby Spring | Florida | 1640 |
| 15 | Dent | Colorado | 566 |
| 16 | Domebo | Oklahoma | 277 |
| 17 | Duewell-Newberry | Texas | Carlson and Steele, 1992 |
| 18 | Elkhart | Indiana | Fisher, 1987 |
| 19 | Escapule | Arizona | 1083 |
| 20 | Fairview | New York | Fisher *et al.*, 1994 |
| 21 | Fenske | Wisconsin | Overstreet, 1998; Overstreet and Kolb, 2003 |
| 22 | Fetterman | Wyoming | Byers, 2002 |
| 23 | Gault | Texas | No published material on fauna |
| 24 | Gingery Cache | Florida | 1620 |
| 25 | Guest Mammoth | Florida | 1590 |
| 26 | Hargis | Arizona | 1091 |
| 27 | Hebior | Wisconsin | Overstreet, 1998; Overstreet and Kolb, 2003 |
| 28 | Heisler | Michigan | Fisher, 1987 |
| 29 | Hell Gap Loess Mammoth | Wyoming | 177 |
| 30 | Hiscock | New York | Laub *et al.*, 1988 |
| 31 | Hornsby Springs | Florida | 1639 |
| 32 | Huntington Mammoth | Utah | Gillette and Madsen, 1993 |
| 33 | Kimmswick | Missouri | 2000 |
| 34 | Kincaid Rockshelter | Texas | 800 |
| 35 | Klein | Colorado | Zier *et al.*, 1993 |
| 36 | Koehn-Schneider | Kansas | Johnson *et al.*, 1990 |
| 37 | Ladson Rise | Florida | 1652 |
| 38 | Lange-Ferguson | South Dakota | 737 |
| 39 | Lehner | Arizona | 1082 |
| 40 | Leikem | Arizona | 1080 |
| 41 | Lewisville | Texas | 714, 715 |
| 42 | Lindsay | Montana | 1080 |
| 43 | Little Salt Spring | Florida | 1662 |
| 44 | Lubbock Lake | Texas | 13 |
| 45 | Manis | Washington | Gustafson *et al.*, 1979 |
| 46 | Martins Creek | Ohio | Brush *et al.*, 1994 |
| 47 | McLean | Texas | Bryan and Ray, 1938; Sellards, 1952 |

**Table II.** (*Continued*)

|  | Site | State | FAUNMAP machine number or reference if not in FAUNMAP |
|---|---|---|---|
| 48 | Midland | Texas | Wendorf *et al.*, 1955; Holliday and Meltzer, 1996 |
| 49 | Miami | Texas | 798 |
| 50 | Mill Iron | Montana | Frison, 1996 |
| 51 | Mockingbird Gap | New Mexico | 1339 |
| 52 | Mud Lake | Wisconsin | Overstreet, 1998; Overstreet and Kolb, 2003 |
| 53 | Murray Springs | Arizona | 1079 |
| 54 | Naco | Arizona | 1081 |
| 55 | New Hudson | Michigan | Fisher, 1987 |
| 56 | Old Humboldt | Nevada | 1726 |
| 57 | Owl Cave | Idaho | 1497 |
| 58 | Page/Ladson | Florida | 1576 |
| 59 | Pendejo Cave | New Mexico | Chrisman *et al.*, 1996; MacNeish, 1996 |
| 60 | Pleasant Lake | Michigan | Fisher, 1984a,b |
| 61 | Priscilla | Florida | 1654 |
| 62 | Russell Farm I | Michigan | Fisher, 1987 |
| 63 | Russell Farm II | Michigan | Fisher, 1987 |
| 64 | Santa Fe | Florida | 1604 |
| 65 | Schaefer | Wisconsin | Overstreet, 1998; Overstreet and Kolb, 2003 |
| 66 | Simpson's Flat | Florida | 1657 |
| 67 | Stolle Mammoth | New Mexico | 2312 |
| 68 | Sunshine | Nevada | Huckleberry *et al.*, 2001; Jones *et al.*, 1996 |
| 69 | Union Pacific | Wyoming | 199 |
| 70 | Van Sickle | Michigan | Fisher, 1987 |
| 71 | Wally's Beach | Alberta | Kooyman *et al.*, 2001 |
| 72 | Ward Island | Florida | 1655 |
| 73 | Warm Mineral Springs | Florida | 1617 |
| 74 | Wattles | Michigan | Fisher, 1987 |
| 75 | Winameg | Ohio | Fisher, 1987 |
| 76 | Zapata | Colorado | Jodry, 1999 |

*Note.* Citations for FAUNMAP sites can be found in FAUNMAP (1994) using the machine number. Selected references are provided for non-FAUNMAP sites.

## ASSESSING THE DATA

Of course, this list of sites and the taxa therein cannot be taken at face value. Each case must be evaluated to assess the nature and strength of the association between the archaeological and faunal remains. We need to differentiate claims of association that are compelling from claims that are not (for a thoughtful approach to this issue, see Haynes and Stanford, 1984). We also need a means of differentiating evidence of hunting from evidence for other behaviors that could lead to an association between Clovis-age artifacts and the bones of now-extinct mammals in archaeological contexts.

Finally, and most obviously, we require published reports that provide sufficient detail to allow those assessments to be done.

Thus, once the initial list was in place, we carefully examined the primary source material for each site. The vetting involved two stages of cuts: the first sought to identify and eliminate all sites that fail to demonstrate at least a minimal association between the archaeological remains and the remains of the extinct mammals, such as their co-occurrence on the same stratigraphic surface. The second cut sought to identify and eliminate all sites that fail to demonstrate the use of the extinct mammals as subsistence resources.

## The First Cut: Eliminating Sites Without a Minimal Association

When examined closely, 47 sites on the initial list of 76 failed to produce minimally acceptable evidence of an association between artifacts and extinct mammals. The 47 sites eliminated on this first cut are listed in Table III.

**Table III.** Sites Excluded From This Analysis

| | Primary reason(s) for rejection | | | | Primary reason(s) for rejection | | |
|---|---|---|---|---|---|---|---|
| Site | 1 | 2 | 3 | Site | 1 | 2 | 3 |
| Burnet Cave | ● | | ● | Martins Creek | ● | | ● |
| Butler | ● | | | McLean | ● | | ● |
| Claypool | | | ● | Mill Iron | | ● | |
| Cole[a] | ● | | | Mockingbird Gap | ● | | |
| Cutler Hammock | | | ● | Mud Lake | ● | | |
| Darby Spring | ● | | ● | New Hudson[a] | ● | | |
| Elkhart[a] | ● | | | Old Humboldt | | | ● |
| Fairview[a] | ● | | | Page/Ladson | | ● | |
| Fenske | ● | | | Pendejo Cave | ● | | |
| Fetterman | | | ● | Priscilla | ● | ● | |
| Gault | ● | | | Russell Farm I[a] | ● | | |
| Gingery Cache | ● | | ● | Russell Farm II[a] | ● | | |
| Guest Mammoth | ● | | ● | Santa Fe | ● | | |
| Hargis | ● | | | Simpson's Flat | ● | ● | |
| Heisler[a] | ● | | | Stolle Mammoth | ● | | ● |
| Hell Gap Loess Mammoth | | | ● | Union Pacific | | | ● |
| Hornsby Springs | ● | | ● | Van Sickle[a] | ● | | |
| Huntington | ● | | | Wally's Beach | | | ● |
| Kincaid Rockshelter | ● | | ● | Ward Island | ● | ● | |
| Koehn-Schneider | ● | | ● | Warm Mineral Springs | ● | | ● |
| Ladson Rise | ● | ● | ● | Wattles[a] | ● | | |
| Leikem | ● | | | Winameg[a] | ● | | |
| Lindsay | ● | | ● | Zapata | ● | | |
| Manis[a] | ● | | ● | | | | |

*Note.* 1 = Insufficient data; 2 = Bone tools only; 3 = Archaeological status doubtful, dismissed, or impossible to prove.

[a] Further discussed in Mastodon Localites.

The reasons for the elimination of these sites varied, and for lack of space we cannot detail them all here. But as can be seen in Table III, the vast majority of the sites were excluded simply because they were insufficiently described or documented. Indeed, it is striking how often sites asserted to provide evidence of Clovis hunting are so inadequately published that the claims for that hunting cannot be properly evaluated and thus must be rejected. In some instances, we could find no more than the name of the site in a list of localities asserted to contain extinct animals and evidence of human activities—as in the case of some ten purported archaeological occurrences of mastodons in the general Great Lakes region (e.g., Fisher, 1987, Table 1; we will speak more directly to these cases below). In other instances, there is more information provided, but crucial details—for instance, the stratigraphic and archaeological context of artifacts and bone or the specific nature of the modifications found on faunal remains—are inadequate, omitted, or glossed with the simple assertion that the extinct mammals occur at the site because of human activity. As all who have followed the development of zooarchaeology and taphonomy in the last several decades are aware, the mere co-occurrence of artifacts and faunal remains in the same site or on the same stratigraphic surface cannot be taken as strong evidence of association, let alone of a predator–prey relationship (e.g., Binford, 1981; Byers, 2002; Haynes, 1991; Lyman, 1994).

Another group of sites, including many of the Florida underwater localities, were eliminated from further consideration because the only evidence of the presence of an extinct mammal was in the form of undoubted or suspected bone or ivory tools (e.g., Dunbar *et al.*, 1989; Dunbar and Webb, 1996). As noted, we are interested in the use of these animals for subsistence, and not as sources of raw material for artifacts. Those bone and ivory tools may have been the end-product of a process that began with the use of those animals as food, but unless that was apparent in other ways, these cases could not be included (see also Goodyear, 1999). After all, not all tools manufactured from bone or tooth were derived from animals acquired for subsistence purposes or even killed by early human hunters; the use of mammoth ivory demonstrably older than the sites in which it occurs is evidence of that (e.g., Bradley and Frison, 1996; Laub, 2002; Yesner, 2001).

Two sites were rejected because the evidence for the association between artifacts and extinct mammals is based on poorly-controlled blood residue analysis. At Martins Creek, Ohio, an unspecified number of nondiagnostic flint artifacts were found "among mastodon and deer bones" (Brush *et al.*, 1994, p. 16). Because it was recognized that these artifacts could have originated higher in the stratigraphic column, five were examined for blood residue; of these, two tested positive for proboscidean. The authors explicitly note that if the results of their analyses are to be considered reasonably secure, control sediment samples must undergo similar tests. However, no such tests were reported by them, and we have rejected their claim. More recently, Kooyman *et al.* (2001) reported horse residue from two Clovis points found on the surface at the Wally's Beach site, Alberta. These points came from a lag deposit; at least one was so heavily wind-eroded that use-wear analysis was not possible. While we are impressed by the possibility that blood residues might survive such wind-blasting, we also note that there is no control over possible sources of contamination of these objects (Shanks *et al.*, 1999). As a result, we reject this site as well.

Finally, in a few other instances sites were eliminated because they were not archaeological. Some of those sites were perhaps inadvertently identified as archaeological in FAUNMAP, since we found no indication in the primary literature that any artifacts were found with the extinct mammals involved (e.g., Hell Gap Loess Mammoth, see Walker, 1987). In other cases (e.g., Claypool, Koehn-Schneider, Union Pacific), the cultural association was considered tenuous—or nonexistent—by the original investigators (Alexon, 1988; Dick and Mountain, 1960; Frison, 1978, pp. 29, 85).

### *Sites That Made the First Cut*

The 29 sites that survive the first cut are presented in Table IV. Note that in several instances we have separately listed components within individual sites. This was done for those sites with archaeological faunas in distinct stratigraphic units (the Gray Sand [GS] and overlying Brown Sand Wedge [BSW] at Blackwater Locality 1 [the Clovis type site], and units C1 and C3 at Kimmswick), or where separate excavations had been conducted and there was insufficient information to enable us to combine the resulting faunas (Lewisville). This table also provides quantitative data—minimum numbers of individuals (MNI) and numbers of identified specimens (NISP), in so far as available—for the taxa at each site.

The sites listed in Table IV provide at least a minimal association between extinct Pleistocene mammals and Clovis-aged peoples and, as a result, provide useful insight into the structure of the terminal Pleistocene archaeological and paleontological records. Consider, for example, the data in Table V, which provides the number of asserted archaeological occurrences for a given genus by "occurrence" (that is, by site or by separate stratigraphic components within sites), as compared with the total number of paleontological occurrences for these same genera (the data for the paleontological occurrences are also derived from FAUNMAP).

As can be seen in Fig. 2, there is a strong tendency for the most common Pleistocene taxa to have been reported in an archaeological context. Of the 35 genera, 13 have been claimed to have been found in such a context. In

**Table IV.** A Preliminary List of Clovis-Aged North American Archaeological Sites Reported to Contain the Remains of Extinct Pleistocene Mammals

| | AR | | CM | | CP | | EQ | | GS | | HE | | HO | | MA | | MM | | MG | | PT | | SM | | TP | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Site | MNI | NISP | MNI | NISP | MNI | NISP | MNI | NISP | MNI | NISP | MNI | NISP | MNI | NISP | MNI | NISP | MNI | NISP | MNI | NISP | MNI | NISP | MNI | NISP | MNI | NISP |
| Agate Basin/Sheaman | | | 1 | 1 | | | | | | | | | | | | | | | | | | | | | | |
| Aubrey | | | | | | | | 1 | | 135 | | | | | | | | 7 | | | | | | | | |
| Blackwater Loc 1 BSW | | | | | | 1 | | 2 | | | | | | | | | | 10 | | | | | | | | |
| Blackwater Loc 1 GS | | | | 4 | | | | 72 | | | | 3 | | | | | | 306 | | | | 2 | | 2 | | |
| Boaz | | | | | | | | | | | | | | | 1 | ~200 | | | | | | | | | | |
| Bonfire | | | | 9 | | 3 | | 46 | | | | | | | | | | 9 | | | | | | | | |
| Burning Tree | | | | | | | | | | | | | | | 1 | ~160 | | | | | | | | | | |
| Carter-Kerr-McGee | | | | 4 | | | | | | | | | | | | | | | | | | | | | | |
| Colby | | | 1 | 2 | | | 1 | 1 | | | | | | | | | 7 | 424 | | | | | | | | |
| Dent | | | | | | | | | | | | | | | | | 12 | | | | | | | | | |
| Domebo | | | | | | | | | | | | | | | | | 1 | ~75 | | | | | | | | |
| Duewall-Newberry | | | | | | | | | | | | | | | | | | >42 | | | | | | | | |
| Escapule | | | | | | | | | | | | | | | | | 1 | 18 | | | | | | | | |
| Hebior | | | | | | | | | | | | | | | | | 1 | ~170 | | | | | | | | |
| Hiscock | | | | | | | | | | | | | | | 4 | | | | | | | | | | | |
| Kimmswick – C1 | | | | | | | | | | | | | | | | + | | | | | | | | | | |
| Kimmswick – C3 | | | | | | | | | | | | | | | | 39 | | | | | | | | | | |
| Klein | | | | | | | | 1 | | | | | | | | | | 1 | | | | | | | | |
| Lange-Ferguson | | | | | | | | | | | | | | | | | 2 | 153 | | | | | | | | |
| Lehner | | | 3 | 41 | | | 1 | 3 | | | 1 | | | | | | 13 | 104 | | | | | | | 1 | 3 |
| Lewisville – 1950s | | | 2 | | | | 8 | 10? | | | | | | | | | 2 | 2 | | | 1 | | | | | |
| Lewisville – 1970s | | | | | | | | 15 | | | | | | | | | | 1 | | | | | | | | |
| Little Salt Springs | | | | | | | | | | | | | | | 1 | 1 | | | 1 | 15 | | | | | | |
| Lubbock Lake | | 6 | | 12 | | 2 | | 21 | | | | 2 | | 2 | | | | >50 | | | | 1 | | | | |
| Miami | | | | | | | | | | | | | | | | | | ~391 | | | | | | | | |
| Midland | | | | | | | | 1 | | | | | | | | | | | | | | | | | | |
| Murray Springs | | | | 8 | | | | 45 | | | | | | | | | | 149 | | | | 1 | | | | |
| Naco | | | | | | | | | | | | | | | | | 1 | 35 | | | | | | | | |
| Owl Cave | | | | | | | | | | | | | | | | | | + | | | | | | | | |
| Pleasant Lake | | | | | | | | | | | | | | | 1 | ~100 | | | | | | | | | | |
| Schaefer | | | | | | | | | | | | | | | | | 1 | ~150 | | | | | | | | |
| Sunshine | | | | 11 | | | | 1 | | | | | | | | | | | | | | | | | | |

*Note.* AR = *Arctodus*; CM = *Camelops*; CP = *Capromeryx*; EQ = *Equus*; GS = *Glossotherium*; HE = *Hemiauchenia*; HO = *Holmesina*; MA = *Mammut*; MM = *Mammuthus*; MG = *Megalonyx*; PT = *Platygonus*; SM = *Smilodon*; TP = *Tapirus*; "+" indicates the presence of a taxon for which no quantitative data are available.

**Table V.** Archaeological and Paleontological Occurrences of Extinct Mammals

| Taxon | *N* of archaeological occurrences | *N* of paleontological occurrences |
|---|---|---|
| *Arctodus* | 1 | 37 |
| *Camelops* | 10 | 139 |
| *Capromeryx* | 3 | 25 |
| *Equus* | 13 | 440 |
| *Glossotherium* | 1 | 48 |
| *Hemiauchenia* | 3 | 54 |
| *Holmesina* | 1 | 22 |
| *Mammut* | 7 | 211 |
| *Mammuthus* | 21 | 337 |
| *Megalonyx* | 1 | 53 |
| *Platygonus* | 4 | 88 |
| *Smilodon* | 1 | 35 |
| *Tapirus* | 1 | 56 |
| Subtotal | 67 | 1545 |
| *All other taxa* | 0 | 377 |
| Grand total | 67 | 1922 |

*Note.* The paleontological occurrences have been tallied from FAUNMAP.

fact, if we focus our attention on just the 13 archaeologically-reported genera and compare the distribution of the number of reported archaeological occurrences (column 1, Table V) to the FAUNMAP distribution of paleontological occurrences for these 13 (column 2, Table V), the difference is not statistically significant ($\chi^2 = 13.14$, $p > 0.10$).

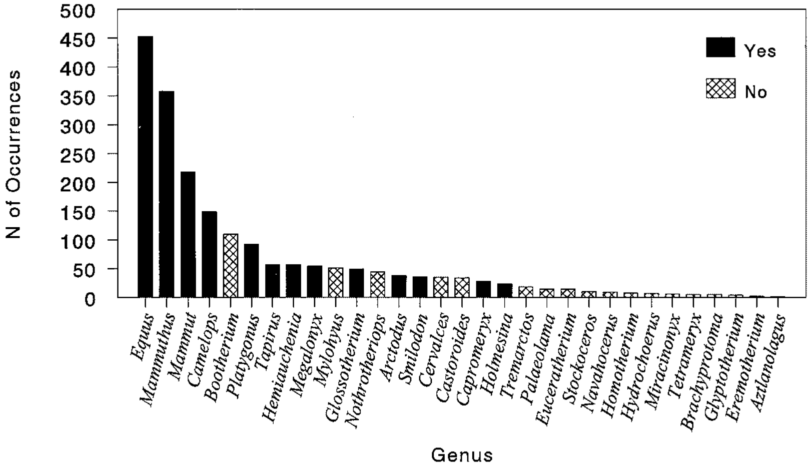

**Fig. 2.** The total number of FAUNMAP occurrences of extinct late Pleistocene North American mammalian genera. Genera claimed to have been found in archaeological association are indicated by solid bars.

Of course, this comparison excludes the 22 other taxa that are not represented archaeologically in any of the sites or components in Table IV. If we include those taxa in a single 2 × 2 contingency table—the 67 archaeological and 1545 paleontological occurrences for the 13 archaeologically-reported genera compared to 0 archaeological and 377 paleontological occurrences for the remaining genera—that difference is quite significant ($\chi^2 = 16.22$, $p < 0.001$). If we exclude carnivores from this comparison, the difference remains significant ($\chi^2 = 14.64$, $p < 0.001$). The archaeological set of reported occurrences thus does not provide a representative sample of the known numerical structure of the late Pleistocene faunal record for these extinct taxa. As a result, the data in Table IV cannot provide support for the assumption that people hunted all now-extinct non-carnivores on the late Pleistocene landscape (Martin, 1967, 1984; Martin and Steadman, 1999). However, and for the same reason, it also cannot be argued that the claimed archaeological occurrences provide evidence for an archaeological signature randomly impressed on a late Pleistocene faunal background. Only for the 13 extinct genera actually claimed to have been found in archaeological context could either of these arguments potentially be made.

## The Second Cut: Eliminating Sites Without Evidence of Predation/Subsistence Activity

During the past few decades, zooarchaeologists have also made significant gains in understanding the multiple mechanisms that can introduce faunal specimens into archaeological contexts, and modify them once they are there (e.g., Binford, 1981; Haynes, 1991; Lyman, 1994; Marean *et al.*, 1992; Marean and Bertino, 1994). In the Paleoindian context, archaeologists have come to realize that the mere occurrence of faunal remains in a site may not indicate human predation or subsistence activities, and have devised methods for assessing the nature of those remains and their use (e.g., Byers, 2002; Carlson and Steele, 1992; Frison and Todd, 1986; Haynes, 1991; Haynes and Stanford, 1984; Hofman, 2001; Holliday *et al.*, 1994; Kreutzer, 1988). Haynes and Stanford (1984), for example, put the growing body of knowledge in this realm into play in an assessment of the evidence for archaeological associations with the extinct camel *Camelops*. Their analysis showed that only 2 of 25 possible *Camelops* associations were sufficiently compelling to possibly indicate human utilization of this animal. We apply a similar approach here, one that does not include a hands-on analysis of the faunal assemblages involved but which does attempt to evaluate all extinct taxa in all suggested archaeological contexts.

In making our assessments, we applied a simple set of criteria closely related to those used by Haynes and Stanford (1984). We examined the published evidence for the association of each taxon with human activities at each site, and accepted that evidence if sufficient stratigraphic information were provided to support not just the contemporaneity of artifacts and faunal specimens, but also evidence of human killing (whether successful or not) and butchering/processing for subsistence purposes (Haynes, 1991; Hofman, 2001, p. 97). We looked for (and included where we found them) cases where artifacts were found intimately associated with bones and/or teeth [as, for instance, with the projectile points in mammoths at Murray Springs and Naco, Arizona (Haury *et al.*, 1953; Hemmings, 1970)], or the presence of compelling evidence of cutmarks or human-caused bone breakage (as, for instance, with the mammoth remains at Blackwater Locality 1, New Mexico, as detailed in Saunders and Daeschler, 1994), or cases of clear spatial manipulation of skeletal elements [as in the case of the mammoth bone "caches" at Colby, Wyoming (Frison and Todd, 1986)].

Evidence for specimens said to be burned or charred was treated on an individual basis, since this diagnosis can be extremely difficult (e.g., Shahack-Gross *et al.*, 1997). We did accept evidence for burning when our stratigraphic requirements were met and artifacts were closely associated with the specimens involved, unless the interpretation of burning has been questioned by others (e.g., the discolored *Tapirus* mandible at Lehner, Arizona; see below). We also accepted evidence for burning when such evidence included the fine-scale analyses needed to make the case (as at Pleasant Lake, Michigan; see Shipman *et al.*, 1984).

We applied these various criteria to each of the 13 taxa found in the 29 sites listed in Table IV. We did so on a site-specific and taxon-specific basis, reasoning that in localities where multiple taxa were present, it might not be possible to support a case of subsistence utilization of one taxon, but possible in the case of another. Vetting the data in this manner ultimately led us to eliminate 14 sites from further analysis: those sites are Agate Basin/Sheaman, Aubrey, Boaz, Bonfire Shelter, Burning Tree, Carter Kerr-McGee, Duewall-Newberry, Hiscock, Klein, Little Salt Spring, Midland, Owl Cave, Schaefer, and Sunshine. In addition, we excluded from further analysis an additional nine taxa that lack secure evidence for any human association or predation. Those taxa are *Arctodus, Capromeryx*, *Glossotherium*, *Hemiauchenia*, *Holmesina*, *Megalonyx*, *Platygonus*, *Smilodon*, and *Tapirus*. We did not exclude, but need to address in some detail, claims for the exploitation by Paleoindians of the American mastodon (*Mammut americanum*).

We recognize, of course, that the faunal occurrences and localities we excluded in this cut are often cited as providing evidence of human predation on extinct large mammals (unlike many of the sites eliminated in the first cut and listed in Table III). As a result, we explain our specific reasons for excluding those localities or taxa within localities. We begin with 11 of the

14 sites that we have rejected entirely; the remaining three (Boaz, Burning Tree, and Hiscock) are included in a discussion of mastodon localities later in this paper.

## *Excluded Sites*

*Agate Basin/Sheaman.* The Clovis faunal assemblage from this location comes from the Agate Basin site proper, and from the Sheaman Locality some 1 km distant. The single camel specimen reported from this assemblage was recovered from redeposited sediments below the Folsom level at Agate Basin, and shows no cultural modification (Walker, 1982, p. 297). The mammoth material from Sheaman consists of a single tusk fragment fashioned into a foreshaft (Frison and Craig, 1982, p. 157; Walker, 1982, p. 295). As this is the only *Mammuthus* at the site, there is no evidence the animal was part of the diet, only that a fragment of its tusk was part of the tool kit. An apparently burned *Platygonus* mandible fragment did come from the Folsom level at this site (Walker, 1982, p. 296) and may suggest human use of this animal at a later date. That occurrence, however, is not relevant to a discussion of Clovis-age hunting, nor is the evidence for the later use of *Bison* at this site (Frison, 1982, pp. 144–145).

*Aubrey.* All but one of the *Glossotherium* dermal ossicles at Aubrey were in pond deposits; none provides evidence of direct human involvement. The single specimen of *Equus* reported from this site may not be associated with the Clovis occupation and is not specifically discussed by Yates and Ferring (2001). Of the seven mammoth specimens (Yates and Lundelius, 2001, p. 107), four were found more than a year after the excavations were completed and may be from "the upper part of Stratum A sediments and not associated with the Clovis occupations" (Yates and Lundelius, 2001, p. 118). The remaining three specimens, attributed to Camp B, are tooth fragments that are not discussed in detail in the text but are explicitly excluded by Ferring (2001, p. 240) as indicators of mammoth processing. As a result, none of this material is considered further.

*Bonfire Shelter.* This site, located on the southernmost margin of the Great Plains of Texas, is best known for its Plainview/Folsom-age bison kills (Dibble, 1970; Dibble and Lorrain, 1968; see also Bement, 1986). Stratigraphically beneath these components is a terminal Pleistocene faunal deposit initially referred to as Bone Bed 1 (Dibble and Lorrain, 1968). Bement subsequently subdivided Bone Bed 1 into seven strata, four of which contain the remains of extinct mammals, including *Camelops*, *Capromeryx*, *Equus*, and *Mammuthus*. A single radiocarbon age of 12,460 ± 490 B.P. was obtained on charcoal from Bement's stratum H1, in the lower half of Bone Bed 1

(Bement, 1986, p. 9). Bement (1986) argues that the extinct animals represented in the several Bone Bed 1 strata were killed and butchered by people (see also Dibble and Lorrain, 1968, p. 28). Since there are no associated stone tools, this claim rests on the presence, near the bone, of large limestone blocks in this otherwise fine-grained deposit; on the presence of charcoal flecks; and, on evidence provided by the bones themselves. The presence of limestone blocks in deposits of a shelter roofed by this material is not surprising [those blocks are not limited to the bone beds, but also occur in the intervening strata (Dibble and Lorrain, 1968)], nor does the presence of charcoal in rockshelter sediments necessarily imply a human presence at the time the charcoal was formed (e.g., Grayson, 1988a, pp. 27–29, 48–49). Johnson (1989) has cautiously suggested that two mammoth and two horse specimens have been modified by human hands, but she also notes that carnivore damage on the Bone Bed 1 specimens "indicate[s] a complex life history" for this material (Johnson, 1989, p. 443) and that deeper analysis of any possible anthropogenic role is required. We agree with her, and with the conclusion reached by Wyckoff (1999, p. 349), that "the case for people being responsible for some of the Bone Bed #1 deposits leaves one with nagging doubt."

*Carter/Kerr-McGee.* Of the four specimens of *Camelops* from the site, one is described as fractured by a heavy blow. However, in their detailed review of possible associations between *Camelops* and people, Haynes and Stanford (1984, p. 223) note that:

> The only Clovis sites . . . with potentially acceptable linkage of *Camelops* bones and human activity are Carter/Kerr McGee, Colby, and Lehner . . . No stone artifacts were excavated with the fragmented *Camelops* bones at Carter/Kerr McGee. At Colby, a single broken *Camelops* bone was excavated near a pile of mammoth bones lying over a Clovis point. The *Camelops* specimen seems to be part of an actual archaeological assemblage, but there is no evidence that people hunted and killed this *Camelops*. The Lehner data have not been fully published, and we thus cannot evaluate this material.

Haynes and Stanford (1984, p. 218) conclude that the evidence for human involvement with the Carter/Kerr McGee camel specimens is "rather weak." We follow their lead and exclude this occurrence.

*Duewall-Newberry.* Of all the sites argued to be archaeological on the basis of bone fragmentation in the absence of artifacts, this is perhaps the most intriguing. Carefully excavated from fine-grained fluvial sediments along the Brazos River in eastern Texas, Duewall-Newberry provided the partial remains of a single mammoth (Carlson and Steele, 1992; Steele and Carlson, 1989). Since there were no associated artifacts, the argument for human interaction with the remains of this animal stems from possible patterning in the distribution of the skeletal elements recovered and from damage to the bones themselves. Most importantly, several thick-walled elements show what appear to be impact fractures (Steele and Carlson, 1989, figures 15, 16). Haynes (1991), however, notes that Steele and Carlson (1989) have not documented that these modifications were necessarily the result of human behavior, and we agree with that observation. We also note that stone implements of sufficient size to break these thick-walled bones were not present, and that, since the remains are undated (Carlson and Steele, 1992), the only evidence that the specimen is of Clovis age comes from the presumption of human modification of the bones. We have, as a result, removed this site from our final list.

*Klein.* This site yielded four artifacts and isolated elements of *Equus* and *Mammuthus*. According to the investigators, there is only a "general association" between the artifacts and the faunal remains, but "no direct evidence that faunal materials at the site are present as a result of cultural behavior" (Zier *et al.*, 1993, p. 208). We accept that assessment.

*Little Salt Spring.* At ca. 12,000 B.P., this site was a sinkhole; the −26 m ledge from which the faunal material was collected would have been at about the water level within the sinkhole itself. That ledge is estimated to have been exposed for between 300 and 1000 years. During that time, it is argued, animals that fell in or were driven into the sinkhole could have swum to the −26 m ledge and died. This history does provide not compelling reasons for faith in any associations between the mammalian and archaeological materials recovered on that ledge. The promised detailed discussion of this site, mentioned in Holman and Clausen (1984), has apparently never appeared. No claim is made that the single mastodon specimen is associated with human activities. Of the 15 *Megalonyx* specimens, four are said to "appear charred," but there is no further information given. The mastodon specimen has been dropped from our list, and we do not find the evidence for human involvement in the accumulation of the *Megalonyx* material compelling, at least not without a more detailed discussion of the evidence for "charring." Although our focus here is on mammals, we also note that there are substantial reasons to be skeptical of the claim that Little Salt Spring contains evidence for human predation on the extinct tortoise *Geochelone* (Clausen *et al.*, 1979; Dunbar and Webb, 1996; Grayson and Meltzer, in press; Holman and Clausen, 1984).

*Midland.* The basal white sand (Pleistocene) from this locality yielded "an overwhelming preponderance of horse remains," as well as nearly half a dozen other extinct mammals, including bison, camel, dire wolf, and mammoth (Wendorf *et al.*, 1955, p. 25; Sellards in Wendorf *et al.*, 1955, p. 127). Additional remains of horse and *Capromeryx* were recovered from higher in the profile in the gray and red sands. However, except for one specimen from the white sand, the presence of none of these mammals is attributed to human agency. Indeed, there is a strong possibility the extinct mammalian fossils from the gray and red sands are not in primary context, but were redeposited from the white sands (see the discussion in Holliday and Meltzer, 1996, pp. 768–769). The single specimen attributed to human agency is a horse femur shaft fragment from the white sand, which displayed apparent cut marks that Wendorf *et al.* (1955, pp. 51–52) believed were probably made by people "fleshing the bone with a very sharp-edged or sharp-pointed instrument." Those purported cut marks, although described with remarkable prescience, are unconvincing by themselves, and no other evidence of cultural activity was seen in the white sand, save for a single flake reported from a road grader trench dug at the site by Sellards, in unknown relationship to the mammal bones recovered earlier by Wendorf (Sellards in Wendorf *et al.*, 1955, p. 127).

*Owl Cave (Wasden).* One of three rockshelters collectively referred to as the Wasden site, Owl Cave provided either three (Miller, 1989) or four (Miller, 1983) partial fluted points in stratigraphic association with a large mammal assemblage that included mammoth, bison and camel, along with a variety of smaller forms (Miller, 1982). The points are described as Folsom, but the associated radiocarbon ages from this stratigraphic unit, on bone, range from Folsom to pre-Clovis in age (Miller, 1989, p. 383). No close association between the stone tools and the vertebrate remains has been claimed by those who have worked with this material; the sediments themselves are heavily cryoturbated and impacted by substantial roof-fall (see Butler, 1969; Miller and Dort, 1978). The argument for a human role in depositing the mammoth material here is based on the bones themselves, and in particular on the fact that the skeletal elements represented are primarily those with dense cortical bone which may have been valued as raw material for tool manufacture, and that the bones are fractured by percussion in a way that suggests a human role (Miller, 1989). The fractured bones are intriguing, but Haynes (1991, p. 238) questions the anthropogenic nature of the mammoth bone breakage here, and no artifacts capable of fracturing those bones are present. As a result, we have dropped this site from our final list.

*Schaefer.* Overstreet (1998, p. 42; see also Overstreet and Kolb, 2003) argues for human involvement in this site for two reasons: two lithic artifacts were found beneath the innominate of the mammoth, and the mammoth ribs at the site were piled in a way that he believes required human interference. Overstreet and Kolb (2003, p. 99) note that detailed analyses have shown that the Schaefer mammoth specimens bear "cut and pry marks assignable to human use of the carcasses," and that such marks are also present on the nearby Hebior, Fenske, and Mud Lake mammoths. These analyses, however, are unpublished (elsewhere in this paper, we accept the

Hebior association, but consider the Fenske and Mud Lake material to be inadequately documented).

We have rejected the archaeological association at Schaefer for two reasons. First, wood at the site is said to be in "intimate association with the Schaefer bone pile" (Overstreet, 1998, p. 42). This wood provided four radiocarbon dates ranging in age from 12,220 ± 80 to 12,610 ± 80 B.P., roughly contemporaneous with AMS dates of 12,310 ± 60, 12,320 ± 50, and 12,390 ± 40 B.P. on the mammoth specimen itself (Overstreet and Kolb, 2003, table I). However, the wood is also said to have been "transported from other locations in the basin" (Overstreet, 1998, p. 42; Overstreet and Kolb, 2003, p. 98), raising the possibility that the two lithic artifacts at issue may not be in primary depositional context. Second, inspection of the distribution map of the Schaefer specimens in Overstreet (1998) does not provide compelling evidence for human involvement in producing the distribution of mammoth bones here. We stress that the brief discussions of Schaefer provided by Overstreet (1998) and Overstreet and Kolb (2003) are clearly not meant to be definitive, and we look forward to seeing additional discussions of this location.

*Sunshine Locality.* Stratum E of this Nevada site yielded both horse and camel remains. The camel skeletal material was closely associated with artifacts, including a fragment of a Great Basin stemmed point. However, as the analysts note, both bones and artifacts occur in stream channel deposits, and, as a result, "the association between these remains is equivocal" (Huckleberry *et al.*, 2001, p. 308; see also Jones *et al.*, 1996). Accordingly, the Sunshine Locality is not included in our further discussion.

### *Excluded Taxa at Included Sites*

We now turn to a discussion of those sites which yielded multiple taxa, in which the evidence for a secure association between artifacts and extinct fauna is acceptable for some taxa but not for others.

*Blackwater Locality 1.* In the two stratigraphic units of interest (the Gray Sand and the overlying Brown Sand Wedge), seven extinct mammalian genera are said to be associated with artifacts. We accept the association of artifacts and mammoth material at this site (see the excellent descriptions and analyses provided by Saunders and Daeschler, 1994). Of the reported *Equus* specimens, one, a metapodial, has been referred to as "charred" and is said to have been found near the tusks of a mammoth skeleton that was in turn associated with artifacts (Hester, 1972, p. 74). Even though it would be valuable to determine whether the discoloration involved does represent burning (e.g., Shahack-Gross *et al.*, 1997), we have included this particular specimen in the subsequent analysis.

A series of additional Blackwater Locality 1 specimens—two of horse, five of camel—have been argued by Johnson (1989) to bear diagnostic human-induced modifications, all from the Gray Sand. Because the camel specimens are well-illustrated in Johnson (1989), it is easy to observe that human activities are just one of a number of processes that could have led to the breakage involved (e.g., Haynes and Stanford, 1984). As a result, we do not accept these specimens. Of the two horse specimens, only one is illustrated in Johnson (1989). This specimen, a distal femur, appears to have been fractured by impact, and the impacting mechanism may well have been human. Haynes and Stanford (1984), however, note that other mechanisms can produce such fractures (see also Haynes, 1991). While we certainly do not disagree with Johnson (1989) that the nature of this specimen may have resulted from human activities, the nondiagnostic nature of the damage has led us to exclude it from further consideration.

There are no indications that the other specimens of horse and camel, or the remains of the other extinct taxa, at this site were associated with human activities save for general assertions, and even those have prompted disagreement (Hester, 1972; Lundelius, 1972; Warnica, 1966).

*Colby.* The remains of three extinct mammals have been recovered from this site, but only one (mammoth) in substantial numbers. We accept the compelling evidence for hunting and butchering of mammoth here. The single *Equus* specimen bears damage felt to be "suggestive" of human activity, but also bears marks suggestive of carnivores. The *Camelops* specimens show breakage patterns that may be due to human involvement, and one may be a tool. Haynes and Stanford (1984) report one *Camelops* specimen—a radius—from Colby; the final report (Frison and Todd, 1986, pp. 196–197) indicates that there were two such specimens, the radius discussed by Haynes and Stanford (1984) and a tibia. Haynes and Stanford (1984) find the radius to be "probably" artifactual but also observe that "there is no evidence that prehistoric people hunted and killed this *Camelops*" (Haynes and Stanford, 1984, p. 223). The tibia fragment may also be part of a tool (Frison and Todd, 1986, p. 196). As with the radius, however, there is no reason to consider this specimen as reflecting a camel kill. We have accordingly dropped the horse and camel specimens from our list.

*Lehner.* This site yielded the remains of five genera of extinct mammals. Haury *et al.* (1959, p. 27) believed that "the majority, if not all, of the animals were slaughtered," but the project's vertebrate paleontologist observed that "except . . . for the presence of artifacts and charred bone, the fossil assemblage does not seem to show features greatly different from those of any typical fossil occurrence in a stream channel" (Lance, 1959, p. 37). To Saunders (1977, p. 51), "it seems that the majority, if not all, of the animals were slaughtered. Certainly this is well-established for the mammoths. Of the projectile points, only two were not in direct or close association with elephant bones." It has also been suggested that the tapir mandible and one camel femur provide evidence for direct human involvement. The tapir mandible is reportedly burned (Saunders, 1977, p. 51), but C. V. Haynes (1990, personal communication) has suggested the discoloration of this specimen might result from manganese staining and we accordingly reject it. Saunders (1977) suggests that the camel femur was fractured during marrow extraction, although Haynes and Stanford (1984) note that this assertion cannot be evaluated on the basis of published data. We have retained the mammoth specimens and one camel specimen, but exclude from further discussion the claims for *Equus*, *Hemiauchenia*, and *Tapirus*.

*Lewisville.* This is an extraordinarily difficult site to evaluate. Insufficient information is available to allow an evaluation of the relationship between the fauna and the artifacts retrieved—partly because the initial work was done by avocational archaeologists in the 1950s and when adequate taphonomic protocols had yet to be developed, and partly because the later excavations, conducted in the late 1970s by Stanford and Banks, remain unpublished, with the exception of a faunal list (Winkler, in Ferring, 2001, p. 241). Crook and Harris (1957, 1958) provide mostly anecdotal information about the fauna. Because they gave some of the recovered faunal remains away as "momentos" (Crook and Harris, 1957, p. 17) to site visitors, it would be impossible to reanalyze the entire suite of remains. We reject all of the anecdotal Crook and Harris data, but accept the broken and burned horse metapodial from Hearth 1. The faunal list from the 1970s work (Winkler, in Ferring, 2001, p. 241) is important, but compromised by the lack of contextual information. As a result, there is no way to evaluate the single mammoth specimen or the 15 horse specimens on that list, and so we cannot include them on ours.

*Lubbock Lake.* The complex depositional history of the Clovis-aged deposits of this site (Johnson, 1995; Kreutzer, 1988) requires that we be cautious in attributing the presence of the remains of extinct species here to human activities. That said, the valuable monograph (Johnson, 1987) and the rich body of supporting literature (e.g., Holliday, 1985; Holliday and Johnson, 1990; Johnson, 1995; Johnson and Holliday, 1989; Kreutzer, 1988) available for this site make it possible to probe—deeper than is possible in most localities—what activities might have taken place here in the late Pleistocene. We include the Lubbock Lake mammoth specimens on our list because of the tight association between mammoth remains and artifacts (Johnson, 1987, p. 101), and because we see no reason to reject the evidence presented by Johnson for anthropogenic mammoth-bone breakage (the Lubbock Lake monograph does not present complete specimen counts for mammoth, making it clear only that more than 50 specimens were recovered, and this is the figure used in Table III).

We conclude otherwise for the Lubbock Lake *Arctodus*, *Camelops*, and *Equus*. *Arctodus* was represented at this site by a single tooth, parts of a right forepaw, and a distal left radius. Three of these specimens have striations interpreted by Johnson (1987, pp. 122–123) as cut marks, and provide the only evidence to suggest this animal was hunted. Johnson (1987) also suggests that the camel and horse remains at this site reflect the results of human hunting. For camel, this suggestion rests on 12 specimens, six of which are phalanges. One of these specimens bears striations also interpreted as cut marks, while four long bone fragments are said to be broken in such a way as to suggest a human cause. Although published before Johnson (1987) appeared, Haynes and Stanford (1984) found neither the cutmarks nor the striated phalanges to be convincing evidence of human involvement. Given the lack of direct association with artifacts, we do not find that the Lubbock Lake camel assemblage provides compelling evidence for the killing and butchering of camel.

The argument that the Clovis-aged horse remains at this site resulted from human hunting is identical to that made for camel: bone breakage felt to be have been due to human activities, and three specimens with reported cutmarks (one of which also bears carnivore damage: Johnson, 1987, p. 150). Again, no artifacts were associated with this material, and even if the position of the faunal specimens is indicative of human involvement, it is not necessarily indicative of human hunting.

In general, the evidence for cutmarks on the Clovis-aged faunal specimens at Lubbock Lake became problematic with the demonstration by Kreutzer (1988) that a good number of these specimens had been realigned and water-transported. While there is no indication that the stream currents involved were sufficiently competent to move large bones long distances, Kreutzer (1988) cautioned that alluvial action could have produced the striations that have been interpreted as cutmarks. She concluded that these marks may well be natural, not cultural, in agreement with earlier cautions in this regard (Haynes and Stanford, 1984). Johnson (1995) has addressed this issue in detail, and while she disagrees with aspects of Kreutzer's results, concludes that the faunal material involved "is a disturbed archaeological occurrence in that bones were realigned but not transported by stream action" (Johnson, 1995, p. 334). Since this is the case, we accept Kruetzer's caution and have excluded *Arctodus*, *Camelops*, and *Equus* from our final tallies.

*Murray Springs.* This site is as difficult to evaluate as Lewisville, and for much the same reason. Although evidently excavated with care, the results of this work have never been published, save as brief preliminary notes or passing comments (e.g., Haynes, 1974, 1976, 1978, 1979, 1980, 1981). As a result, most of the available information on the relationship between faunal remains and artifacts is largely anecdotal, difficult to tally in any systematic fashion, and occasionally self-contradictory.

We therefore rely heavily on Hemmings' 1970 dissertation; the data themselves have been extracted from Hemmings' Appendix A. These tables, however, do not specify the area of the site from which a particular specimen came; these we have reconstructed, to the best of our ability, from the large format maps in Hemmings (1970). In a few cases, bones were found between numbered areas, and these were assigned to the nearest such area. Area 7, the camp, contained no faunal material; we do not consider the fauna from the sand-filled spring conduits, since the significance of that evidence is uncertain, and the association not considered definitive (Haynes, 1979, p. 263).

Hemmings (1970, p. 59) observes that Area 1 provided five lithic flakes "within 3 m of the concentration of mammoth bones"; Area 2 provided no artifacts at all. Hemmings (1970) argues that the mammoth material in both areas is associated with human activity, but given the absence of tight associations between artifacts and mammoth remains, as well as the absence of a taphonomic assessment of the mammoth bones themselves, we do not find this assertion compelling, and do not accept this as evidence of subsistence use.

Similarly, no artifacts appear to have been found among the mammoth material in Area 3, but a cobble hammer was found just 0.5 m west of the mammoth and a pile of debitage 0.5 m to the east. Further, Hemmings (1970, pp. 95–96) notes that the mammoth skeleton was "disarranged," and that the left hindlimb and right radius and ulna were missing. Although a taphonomic analysis of this mammoth material would be helpful, we nonetheless accept this case. Area 3 also produced the apparent mammoth tracks and the famous mammoth bone shaft wrench (Haynes and Hemmings, 1968). Interestingly, it also yielded a good deal of *Bison* bone associated with artifacts, bone that is said to be burned.

Most of the material from Area 4 is *Bison* (233 specimens). There is no indication that the *Equus* and *Platygonus* teeth reported from here are associated with human activity, and they are not included in our subsequent discussion.

Finally, Area 5 is said to represent a horse kill, but the evidence for this is not compelling. Only teeth are reported from this area, and Hemmings (1970, pp. 154–155) notes that "no skeletal material was preserved showing the position of the carcass, degree of articulation, or dismemberment, or removal of body parts, nor was a hearth for cooking or processing tasks uncovered in the area excavated." There is debitage located not far from the horse teeth, but in the absence of the horse itself, we do not find Area 5 to provide convincing evidence of a horse kill or even of an association with human activity.

### *Single-Taxon Mammoth Sites*

In addition to the associations we have just accepted, we find compelling evidence that human predation played a causal role in producing the archaeological associations with mammoth at seven sites we have not yet discussed: Dent, Domebo, Escapule, Hebior, Lange-Ferguson, Miami, and Naco. Many of these are classic Clovis sites, with projectile points tightly associated with mammoth remains.

Although we have accepted Dent and Hebior, these are perhaps the least compelling sites on our list. Because the materials at Dent are not in primarily depositional context, the meaning of the association between artifacts and mammoth bones cannot be fully evaluated, but it is this association that has led us to accept the site [Brunswig and Fisher (1993, p. 64) report the presence of "probable butchering marks on the mammoth bone," but we are aware of no published analysis supporting this claim]. We accept Hebior because of the apparently tight association between mammoth remains and artifacts it provided, though a more detailed discussion of this material than presented by Overstreet (1998) and Overstreet and Kolb (2003) would be quite helpful.

### *Mastodon Localities*

It has long been obvious (e.g., Haynes, 1966) that the most common extinct taxon in Clovis archaeological sites is mammoth. It has long been assumed (e.g., Martin, 1967; Mason, 1962; Stoltman, 1978; West, 1983) that Clovis-age groups in other parts of North America, especially in the forests of eastern North America, exploited not mammoth (which was relatively uncommon in this setting), but mastodon, the local proboscidean. However, after many decades of searching, unequivocal associations of artifacts and mastodon remains are extremely rare (Goodyear, 1999; Lepper, 1999; Meltzer, 1988). We found only six sites—Boaz, Burning Tree, Hiscock, Kimmswick, Little Salt Spring, and Pleasant Lake—that provide even minimum evidence for human interaction with mastodon anywhere in North America (Table III). Of those, we accept only Kimmswick, with its fluted points and other artifacts in close association with mastodon skeletal material (Graham *et al.*, 1981; Graham and Kay, 1988), and Pleasant Lake (see below), as providing secure evidence of that interaction.

The scarcity of this taxon in archaeological sites stands out in stark relief against the great number of mastodons known from terminal Pleistocene paleontological occurrences (Grayson, 1984a; Martin, 1982; Meltzer, 1986; Meltzer and Mead, 1985). That mastodons have proven so archaeologically elusive, both in comparison to mammoth and with the expectation that they should have been prey to human hunters, raises the question of whether this animal truly is rare in archaeological sites, or whether we have been too hasty in discarding potential archaeological occurrences. As a result, we detail the archaeological claims for this taxon that we have rejected (our assessment of Little Salt Spring, presented above, is not repeated here).

*Boaz.* The reported association between a mastodon skeleton and a projectile point at this site is based on recollections more than 60 years after the fact by one of the people who helped excavate the skeleton. He recalled that a single "arrowhead" had been recovered on the third day of the project; shown two artifacts held at the University of Wisconsin in a box labeled "Allegedly found with U.W. elephant," he identified the smaller of the two as resembling the one found with the bones, though he could not be sure that this was the same object. The specimen he identified was a fluted point made of Hixton quartzite, the source of which is about 130 km north of the site. His older brother, by then deceased, had reportedly found the specimen "imbedded in the same clay as the bones within a few inches of a rib" (Palmer and Stoltman, 1976, p. 167). The association barely meets our criterion of a minimal association but does little beyond that. The site is intriguing but inconclusive, and we have accordingly eliminated it from further analysis.

*Hiscock.* The excavators of this site note that fluted points and other artifacts occur with mastodon remains on a lag surface, one of the only sites in eastern North America in which such remains are in relative proximity to one another. Although occasionally cited as providing evidence of mastodon predation (e.g., Meltzer, 1993b; Webb, 1992), there is neither a clear association nor a necessary relationship between the artifacts and the faunal remains (Laub *et al.*, 1988, p. 76). In fact, Laub (2002) has recently raised the intriguing possibility that eastern fluted point groups treated this locality as a bone quarry, where they occasionally collected skeletal parts of long-dead mastodons to fashion into tools.

*Manis.* Excavated during the 1970s, this site provided a "virtually" complete mastodon skeleton (Gustafson, 1985, p. 285). One of the specimens from this skeleton accounts for the site's fame: a fragmentary rib with the tip of a bone object protruding from the near the rib's head (see the illustration in Gustafson *et al.*, 1979). The assumption this protruding object must be the tip of a projectile led to the further assumption that this animal had been attacked by people.

In addition to the fragmentary rib, two other lines of evidence have been used to argue that the Manis mastodon is archaeological. First, "the bones of the right limb were scattered about and possess numerous cuts, scratches, and breaks suggestive of butchering" (Gustafson, 1985, p. 284). Second, a "flaked cobble spall" is said to have been found associated with the mastodon bones (Gustafson *et al.*, 1979, p. 163), as were "several pieces of worked bone and tusk" (Gustafson *et al.*, 1979, p. 157).

Even though Gustafson (1985) quickly turned the Manis locale into a "kill site," we concur with Carlson (1990) in finding no compelling evidence for human involvement with this animal. This is an easy conclusion to reach because so little has been published on the results of the excavations that occurred here. There are no descriptions of the "several pieces of worked bone and tusk," and only a crude illustration of the flaked cobble spall said to be an artifact. What has been published leaves us in strong doubt. The "flaked cobble spall" was not the only stone object found in the mastodon component at Manis. Instead, it was selected as archaeological from amongst a number of other, apparently larger, objects that had been "chipped and broken" but none of which "can be shown definitely to have been altered by man" (Gustafson *et al.*, 1979, p. 163). Given this context, and given the nature of the "flaked cobble spall" illustrated by Gustafson *et al.* (1979, p. 163), we are unconvinced that this is an artifact.

We are also unconvinced that the "cuts, scratches, and breaks" mentioned by Gustafson (1985), and in part illustrated by Gilbow (1981, figures 3.12, 3.12), are of anthropogenic origin. None of the marks is such that it would have suggested human interference in the absence of the pointed bone object found in the mastodon rib.

That object is certainly curious. One of us (DKG) arranged to have a tomogram made of this specimen shortly after it was excavated. Although the image has never been published, the results are accurately reported in Gustafson *et al.* (1979). What we do not know is what this apparently intrusive object is. Gustafson *et al.* (1979, p. 157) make it very clear that they did not know either, referring to it as a "supposed projectile point." Given that the Manis mastodon site has never been adequately discussed in print, other than the paleoenvironmental analysis conducted by Peterson *et al.* (1983), and that the critical rib fragment has never been analyzed in any detail, this site cannot be accepted as providing secure evidence for human interaction with or predation on mastodon.

*Great Lakes Mastodon Localities.* We react somewhat differently to the series of sites in the Great Lakes region argued by Fisher (1984a,b, 1987) and his colleagues (Fisher *et al.*, 1991, 1994; Shipman *et al.*, 1984) to contain evidence for the processing of mastodon carcasses by people. By our count, there are 12 such sites: Burning Tree, Ohio; Cole, Michigan; Elkhart, Indiana; Fairview, New York; Heisler, Michigan; New Hudson, Michigan; Pleasant Lake, Michigan; Russell Farm I and II, Michigan; Van Sickle, Michigan;

Wattles, Michigan; and Winameg, Ohio (in a few cases, we have inferred the state involved since that information was not provided).

The argument that mastodon remains from these sites represents animals that were killed and/or butchered by people rests on several kinds of evidence, all of which are provided by the bones themselves; in no case have artifacts been found associated with any of the mastodons. This may reflect the fact that most of the excavations involved were "essentially salvage efforts" (Fisher, 1987, p. 316), with material not retrieved in such a way as to ensure that any artifacts that were present would have been retrieved. However, the Burning Tree mastodon (see below) and several other sites were excavated with "extensive sieving or screen washing" (Fisher, 1987, p. 316), and these also failed to provide artifacts (Fisher *et al.*, 1991).

Fisher has suggested that artifacts are absent because people carried all of that material away, or because the butchering was done elsewhere and only the meat/bones brought to these sites (e.g., Fisher, 1984a, 1987; Fisher *et al.*, 1994). To us, it seems highly unlikely that hunter-gatherers would so thoroughly tidy a butchering site, let alone retrieve all points, tools, or flakes that broke and/or were hidden deep within a carcass (Meltzer, 1988; also Lepper, 1999). Kimmswick, for example, produced thousands of tiny flakes (Graham *et al.*, 1981). Even where bone tools were used [e.g., Lange-Ferguson (Hannus, 1990; Martin, 1987)], stone artifacts are nonetheless present. We also note that mammoth kill, butchering, and scavenging localities in the west routinely produce stone artifacts, unlike the 12 mastodon sites on Fisher's list.

Obviously, the archaeological claim for these sites must come from the bones alone. Unfortunately, only 2 of these 12 sites have been discussed in any detail in print: Pleasant Lake and Burning Tree. While the others are said to have provided evidence similar to that provided by these two sites, that evidence has not been adequately described, and the association of human activity and the extinct fauna rests entirely on assertion (which is why they were removed in the first cut; see Table II).

The Pleasant Lake mastodon was discovered during dragline excavation of a pond; when a tusk was noted, work stopped, and the remaining material excavated professionally. No artifacts were discovered, but subsequent analysis by Shipman *et al.* (1984) demonstrated the presence of a series of modifications strongly suggestive of human butchering. These included striations and polishing on the adjoining articular ends of once-articulated bones as well as more conventional cut marks. Other specimens are "blackened and show microstructural changes . . . known to occur as a bone is heated" (Shipman *et al.*, 1984, pp. 363–364). While it would certainly be helpful to have a specimen-by-specimen account of the Pleasant Lake mastodon, the detailed analysis presented by Shipman *et al.* (1984)

leads us to accept this mastodon as archaeological (compare Haynes, 1991, pp. 251–252).

The Burning Tree mastodon is more problematic. Like Pleasant Lake, the Burning Tree mastodon was discovered during a dragline operation, and then professionally excavated as well as it could be given the season (winter) and salvage context. A nearly complete mastodon, but no artifacts, was recovered. Fisher *et al.* (1991, 1994) argue this individual had been butchered in a way generally similar to that seen at Pleasant Lake. Unfortunately, the illustrations in the Burning Tree reports—simple line drawings—are not of sufficient quality to allow this argument to be assessed (compare, for instance, the illustrations in Fisher *et al.*, 1994 with those in Fisher, 1984b or Saunders and Daeschler, 1994). As intriguing as we find this site, it cannot be accepted as providing strong evidence for human interaction with mastodon because the evidence for such an interaction has not been adequately presented (compare Lepper, 1999, p. 382).

Of the 12 sites suggested by Fisher to provide evidence of human butchering of mastodon, then, only one has been published in such a way as to allow an independent assessment of that evidence. That site, Pleasant Lake, we accept, even while remaining puzzled by the fact that no artifacts were found associated with it, or at any of the other 11 sites included in Fisher's claims.

## EXTINCT MAMMAL GENERA IN CLOVIS-AGE ARCHAEOLOGICAL SITES

The results of this second cut of the data can be seen in Table VI. There are several aspects of this table that merit comment.

First, measured any way one likes, this is a remarkably small record: just 17 occurrences spread across 15 localities. This is in stark contrast with that available from the late Upper Paleolithic of western Europe. Costamagno (1999), for instance, has inventoried 81 Magdalenian sites, including a total of 114 separate faunal assemblages, from just the southern half of France. These faunas, marked by the presence of large mammals that became locally extinct with the end of the Pleistocene, accumulated over some 6000 years, six times longer than the Clovis-age record, but from an area about the size of the state of Colorado. When put to the same temporal and spatial scales, the density of sites with extinct faunas in Upper Paleolithic France is ~27.3 times greater than that of Clovis North America. We grant that southern France is blessed with caves and rockshelters and that Costamagno's inventory includes many sites from such settings, but we also note the Paris Basin, in northern France, contains exquisite Magdalenian open sites, of

**Table VI.** Clovis-Aged North American Archaeological Sites With Securely-Associated Remains of Extinct Pleistocene Mammals

| Site | *Camelops* |  | *Equus* |  | *Mammut* |  | *Mammuthus* |  |
|---|---|---|---|---|---|---|---|---|
|  | MNI | NISP | MNI | NISP | MNI | NISP | MNI | NISP |
| Blackwater Loc 1 BSW |  |  |  | 1 |  |  |  | 10 |
| Blackwater Loc 1 GS |  |  |  |  |  |  |  | 306 |
| Colby |  |  |  |  |  |  | 7 | 424 |
| Dent |  |  |  |  |  |  | 12 |  |
| Domebo |  |  |  |  |  |  | 1 | ∼75 |
| Escapule |  |  |  |  |  |  | 1 | 18 |
| Hebior |  |  |  |  |  |  | 1 | ∼170 |
| Kimmswick – C1 |  |  |  |  |  | + |  |  |
| Kimmswick – C3 |  |  |  |  |  | 39 |  |  |
| Lange-Ferguson |  |  |  |  |  |  | 2 | 153 |
| Lehner |  | 1 |  |  |  |  | 13 | 104 |
| Lewisville – 1950s |  |  |  | 1 |  |  |  |  |
| Lubbock Lake |  |  |  |  |  |  |  | >50 |
| Miami |  |  |  |  |  |  |  | ∼391 |
| Murray Springs |  |  |  |  |  |  |  | 55 |
| Naco |  |  |  |  |  |  | 1 | 35 |
| Pleasant Lake |  |  |  |  | 1 | ∼100 |  |  |

*Note.* NISP values designated as approximate (∼) are those we have estimated from published maps and/or descriptions. In the case of the Miami locality, the NISP value has been derived from the 337 specimens collected in 1990 (Holliday *et al.*, 1994) plus an estimated 54 specimens shown by the site plan map in Sellards (1952).

roughly Clovis age, with equally exquisite faunas (e.g., Audouze and Enloe, 1997; Enloe and Audouze, 1997; Leroi-Gourhan and Brézillon, 1972).

Second, and as Table VI also shows, there are four taxa in these Clovis and Clovis-aged sites: *Camelops*, *Equus*, *Mammut*, and *Mammuthus*. Although we have accepted the camel and horse specimens, these taxa are represented by only three bones scattered across three sites. To us, this record is insufficient to establish human predation on the animals involved. Only for mammoth and, to a lesser extent, mastodon, is there abundant and compelling evidence-from 14 sites–that human predation played a causal role in producing the archaeological associations involved. Only for mammoth and, to a lesser extent, mastodon, is there abundant and compelling evidence–from 14 sites–that human predation played a causal role in producing the archaeological associations involved. These sites are listed in Table VII. Besides mammoth and mastodon, the only other large mammal to have been reported in significant numbers in Clovis-aged sites is *Bison*—38 specimens from Lehner, for instance, 186 specimens from Blackwater Locality 1, and 338 from Murray Springs (see above for references).

In contrast, the late Magdalenian site of Pincevent in northern France provided the remains of at least 97 reindeer (Enloe and Audouze, 1997; Leroi-Gourhan and Brézillon, 1972). The late Magdalenian faunal assemblages of southern France routinely contain six or more genera of ungulates alone, and NISP counts for the assemblages that contain them typically run into the thousands. The Magdalenian unit at Grotte XVI, for example, contains nine ungulate genera and 2139 specimens (Grayson *et al*., 2001); Duruthy, eight genera and 6004 specimens (Delpech, 1983); Rond-du-Barry (Couche E), nine genera and 2771 specimens (Costamagno, 1999).

**Table VII.** Archaeological Sites With Evidence Suggesting Human Predation on Now-Extinct Pleistocene Genera

| Site | Taxon |
|---|---|
| Blackwater Loc 1 | Mammoth |
| Colby | Mammoth |
| Dent | Mammoth |
| Domebo | Mammoth |
| Escapule | Mammoth |
| Hebior | Mammoth |
| Lange-Ferguson | Mammoth |
| Lehner | Mammoth |
| Lubbock Lake | Mammoth |
| Miami | Mammoth |
| Murray Springs | Mammoth |
| Naco | Mammoth |
| Kimmswick | Mastodon |
| Pleasant Lake | Mastodon |

Third, while there are relatively few secure cases of extinct mammals—mammoth and mastodon—in kill/butchery association in Clovis sites, where they do occur there is usually little ambiguity about them. When humans exploited these animals, they left behind obvious and distinctive traces of their activities—impact-fractured projectile points, knives, large numbers of resharpening flakes—around or within carcasses, as well as unmistakable cut marks, burned bone, or nonrandomly stacked or distributed bone elements. This is not to say that each mammoth or mastodon site in Table VII has all of those attributes; rather, that in each of those cases there was sufficient evidence of this sort to make a claim of an archaeological association compelling. To counter the suggestion that this is so only because our criteria for an archaeological association were unduly rigid, thus limiting the sites we would find acceptable and making our conclusion about how few there are self-fulfilling, we point out that the kind of evidence we seek to demonstrate human exploitation of extinct mammals is precisely the same kind of evidence we seek (and find) in post-Clovis-age modern faunas killed and butchered by humans. We might not see impact-fractured points in all cases (Hofman, 2001, p. 98), or clear evidence of butchering (Haynes, 1991, p. 303), but signs of human activity should certainly be present nonetheless. To imply otherwise [and we note that neither Hofman (2001) nor Haynes (1991) is doing so]—that human exploitation of these animals would leave no traces at all—requires special pleading that the Clovis archaeological record is unique or otherwise different from later periods or other areas, and draws us into an unacceptable netherworld in which negative evidence becomes positive.

As to the other 33 genera of now extinct-mammals, we have no evidence at all for their exploitation by humans in a predator–prey relationship. That a very few of their bones or bone fragments have occasionally ended up in archaeological contexts is intriguing, but can do little more than document their contemporaneity on the landscape, a fact easily established independently of such evidence.

## THE ARCHAEOLOGY OF “OVERKILL”

Obviously, these results have significant implications for the claim that human hunters caused the extinction of some 35 genera of North American Pleistocene mammals. That claim, as developed by Martin (1967, 1984, 1990; Martin and Steadman, 1999) rests on four distinct premises (Grayson, 2001):

1 That it has been well-established, by archaeological and paleontological research, that the human colonization of islands is followed by vertebrate extinctions;

2 That Clovis people were very likely the first to enter the Americas, shortly before 11,000 years ago, and were certainly the first big game hunters in North America;
3 That the extinction of those mammals occurred at about 11,000 years ago; and,
4 That Clovis people preyed upon a wide variety of now-extinct large mammals.

From these premises, Martin draws the conclusion that Clovis hunters caused the North American extinctions.

We have explored the first three of these premises in detail elsewhere (Grayson, 2001; Grayson and Meltzer, in press). We can summarize that work by noting that the first of them is most certainly true: on island after island, the initial human colonization led to vertebrate extinction (see the review in Grayson, 2001). The poster child for this phenomenon is New Zealand. Before permanent human settlement at about 900 years ago, New Zealand's North and South islands supported some 11 species of moas, large flightless birds whose estimated live weights ranged from 20 to over 100 kg. After just a few hundred years of human settlement, all, along with a series of other vertebrates, were extinct (Anderson, 1989; Grayson, 2001; Worthy and Holdaway, 2002).

While New Zealand may provide a particularly well-known example, however, the same process occurred on virtually every island whose archaeology is sufficiently well-documented to tell (see Grayson, 2001 for references). On the islands of the Mediterranean, for instance, only two mammal species survived human colonization, and both of these are shrews (Blondel and Vigne, 1993; Vigne, 1999); similar phenomena are known from islands as diverse as Madagascar (e.g., Burney, 1997, 1999; Dewar, 1997a,b) and those in the Caribbean (e.g., Morgan, 2001; Morgan and Woods, 1986).

The precise causes of the extinction of each of the species involved are not known. Nonetheless, the ultimate cause is not in doubt. This is because the extinctions were accompanied by massive vegetation change, routinely due to burning, by the introduction of such predators and competitors as rats and dogs (among other things), and, at times, by direct human predation. That is, these extinctions were caused by the multiple impacts of human arrival (Grayson, 2001).

That island faunas are vulnerable to such things is not surprising. As Steadman (1997) has observed, island birds are at risk in these settings because they have relatively small population sizes, are confined to tightly bounded areas of land that may undergo rapid environmental change, and may have lost—and in some cases have clearly lost—the mechanisms needed to cope with introduced pathogens, predators, and competitors. Much the same can be said for all island vertebrates, and to all of this must be added the fact that the isolated nature of islands means that there are no nearby sources of conspecific individuals to replace dwindling local populations. No wonder, as Steadman *et al.* (1991, p. 126) point out, "animals on oceanic islands tend to be more vulnerable to extinction or extirpation than their continental counterparts" and that, as Paulay (1994, p. 134) notes, island faunas are "among the most vulnerable in the world."

In all cases, the extinctions that occurred on islands after prehistoric human colonization are attributed, even by Martin (e.g., Martin, 1984), to a complex set of anthropogenic alterations to the landscape. In no case has the extinction of any island vertebrate shown to have been the result of hunting alone, yet it is only hunting that Martin targets as the cause of the North American continental extinctions. We also note that there is no evidence for widespread human-caused landscape alteration at the time of the Clovis arrival—no massive burning, no rats, no pigs, no chickens, and, although they might have been present (Walker, 1982), no secure evidence for dogs. Finally, the geographic conditions that make island faunas especially vulnerable to extinctions are simply irrelevant to a continent the size of North America.

In regard to Martin's second premise, it is, as we have observed, extremely unlikely that Clovis people actually were the first Americans, given the strong evidence for human occupation at Monte Verde, southern Chile, at about 12,500 years ago (Dillehay, 1997; Meltzer, 1997, Meltzer *et al.*, 1997). Interestingly enough, this, too, is likely to be irrelevant to Martin's argument, and it is Martin himself who made it so. As he noted in 1967, "the possibility that *Homo sapiens* spread into the Americas long before the late-glacial by no means eliminates the hypothesis of overkill (Martin, 1967, p. 101). "Whether or not prehistoric peoples were in North America," Martin (1984, p. 363) emphasized, "11,000 B.P. is the time of unmistakable appearance of Paleo-Indian hunters using distinctive projectile points."

In fact, the possibility that the Americas were occupied prior to Clovis times is so repugnant to Martin that he has recently likened the search for pre-Clovis Americans to "something less than serious science, akin to the ever-popular search for 'Big-Foot' or the 'Loch Ness Monster' " (1999, p. 278). We are surprised that the author of the overkill argument, an argument whose very foundation would appear to lie in the nature of the late Pleistocene archaeology of North America, can dismiss as charlatans those who explore the deeper aspects of this archaeology. Nonetheless, he has done so at the same time as he has dismissed the relevance to the overkill notion of whatever it is they might discover.

Martin's third premise, that all the extinctions occurred about 11,000 years ago, may, in fact, be correct. However, to date, of the 35 genera involved, only 15 can be shown to have survived beyond 12,000 years ago. As a result, it is possible, though certainly not demonstrated, that a significant number of the losses predated the Clovis arrival (Goodyear, 1999; Grayson, 1987, 1989; Meltzer and Mead, 1985). In western Europe, where the late Pleistocene history of now-extinct or extirpated mammals is far-better known than it is in the New World, the losses of mammals were scattered in time and space (e.g., Delpech, 1999). There is little reason to think that the situation must have been otherwise in North America. As one of us observed a number of years ago (Grayson, 1991, p. 206), assuming that the extinctions were synchronous requires that we attribute to the extinction "event" a set of properties, most notably speed and taxonomic breadth, that it may or may not have possessed. Once that is done, explanations of the extinctions must be structured to account for these assumed properties, whether those explanations focus on people, climate (e.g., Graham and Lundelius, 1984) or disease (e.g., MacPhee and Marx, 1997).

Nonetheless, it is true that there is a strong positive relationship between the number of North American paleontological sites for a given extinct taxon and the chance that it has been dated to, or near to, Clovis times (Grayson and Meltzer, in press). But even if we assume, as Martin does, that all the extinctions occurred at around 11,000 years ago and share a common cause, North America was not the only part of the Northern Hemisphere to see significant extinction at this period of time (Grayson and Meltzer, in press). The same phenomenon occurs, for instance, in western Europe (Bridault *et al.*, 2000; Delpech, 1999) and on the northern Siberian mainland (MacPhee *et al.*, 2002). Neither place harbored Clovis hunters. The late Pleistocene of southwestern France saw the intense hunting of reindeer (*Rangifer tarandus*) throughout much of the Upper Paleolithic, but not until the very end of the Pleistocene, some 11,000 years ago, were these animals extirpated from lower elevation settings, with those in the uplands soon to follow (Bridault *et al.*, 2000; Delpech, 1999; Straus, 1995). In Ireland, reindeer were extirpated, and giant deer (*Megaloceros giganteus*) became extinct, soon after 11,000 years ago, in the absence of a human presence (Woodman *et al.*, 1997). With or without Clovis, and even with or without people, the Northern Hemisphere saw terminal Pleistocene extinctions. Only in the New World have those extinctions been attributed to human hunting.

Martin's final premise maintains that Clovis hunters preyed on a wide variety of now-extinct mammals, an assertion that is especially critical to his argument. If Clovis people did not hunt a broad set of the herbivores that became extinct, these groups can hardly be held responsible for their demise. As the assessment we have provided here shows, however, there is no evidence that Clovis people preyed on a wide variety of now-extinct large mammals. There is evidence only that they at least occasionally took mammoth and mastodon.

Indeed, it is significant that for 33 extinct genera, and for 26 of the 28 extinct herbivores, there is no archaeological evidence at all for hunting, and only a limited number of kill/butchering sites for the other two. Yet Clovis age groups incorporated bison into their diets with some frequency, as attested by unequivocal evidence at sites such as Blackwater Locality No. 1, Lehner, and Murray Springs. Moreover, people continued to exploit this genus over the next 10,000 years, often killing hundreds of animals in a single event (e.g., Wheat, 1972). Thus, where we have virtually no evidence of human predation, the genera became extinct; where we have evidence of intensive predation, the genus survives.

## CONCLUSIONS

Of the 76 localities with asserted associations between people and now-extinct Pleistocene mammals, we found only 14 (12 for mammoth, 2 for mastodon) with secure evidence linking the two in a way suggestive of predation. This result provides little support for the assertion that big-game hunting was a significant element in Clovis-age subsistence strategies. This is not to say that such hunting never occurred: we have clear evidence that proboscideans were taken by Clovis groups. It just did not occur very often. In fact, four of the 12 mammoth sites on our list (Escapule, Lehner, Murray Springs, and Naco) are located very close to one another on tributary arroyos of Arizona's San Pedro river [the furthest distance between any two of the sites is just 35 km; two are within 5 km of one another (Haynes, 1987; Hemmings and Haynes, 1969)]. Given that two of sites (Escapule and Naco) have single animals that were attacked but not butchered (the ones that "got away"?), all of these could even be the result of a single group's activities—with obviously disproportionate influence on our view of Clovis subsistence.

Proponents of big-game hunting might reply that there are simply too few sites to say anything at all about Clovis subsistence strategies, and at first glance there is merit in that argument. There are relatively few sites from this time period, with or without extinct mammals. Perhaps, proponents might argue, these groups were hunting now-extinct big-game but we have yet to find the sites to prove it. If anything, however, our search strategies are biased toward the discovery and recovery of sites containing the remains of Pleistocene megafauna, simply by virtue of their greater archaeological visibility and our interest in such remains (Grayson, 1988b; Meltzer, 1993a). It seems fair to say that if these groups were routinely hunting now-extinct mammals, it is just as likely we would have seen it by now, as we so clearly do in other parts of the prehistoric world.

Our focus in this paper has been relatively narrow: we have addressed whether Clovis-age peoples were hunting now-extinct mammals, and not (except in passing) what other resources these groups utilized. It is worth observing that these groups appear to have utilized a variety of subsistence resources, and that there might be some regional patterns to their subsistence strategies. For instance, the early sites of eastern North America, including Bull Brook, Holcombe, Udora, and Whipple, lack the remains of extinct mammals, but do contain caribou (*Rangifer tarandus*) and the remains of other extant mammals (e.g., Spiess *et al.*, 1985; Storck and Spiess, 1994). However, the subsistence data from early North American archaeological sites are sparse, and what does exist has yet to be adequately assessed on a continental scale.

As to the role of human hunters in the extinction of the large Pleistocene mammals, the results of our examination should by now be clear. No statistical analysis is needed to observe that the late Pleistocene peoples of North America cannot be shown to have been preying on a full-array of now-extinct herbivores. Archaeologists have pointed this out all along (e.g., Hester, 1967; Jelinek, 1967), though it is certainly valuable to have this conclusion more firmly grounded. Martin's only response to this situation has been to argue that it all happened so fast that there was no time for the results to have been preserved (e.g., Martin, 1973, 1984), that the wonder is not that there are so few kill sites but that there are any at all, and that "much evidence of killing or processing of the extinct fauna is not predicted" by his position (Martin, 1984, p. 397). This is an argument whose scientific logic has always eluded us (Grayson, 1984b; Meltzer, 1993b). It does, however, make a great deal of sense once it is accepted that Martin's argument is meant to appeal not to scientific reason but instead to faith, more akin to religion than to biology (Grayson, 2001; Grayson and Meltzer, in press). His suggestion that overkill happened so fast that no evidence of it is either expected or required follows inexorably from that stance.

It has long struck us that those who seem supportive of the overkill notion are scientists whose work focuses on contemporary organisms (e.g., Alroy, 2001; Alvard, 1994, 1998; Brown and McDonald, 1995, 1997; Diamond, 1984, 1986, 1989, 1992; Paulay, 1994; Pimm, 2001), some of whom have produced elegant models to show how this must have happened (e.g., Alroy, 2001; but see the discussion in Grayson and Meltzer, in press). However, the issue is not whether Clovis groups were "capable" of hunting the Pleistocene fauna to extinction, but whether they actually did so, and that is an archaeological question. The archaeological answer is clear enough: they did not. This is why overkill finds so little support among those who are familiar with the empirical record of late Pleistocene archaeology and paleontology.

Our attention, therefore, needs to be turned elsewhere if we are to find the causes of late Pleistocene extinctions in North America and to understand the adaptive mechanisms by which Clovis groups and their contemporaries were able to spread across North America with such apparent speed. Whatever those adaptive mechanisms were, they clearly did not involve the relentless pursuit of now-extinct Pleistocene mammals across ecological boundaries on the diverse and dynamic late Pleistocene North American landscape.

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