

# Early Paleoindian foraging: examining the faunal evidence for large mammal specialization and regional variability in prey choice

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## Abstract

North American archaeologists have spent much effort debating whether Early Paleoindian foragers were specialized hunters of megafauna or whether they pursued more generalized subsistence strategies. In doing so, many have treated the foraging practices of early North Americans as if they must have been uniform across the continent, even though others have pointed out that adaptations appear to have varied among groups inhabiting different kinds of environments. Resolving these issues fully requires referring to archaeofaunal data and evaluating those data critically. In this paper, we conduct such an evaluation of the existing Early Paleoindian faunal record, which we then use to test the hypothesis that early Americans across the continent specialized in the hunting of megafauna. After detailed attention is given to taphonomic issues, to the limited geographical distribution of sites with secure associations between humans and prey taxa, and to differences among sites in the roles that they likely played in settlement and subsistence systems, it becomes clear that the faunal record provides little support for the idea that all, or even any, Early Paleoindian foragers were megafaunal specialists. It does appear, however, that there was considerable variability in Early Paleoindian prey choice across the continent, which was likely related to variability in the environments that different groups inhabited.

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## 1. Introduction

North American archaeologists have long debated whether Early Paleoindian foragers were subsistence specialists who selectively hunted megafauna—particularly mammoths and mastodons—or whether they were generalists who relied on a variety of plant and animal resources (e.g., Haynes, 1966, 1970, 1980; Collins, 1976; Judge, 1976; Johnson, 1977, 1991; Saunders, 1977, 1980; Meltzer and Smith, 1986; Bonnicksen et al., 1987; Belovsky, 1988; Grayson, 1988a; Kelly and Todd, 1988; Meltzer, 1988, 1993; Hannus, 1990a; Jones, 1990; Olsen, 1990; Bryan, 1991; Frison, 1991; Stanford, 1991; Hofman and Todd, 2001; Grayson and Meltzer, 2002, 2003; Haynes, 2002a, b; Waguespack and Surovell, 2003). When taking sides in this debate, many of these archaeologists have discussed Early Paleoindian

subsistence practices on a continental scale, thereby treating them—often implicitly but occasionally explicitly (e.g., Haynes, 1982)—as if they must have been uniform across North America.

Such treatment begs the question of whether it is appropriate to generalize about Early Paleoindian foraging strategies at this large a scale. More specifically, can we assume that all Early Paleoindian groups were alike in focusing on megafauna (e.g., Kelly and Todd, 1988; Waguespack and Surovell, 2003)? Such an assumption seems problematic given the potentially substantial regional differences that existed during the terminal Pleistocene in the communities of prey taxa available to human foragers (e.g., Lyons, 2003; Cannon, 2004; Webb et al., 2004). This assumption should be evaluated critically, and one way to do so would be to ask whether Early Paleoindian subsistence practices varied across the continent in a manner that might be understood in terms of environmental variability (e.g., Meltzer, 1993).

Answering this question obviously requires a comprehensive and systematic examination of subsistence

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data from Early Paleoindian sites across the continent. It is not unfair to observe, however, that few previous studies of Early Paleoindian subsistence have involved such an examination. Rather, most have either generalized about continent-wide practices based on observations taken from individual sites or limited regions (particularly the Southwest and the Plains, with their spectacular Clovis mammoth kills), or they have advanced lightly tested theoretical arguments about optimal adaptive strategies during the terminal Pleistocene. We ourselves are not immune to such criticism (e.g., Meltzer and Smith, 1986).

Recently, though, some authors have examined faunal data from Early Paleoindian sites located throughout North America (Haynes, 2002a,b; Waguespack and Surovell, 2003). These publications are welcome contributions to the literature, but they unfortunately devote little attention to taphonomic issues that must be addressed before animal remains can be treated as evidence of human subsistence practices (e.g., Haynes and Stanford, 1984; Haynes, 1991; Lyman, 1994; Hofman and Todd, 2001; Grayson and Meltzer, 2002). Because the specialist-generalist debate and questions of geographic variability in foraging strategies can only be resolved empirically, and because faunal data must play a central role in doing so, it is crucial that these data be evaluated much more critically: it must be clear that the animal bones recovered from Early Paleoindian sites were deposited there as a result of human subsistence activities. Grayson and Meltzer (2002) provide such a critical evaluation of the evidence for Early Paleoindian subsistence use of extinct mammals, concluding that direct indications of predation exist for only a few extinct taxa from a small number of sites. This conclusion, however, raises an obvious question: if Early Paleoindian foragers were not routinely hunting extinct mammals, then what resources were important to them?

In this paper, we seek to close the gap between these previous efforts by examining the available evidence for subsistence use of all vertebrate taxa, not limited to extinct mammals. We do this using data from the largest sample that we can compile of sites with faunal remains that date, at least potentially, to the Early Paleoindian period and for which human associations have been suggested. We first evaluate which taxa in which sites can reasonably be concluded to have been killed, butchered or processed by Early Paleoindians for subsistence purposes. Then, taking into account factors that have apparently introduced substantial biases into the existing sample of Early Paleoindian assemblages, we use the vetted faunal data to evaluate hypotheses about subsistence practices in North America during this period. We conclude by arguing that once detailed attention is given to taphonomic issues, to the limited geographical distribution of sites that provide

faunal evidence of subsistence practices, and to differences among sites in the roles that they likely played in settlement and subsistence systems, the picture of Early Paleoindian subsistence that emerges is much more complex than the one that many authors have advanced.

### 1.1. Notes on terminology

For ease of discussion, we refer to the sites that we consider here as “Early Paleoindian”. We recognize that there is considerable variability among the artifact assemblages from these sites (see, e.g., Stanford, 1991; Meltzer, 1993; Beck and Jones, 1997), but of greatest relevance is that the technological complexes found at them generally represent the earliest secure evidence of a human presence in the regions in which they occur. These sites vary somewhat in age from region to region (Meltzer, 2004): for example, the “classic” Clovis localities of the Southwest and the Great Plains date to between 11,500 and 10,900 <sup>14</sup>Cyr BP (Holliday, 2000), and the Stemmed Point occupations of the intermountain west may date to at least as early as 11,200 <sup>14</sup>Cyr BP (e.g., Beck and Jones, 1997), while the early sites of eastern North America, at which artifacts of the Eastern Fluted Point complex are found, were apparently not first occupied until after about 10,900 <sup>14</sup>Cyr BP (Dent, 2002). However, given that the sites that we use represent the earliest well-documented human occupations in their respective regions, and given that the subsistence practices of early North Americans are often considered to be of central importance to our understanding of larger issues relating to the initial human colonization of the continent (e.g., Martin, 1973; Kelly and Todd, 1988; Surovell, 2000; Haynes, 2002a; see also Meltzer, 1993), our sample of sites is easily justified as an analytic unit.

Regarding the vertebrate taxa that occur in these sites, we note that phrases such as “big game” and “large mammals” are often used in the Early Paleoindian literature as synonyms for extinct Pleistocene megafauna (even by authors who explicitly disavow using these phrases in this manner: e.g., Kelly and Todd, 1988). However, not all extinct Pleistocene mammals were megafauna (e.g., *Aztlanolagus*, the Aztlan rabbit), nor did all megafaunal taxa become extinct (e.g., *Bison*). We consider both extinct and extant taxa here, and we use the term “megafauna” to refer to herbivores with estimated body masses greater than ca 400 kg: in the samples that we use, this includes members of the genera *Glyptotherium*, *Glossotherium*, *Mammut*, *Mammuthus*, *Equus*, *Camelops*, *Cervalces* and *Bison*. Below, we present analyses that consider the degree to which Early Paleoindian faunal assemblages are dominated by “large herbivores”, a category that consists of all extinct xenarthrans, all proboscideans, perissodactyls and

artiodactyls, and the large rodent *Castoroides*; as such, this category includes both “megafauna” and smaller-bodied herbivores. We use the term “large mammal” as a synonym for this “large herbivore” class.

## 2. The data

The sites that we consider are listed in Table 1 and mapped in Fig. 1; for stratified or multi-component sites, we note in Table 1 the subset of the total site assemblage that we include in our discussions and analyses. This sample of sites was compiled from individual site reports, from the FAUNMAP database (FAUNMAP Working Group, 1994), and from the lists presented by Grayson and Meltzer (2002, Table IV), Haynes (2002a, Tables 2.3, 2.4 and 5.1) and Waguespack and Surovell (2003, Table 2). For all of these sites, there is some reason, such as radiocarbon dates, artifact typology, or stratigraphy, to think that they may contain bones dating to the Early Paleoindian period as defined above. Following Grayson and Meltzer (2002, Table III), we have performed a “first cut” to eliminate from our sample sites that are inadequately published or of immediately doubtful archaeological status; we include such sites here only if they are used by Haynes (2002a) or Waguespack and Surovell (2003). We include a very few sites that have only recently been discovered and that are not yet fully published (e.g., Jake Bluff), but which already provide sufficient information for evaluation purposes and which will likely be reported in more detail soon<sup>1</sup>. Finally, we include in our sample only sites located in mid-latitude North America south of the late Pleistocene continental ice sheets and north of Mexico, which is the area within which North American Early Paleoindian materials are best known and most widely distributed (e.g., Ranere and Cooke, 1991; Lorenzo and Mirambell, 1999; Bever, 2001; Haynes, 2002a). Thus derived, our sample consists of 62 sites.

In our analysis of faunal assemblage content, we consider mammal remains in greatest detail because this class of vertebrates is the best represented in, and the best described from, most early sites. The sites in our sample contain a cumulative total of 78 mammalian genera, 19 of which became extinct in North America by the end of the Pleistocene. These genera are listed in Table 2, and Tables 3 and 4 list the taxa that have been reported from each site individually (we include in these tables only specimens that have been identified to the taxonomic level of genus or below). We give taxonomic

abundance values for mammal genera—in units of Minimum Number of Individuals (MNI) and/or Number of Identified Specimens (NISP; see Grayson, 1984 for definitions)—for sites for which such values are available. For some sites we have estimated NISP values by counting specimens plotted on site maps.

Many of the sites in Table 4 contain the remains of vertebrates other than mammals, but because these non-mammalian classes are superficially documented for most of these sites, we indicate only the presence or absence of higher taxonomic units at them (the category “other herps” includes all amphibians and reptiles other than turtles, which are by far the most common kind of reptile at early sites). In cases in which there is strong evidence for subsistence use of non-mammalian vertebrates, however, we do mention the particular taxon that is reported.

Finally, we note that we have divided the assemblages from two sites—Blackwater Locality 1 and Lewisville—into two “faunules” each. These correspond to subsets of the assemblages from these sites that, in addition to coming from different areas and/or strata, were analyzed by different researchers at different times and are presented in different formats.

## 3. Evaluating evidence for subsistence use of vertebrate taxa

Given that archaeologists have increasingly come to recognize the importance of taphonomic issues over the last few decades (see, e.g., Binford, 1981; Haynes and Stanford, 1984; Haynes, 1985, 1987, 1991; Lyman, 1994), recent compilations of Early Paleoindian faunal data (Haynes, 2002a,b; Waguespack and Surovell, 2003) have devoted surprisingly little attention to two questions that must be asked whenever animal bones are used to support arguments about past human subsistence. The first of these questions involves the issue of association: can the bones recovered from a given site be shown to have been deposited by people in conjunction with subsistence activities? As is now well known, simple co-occurrences of artifacts and bones cannot be treated as if they reflected human consumption of animals, and detailed descriptions of such things as bone modification and site stratigraphy are necessary before we can answer this first question. If it can be shown that humans were involved in the taphonomic history of the bones from a site, then the second question, which involves the issue of bias, must also be asked: has that taphonomic history left us an accurate representation of the variety of taxa that people used and of the relative frequencies with which they used them? It is not enough simply to suggest that a biased or “imperfect” faunal record must be used either as is or not at all (e.g., Waguespack and Surovell, 2003, p. 347). There are ways in which biases in that

<sup>1</sup>This is in contrast to sites that were excavated years or decades ago and that remain insufficiently reported. Sites of this sort were eliminated in our “first cut” because it is unlikely that detailed publications on them will appear anytime soon.

Table 1  
Sites with Early Paleoindian or potentially Early Paleoindian faunal remains (see Fig. 1 for locations)

Site	State	References	Strata/analysis units considered
Agate Basin	WY	Frison and Stanford (1982)	Clovis Stratum
Alexon (Wacissa River)	FL	Mihlbachler et al. (2000), Webb et al. (1983, 1984)	Assemblage
Aubrey	TX	Ferring (2001)	Pond Str. C2/E1 and E1, Red Wedge, Camp B
Blackwater Locality 1	NM	Hester (1972) and Slaughter (1975)	Brown Sand Wedge, Gray Sand
Boaz	WI	Palmer and Stoltman (1976) and Stoltman (1991)	Assemblage
Bonfire Shelter	TX	Bement (1986) and Dibble and Lorrain (1968)	Bone Bed 1 (1980s)
Bull Brook	MA	Byers (1954), Grimes et al. (1984) and Spiess et al. (1985)	Assemblage
Burning Tree	OH	Fisher et al. (1994)	Assemblage
Carter/Kerr-McGee	WY	Frison (1984)	Clovis component
Coats-Hines	TN	Breitburg and Broster (1995) and Breitburg et al. (1996)	Assemblage
Colby	WY	Frison and Todd (1986)	Assemblage
Connley Caves	OR	Bedwell (1973), Grayson (1979) and Beck et al. (2004)	Stratum 4 in Caves 4 and 6
Dent	CO	Brunswick and Fisher (1993) and Cassells (1997)	Assemblage
Domebo	OK	Leonhardy (1966)	Elephant quarry
Duewall-Newberry	TX	Steele and Carlson (1989)	Assemblage
Dutton	CO	Stanford (1979)	Clovis layer (above Gleysol)
Escapule	AZ	Hemmings and Haynes (1969) and Saunders (n.d.)	Assemblage
Fishbone Cave	NV	Orr (1956, 1974)	Level 4
Fort Rock Cave	OR	Bedwell (1973) and Grayson (1979)	Stratum 3
Gault	TX	Collins (1999)	Assemblage
Guest	FL	Hoffman (1983)	Assemblage
Hebior	WI	Overstreet (1998) and Overstreet and Kolb (2003)	Assemblage
Heisler	MI	Fisher (1987, 1996)	Assemblage
Henwood	CA	Douglas et al. (1988)	Component 1
Hermit's Cave	NM	Ferdon (1946) and Harris (1985)	Assemblage
Hiscock	NY	Laub (2002), Laub et al. (1988) and Steadman (1988)	Gravelly clay
Huntington Dam	UT	Gillette and Madsen (1992, 1993) and Madsen (2000)	Assemblage
Jaguar Cave	ID	Kurten and Anderson (1972), Miller (1965) and Sadek-Kooros (1972a)	Hearth III
Jake Bluff	OK	Bement and Carter (2003)	Assemblage
Kimmswick	MO	Graham and Kay (1988)	Units C1 and C3
Kincaid Shelter	TX	Collins (1990) and Collins et al. (1989)	Zone 4
Klein	CO	Zier et al. (1993)	Assemblage
Lange-Ferguson	SD	Hannus (1990a, b), Martin (1987) and Stewart and Martin (1993)	Assemblage
Lehner	AZ	Haury et al. (1959), Lance (1959) and Saunders (1977, n.d.)	Clovis Surface
Leikem	AZ	Saunders (n.d.)	Assemblage
Levi Shelter	TX	Alexander (1963, 1982)	Zone II
Lewisville	TX	Crook and Harris (1957, 1958) and Ferring (2001)	1950s and 1970s Assemblages
Little Salt Spring	FL	Clausen et al. (1979) and Holman and Clausen (1984)	Assemblage
Lubbock Lake	TX	Johnson (1987)	Strata IB and IC
Manis	WA	Gustafson (1985), Gustafson et al. (1979) and Petersen et al. (1983)	Brown Alluvium
Martin's Creek	OH	Brush and Smith (1994)	Assemblage
McLean	TX	Bryan and Ray (1938), Ray (1942) and Ray and Bryan (1938)	Assemblage
Meadowcroft Shelter	PA	Adovasio et al. (1982) and FAUNMAP Working Group (1994)	Stratum IIA 70–170 cm Inside
Miami	TX	Sellards (1952)	Assemblage
Midland	TX	Holliday and Meltzer (1996), Wendorf et al. (1955) and Wendorf and Krieger (1959)	White, Gray and Red Sands
Murray Springs	AZ	Haynes (1973, 1974, 1976) and Hemmings (1970)	Hemmings assemblage
Naco	AZ	Haury et al. (1953) and Lance (1959)	Assemblage
Navarette	AZ	Saunders (n.d.)	Assemblage
Owl Cave	ID	Guilday (1969), Miller (1982, 1989) and Miller and Dort (1978)	Proboscidean Layer
Pleasant Lake	MI	Fisher (1984a, b, 1987, 1996) and Holman et al. (1986)	Assemblage
Sandy Ridge	Ontario	Jackson (1994, 1997)	Feature 1
Schaefer	WI	Joyce and Blazina-Joyce (2002), Overstreet (1998) and Overstreet and Kolb (2003)	Assemblage
Shawnee-Minisink	PA	Dent (2002) and McNett (1985)	Paleoindian Zone
Sheaman	WY	Frison and Stanford (1982)	Clovis component

Table 1 (continued)

Site	State	References	Strata/analysis units considered
Sheriden Cave	OH	Tankersley (1999), Tankersley and Redmond (1999) and Tankersley et al. (2001)	Strata IIa, IIb and IIc
Sloth Hole	FL	Hemmings (1998, 2000)	Assemblage
Smith Creek Cave	NV	Bryan (1979) and Miller (1979)	Mt. Moriah occupation
Sunshine	NV	Huckleberry et al. (2001)	Stratum E
Udora	Ontario	Storck and Spiess (1994)	Feature 1
Union Pacific	WY	Irwin et al. (1970)	Assemblage
Whipple	NH	Curran (1984) and Spiess et al. (1985)	Assemblage
Wilson Butte Cave	ID	Gruhn (1961, 1965, 1995)	Lower stratum C



Fig. 1. Sites with Early Paleoindian or potentially Early Paleoindian faunal remains.

record can be detected and controlled, and it is of fundamental importance that this be done.

Detailed taphonomic studies directed at answering the association question have been conducted for some Early Paleoindian sites (e.g., Shipman et al., 1984; Frison and Todd, 1986; Kreutzer, 1988; Saunders and Daeschler, 1994; Johnson, 1995; Byers, 2002), but many assemblages that have not been studied in this manner have been invoked to support the notion that early Americans were specialized hunters of megafauna. In addition, despite suggestions that the existing Early Paleoindian faunal record is biased in favor of sites that

contain the bones of megafauna (e.g., Grayson, 1988a; Meltzer, 1989, 1993), the effects of such potential biases have not been evaluated quantitatively. We address issues of bias in detail below.

In this section, we examine published evidence from the sites in our sample relevant to the issue of association. In doing so, we accept any of the following as strong evidence for subsistence use of individual taxa: clear indications of butchering such as unambiguous cut marks on bones; clear indications of predation such as the occurrence of bones in direct spatial association with artifacts (especially projectile points and butchering or

Table 2  
Mammal genera reported from the sites listed in Table 1

Genus	Common name	Genus (continued)	Common name
<b>Order Didelphimorphia</b>		<i>Cervus</i> <sup>a</sup>	Red deer (Elk)
<i>Didelphis</i>	Large American opossums	<i>Odocoileus</i> <sup>a</sup>	White-tailed and Mule deer
<b>Order Xenarthra</b>		<i>Rangifer</i> <sup>a</sup>	Caribou
<i>Holmesina</i> <sup>a,b</sup>	Northern pamphater	<i>Navahoceros</i> <sup>a,b</sup>	Mountain deer
<i>Glyptotherium</i> <sup>a,b</sup>	Simpson's glyptodont	<i>Cervalces</i> <sup>a,b</sup>	Elk-moose
<i>Megalonyx</i> <sup>a,b</sup>	Jefferson's ground sloth	<i>Antilocapra</i> <sup>a</sup>	Pronghorn
<i>Nothrotheriops</i> <sup>a,b</sup>	Shasta ground sloth	<i>Capromeryx</i> <sup>a,b</sup>	Diminutive pronghorn
<i>Glossotherium</i> <sup>a,b</sup>	Harlan's ground sloth	<i>Bison</i> <sup>a</sup>	Bison
<i>Dasypus</i> <sup>a,c</sup>	Long-nosed armadillos	<i>Ovibos</i> <sup>a</sup>	Muskox
<b>Order Insectivora</b>		<i>Ovis</i> <sup>a</sup>	Sheep
<i>Blarina</i>	American short-tailed shrews	<b>Order Rodentia</b>	
<i>Cryptotis</i>	Small-eared shrews	<i>Cynomys</i>	Prairie dogs
<i>Notiosorex</i>	Desert shrew	<i>Marmota</i>	Marmots
<i>Sorex</i>	Holarctic shrews	<i>Sciurus</i>	Tree squirrels
<i>Parascalops</i>	Hairy-tailed mole	<i>Spermophilus</i>	Ground squirrels
<i>Scalopus</i>	Eastern mole	<i>Tamias</i>	Chipmunks
<b>Order Carnivora</b>		<i>Tamiasciurus</i>	Red squirrels
<i>Alopex</i>	Arctic fox	<i>Glaucomyis</i>	New world flying squirrels
<i>Canis</i>	Wolves and Coyote	<i>Castor</i>	American beaver
<i>Vulpes</i>	Foxes	<i>Castoroides</i> <sup>a,b</sup>	Giant beaver
<i>Lynx</i>	Lynxes	<i>Geomys</i>	Eastern pocket gophers
<i>Puma</i>	Puma	<i>Thomomys</i>	Western pocket gophers
<i>Smilodon</i> <sup>b</sup>	Sabertooth cat	<i>Dipodomys</i>	Kangaroo rats
<i>Mephitis</i>	Striped skunks	<i>Perognathus/Chaetodipus</i>	Pocket mice
<i>Gulo</i>	Wolverine	<i>Zapus</i>	Jumping mice
<i>Martes</i>	Martens	<i>Clethrionomys</i>	Red-backed voles
<i>Mustela</i>	Weasels	<i>Lemmyscus</i>	Sagebrush vole
<i>Taxidea</i>	American badger	<i>Microtus</i>	Meadow voles
<i>Procyon</i>	Raccoons	<i>Ondatra</i>	Muskrat
<i>Arctodus</i> <sup>b</sup>	Giant short-faced bear	<i>Phenacomys</i>	Heather voles
<i>Ursus</i>	Black and brown bears	<i>Synaptomys</i>	Bog lemmings
<b>Order Proboscidea</b>		<i>Neotoma</i>	Woodrats
<i>Mammot</i> <sup>a,b</sup>	American mastodon	<i>Onychomys</i>	Grasshopper mice
<i>Mammuthus</i> <sup>a,b</sup>	Mammoths	<i>Oryzomys</i>	Rice rats
<b>Order Perissodactyla</b>		<i>Peromyscus</i>	Deer mice
<i>Equus</i> <sup>a,b</sup>	Horses	<i>Reithrodontomys</i>	American harvest mice
<i>Tapirus</i> <sup>a,b</sup>	Tapirs	<i>Sigmodon</i>	Cotton rats
<b>Order Artiodactyla</b>		<i>Erethizon</i>	North American porcupine
<i>Mylohyus</i> <sup>a,b</sup>	Long-nosed peccary	<b>Order Lagomorpha</b>	
<i>Platygonus</i> <sup>a,b</sup>	Flat-headed peccary	<i>Ochotona</i>	Pikas
<i>Camelops</i> <sup>a,b</sup>	Yesterday's camel	<i>Brachylagus</i>	Pygmy rabbit
<i>Hemiauchenia</i> <sup>a,b</sup>	Large-headed llama	<i>Sylvilagus</i>	Cottontails
<i>Palaeolama</i> <sup>a,b</sup>	Stout-legged llama	<i>Lepus</i>	Hares and jackrabbits

Note: For extant taxa, genus and common names follow Wilson and Cole (2000), as does the order in which taxa are listed; designations for extinct taxa follow Grayson and Meltzer (2002, Table I) and FAUNMAP Working Group (1994).

<sup>a</sup> Large herbivore.

<sup>b</sup> Genus became extinct in North America by the end of the Pleistocene.

<sup>c</sup> The Blackwater Locality 1 *Dasypus* specimens are from the larger, extinct *D. bellus* (Beautiful Armadillo), while the smaller, extant *D. novemcinctus* (Nine-banded armadillo) is reported from the Clovis stratum in Kincaid Shelter (see Table 4). The extant armadillo from Kincaid is not treated as a large herbivore in the analyses in this paper.

processing tools) in depositional contexts that are documented well enough to rule out a non-human cause of the association; bones found near features and/or non-randomly stacked or distributed bones in similarly documented contexts; and bone that is undoubtedly burned and for which non-human causes of the burning can be ruled out (these criteria are the same as those used by Grayson and Meltzer, 2002, p. 344; also see

Haynes and Stanford, 1984; Frison and Todd, 1986; Haynes, 1991; Saunders and Daeschler, 1994; Byers, 2002).

Because Grayson and Meltzer (2002) have already considered potential associations with extinct mammals in detail, no more than a brief review of sites that contain only such taxa is necessary here. After presenting such a review, we move on to a more detailed

Table 3  
Mammal genera reported for assemblages containing only extinct mammals, with taxonomic abundance values

Assemblage	Abundance units	<i>Arctodus</i>	<i>Mammut</i>	<i>Mammuthus</i>	<i>Equus</i>	<i>Camelops</i>	Other taxa mentioned but not reported in detail
Boaz	MNI		1				
Burning Tree	MNI		1				
Carter/Kerr-McGee	NISP					4	
Dent	MNI			12*			
Duewall–Newberry	MNI			1			
Dutton	NISP				1		
Escapule	MNI/NISP			1/18*			
Hebior	MNI			1*			
Heisler	MNI		1				
Huntington Dam	MNI	1		1			
Klein	NISP			1			
Leikem	MNI/NISP			2/33			
McLean	MNI			1			+
Miami	MNI/NISP			5/> 54*			
Navarette	MNI/NISP			2/9			
Pleasant Lake	MNI		1*				
Schaefer	MNI			1			
Sloth Hole	NISP		1				

Note: Asterisks (“\*”) indicate taxa in individual assemblages for which there is strong evidence for subsistence use, as discussed in the text, for at least some specimens.

discussion of sites that contain taxa other than extinct mammals.

### 3.1. Sites with extinct mammals only

There are 18 sites in our sample that contain only the remains of mammal genera that became extinct in North America by the end of the Pleistocene; faunal data from these sites are provided in Table 3. We accept, as do Grayson and Meltzer (2002), that there is good evidence for human predation on mammoths from four of these sites—Dent (TX), Escapule (AZ), Hebior (WI), and Miami (TX)—and that another—Pleasant Lake (MI)—provides reasonably well-documented evidence for mastodon butchery. Escapule is the only one of these sites from which a non-proboscidean taxon (*Equus*) has also been reported, but there is apparently nothing to suggest that humans were involved with this taxon here (Saunders, n.d., p. 39).

Of the remaining 13 sites, 10 were considered by Grayson and Meltzer (2002, pp. 321–323, 328–341), and most of these 10 are also included in the samples used by Haynes (2002a) and/or Waguespack and Surovell (2003). These include Boaz (WI), Burning Tree (OH), Carter/Kerr-McGee (WY), Duewall-Newberry (TX), Heisler (MI), Huntington Dam (UT), Klein (CO), Leikem (AZ), McLean (TX), and Schaefer (WI). For reasons noted by Grayson and Meltzer (2002), we see no compelling evidence from any of these sites to suggest that people were involved with the taxa recovered from them; in many cases, the reason for this is simply that too little has been published to allow independent evaluation of the purported associations.

For three of these 10 sites Haynes (2002a) and/or Waguespack and Surovell (2003) cite references that Grayson and Meltzer (2002) did not, and because of this these sites deserve further attention. Grayson and Meltzer eliminated Huntington Dam in their first cut for reasons of insufficient data, but they did not cite Madsen (2000), who describes the archaeology of this site in considerable detail. Due to the detail provided in this report, however, it becomes even more clear that any suggested association between humans and extinct mammals here is problematic. For example, the artifacts found near the mammoth and short-faced bear remains at this site all appear to be early Holocene in age, while radiocarbon dates on amino acids extracted from bones of both taxa fall within the Early Paleoindian range. In addition, surface modifications on the bones of the mammoth provide at least as much reason to think that this animal was killed by a carnivore as there is to think that it was killed by humans. Grayson and Meltzer likewise eliminated Heisler and Leikem in their first cut for reasons of insufficient data without citing relevant references (Fisher, 1996 and Saunders, n.d., respectively), but neither of these publications provides the detail necessary for an independent evaluation of the proposed associations at these sites. Fisher (1996) adds only a radiocarbon date to the literature on Heisler and does not elaborate on the inadequately documented modification that the mastodon bones from this site are said to exhibit. About Leikem, Saunders (n.d., p. 34) merely says that “a Clovis fluted projectile point discovered without provenance during excavation and stratigraphic testing of the site suggests [*sic*] a cultural association [for one of the mammoths here]”.

Table 4

Mammal genera and other vertebrate classes reported for assemblages containing taxa other than extinct mammals, with mammal taxonomic abundance values as available

Assemblage	Abundance Units	<i>Didelphis</i>	<i>Holmesina</i>	<i>Glyptotherium</i>	<i>Megalonyx</i>	<i>Notruetheriops</i>	<i>Glossotherium</i>	<i>Dasyops</i>	<i>Blarina</i>	<i>Cryptotis</i>	<i>Notiosorex</i>	<i>Sorex</i>	<i>Parascalops</i>	<i>Scalopus</i>	<i>Alapex</i>	<i>Canis</i>	<i>Vulpes</i>	<i>Lynx</i>	<i>Puma</i>	<i>Smilodon</i>	<i>Mephitis</i>	<i>Gulo</i>	<i>Martes</i>	<i>Mustela</i>	<i>Taxidea</i>	<i>Procyon</i>	<i>Arctodus</i>	<i>Ursus</i>	<i>Mammut</i>	<i>Mammuthus</i>
Agate Basin	M/N																													
Alexon	M/N																													
Aubrey	N						135						55																3	
Blackwater, BSW	N	1						4				2				3	1									1	1		10*	
Blackwater, GS	N															6	1			2									306*	
Bonfire Shelter	N																												9	
Bull Brook	N																													
Coats-Hines	M														+													1		
Colby	M/N																												7/424*	
Connley Caves	M/N															4/4	1/2	1/3				1/1								
Domebo	M/N																												1/~75*	
Fishbone Cave																														
Fort Rock Cave	N																													
Gault																													+	
Guest	M																												3	
Henwood	N																													
Hermit's Cave											+	+				+													+	
Hiscock	M																											8		
Jaguar Cave	M															2	1						1	1						
Jake Bluff	M/N																													
Kimmswick							+	+								+								+				+	*	
Kincaid Shelter								+																	+	+			+	
Lange-Ferguson	M/N								2/7			5/?																	2/153*	
Lehner	M/N															2/8											2/9*		13/104*	
Levi Shelter	M														2		1													
Lewisville, 1950s	M/N			1/?										1/1		2/?*					2/2					5/?*	1/1		2/2	
Lewisville, 1970s	N									4			2			1												1		
Little Salt Spring	M/N				1/15																						1/1			
Lubbock Lake	N		2					1							+	+										6		>50*		
Manis	M																											1		
Martin's Creek	M																											1		
Meadowcroft	N							2					4	1		2		1					1	1						
Midland																+													+	
Murray Springs	N															18													149*	
Naco	M/N																												1/35*	
Owl Cave	M															+	+							+				1		
Shawnee-Minisink																														
Shcaman	M/N															1/1													1/1	
Sheridan Cave									+			+				+	+						+	+		+	+	+		
Smith Creek Cave																			+											
Sunshine	N															1	1													
Udora	N														1*															
Union Pacific	M																												1	
Whipple	N																													
Wilson Butte Cave	N					1																			1	5				



Table 4 (continued)

Assemblage	Dipodomys	Perganahus/Chaetodipus	Zapus	Clethrionomys	Lemmyscus	Microtus	Ondatra	Phenacomys	Synaptomys	Neotoma	Oryzomys	Peromyscus	Reithrodontomys	Sigmodon	Erethizon	Ochotona	Brachylagus	Sylvilagus	Lepus	Birds	Turtles	Other Herps	Fishes	Other Taxa	Mentioned but not Reported in Detail
Agate Basin					1/2	1/1																			
Alexon																									
Aubrey	1	5				119	6	15	5		1	12	2	6			8		2	+	+	+	+	+	
Blackwater, BSW						>14	6	9			3	2	5						1	+	+	+	+	+	
Blackwater, GS						2																			
Bonfire Shelter																									
Bull Brook																									
Coats-Hines																									
Colby																			1/3						
Combley Caves	2/2							7/9						1/2	6/6	12/34	21/44	41/392	+	+					+
Domebo		1/1												?											
Fishbone Cave																									
Fort Rock Cave																	1	1	2						
Gault																									+
Guest																									
Henwood	31	84							10								104		94	+	+				
Hermif's Cave																									
Hiscock																									
Jaguar Cave																									
Jake Bluff																									
Kimmswick																									
Kincaid Shelter																									
Lange-Ferguson																									
Lehigh	1/1																								
Levi Shelter																									
Lewisville, 1950s																									
Lewisville, 1970s																									
Little Salt Spring																									
Lubbock Lake																									
Mamie																									
Martin's Creek																									
Meadowcroft																									
Midland																									
Murray Springs																									
Naco																									
Owl Cave																									
Shawnee-Minisink																									
Sheaman																									
Sheridan Cave																									
Smith Creek Cave																									
Sunshine	2																								
Udora																									
Union Pacific																									
Whipple																									
Wilson Butte Cave																									

Note: For taxonomic abundance units, "M" = MNI and "N" = NISP. Plus signs ("+") indicate the presence of mammal genera for which abundance values are not available and the presence of other classes of vertebrates. Asterisks ("\*\*") indicate taxa in individual assemblages for which there is strong evidence for subsistence use, as discussed in the text, for at least some specimens.

The final three extinct-mammal-only sites in our sample are ones listed by Haynes (2002a) but not considered by Grayson and Meltzer (2002): Dutton (CO), Navarette (AZ), and Sloth Hole (FL). Unfortunately, far too little has been published on the latter two of these to allow evaluation of their proposed associations. Regarding Navarette, Saunders (n.d., p. 40) states only that “two artifacts were recovered, one provisionally and the other certainly in association with the partial remains of two mammoths”; the artifacts are not described. The mastodon specimen from the underwater Sloth Hole site is said to exhibit cut marks (Hemmings, 1998), but neither these marks nor the stratigraphy of the site have yet been documented in much detail.

Dutton, on the other hand, has been published in some detail (Stanford, 1979), and it is clear that any purported association between Clovis artifacts and extinct mammals from this site is very tenuous. Dutton is probably best known because it has been proposed—based on equivocal bone breakage patterns—to have been the site of a pre-Clovis occupation, but a Clovis point was also recovered here, which Haynes (2002a, Table 2.3) suggests was found in association with mammoth remains. This point, however, was actually found in a construction backdirt pile, and Stanford (1979, p. 116) states that the sediment adhering to it is consistent with a stratigraphic context above the mammoth bones. Moreover, the only lithic artifacts reported from the mammoth-bearing stratum are small flakes, which Stanford admits may be intrusive, and an end-scraper that was found “at the bottom of a rodent burrow” (Stanford, 1979, p. 115). The single faunal specimen that does appear to be stratigraphically associated with the Dutton Clovis point is an *Equus* tooth that was also recovered from backdirt with adhering sediments similar to those found on the point. There is thus no real stratigraphic association between Clovis lithics and mammoth remains here, and it is impossible to evaluate any potential behavioral association between the Clovis point and the horse tooth since neither was recovered in buried context.

### 3.2. Sites with extant mammals and/or other classes of vertebrates

Table 4 presents faunal data from the 44 sites in our sample that contain taxa other than, or in addition to, extinct mammals. Six of these sites were eliminated by Grayson and Meltzer (2002, Table III) in their first cut but have been used by Haynes (2002a) and/or Wague-spach and Surovell (2003): these include Gault (TX), Guest (TX), Kincaid Shelter (TX), Manis (WA), Martin’s Creek (TX), and Union Pacific (WY). For these six sites, we concur with Grayson and Meltzer that much more detailed analyses and descriptions are

necessary before it will be possible to evaluate their potential associations between humans and any vertebrate taxon, extinct or otherwise. We discuss the remaining 38 of these 44 sites at greater length, grouping them by the geographic region in which they are located.

*Intermountain West:* Three caves from Idaho’s Snake River Plain and nearby mountains—Jaguar Cave, Owl Cave and Wilson Butte Cave—have been proposed to have been occupied by humans during the late Pleistocene (e.g., Gruhn, 1961; Sadek-Kooros, 1972a, b; Miller, 1989). However, these proposals are based largely on bone breakage patterns, which provide evidence of human activity that is equivocal at best (e.g., Shipman and Phillips-Conroy, 1977). As Grayson and Meltzer (2002, p. 331) discuss, there is no unambiguous indication of an early occupation at Owl Cave, and this applies as well to the other two sites (also see McGuire, 1980). Additional evidence offered in support of an early human presence at Jaguar Cave includes “stone-lined ovens” and “well-defined hearths”, but because these features are not illustrated or described in publications, whether they were created by people must remain in doubt. We also note that Guilday and Adam (1967), who analyzed the small mammal remains from this site,<sup>2</sup> argue that most of these were deposited by agents other than humans. As for Wilson Butte Cave, Gruhn (1995, p. 17) sums things up well in her discussion of the early strata here: “the evidence of human presence in Stratum E is still unclear; and the dating of the lower levels of Stratum C, in which there are numerous definite artifacts, remains ambiguous.” Obviously, because none of these sites contains clear evidence of an Early Paleoindian human occupation, none of the bones in them can be considered to provide evidence of Early Paleoindian subsistence practices.

In the Great Basin, four cave sites—the Connley Caves (OR), Fishbone Cave (NV), Fort Rock Cave (OR), and Smith Creek Cave (NV)—and one open site—the Sunshine Locality (NV)—contain, or may contain, Early Paleoindian faunal remains. At Sunshine, a fluted point and other early artifacts were recovered from stream channel deposits along with bones of both extinct and extant taxa that showed no clear signs of human modification. Due to the geological context of this site, the excavators recognize that a behavioral link between artifacts and animals—extinct or otherwise—cannot be drawn with confidence (e.g., Huckleberry et al., 2001, p. 308).

The lowermost strata in the Connley Caves and nearby Fort Rock Cave may at least overlap with the Early Paleoindian period. Stratum 4 in the Connley Caves has produced one radiocarbon date of 11,200 <sup>14</sup>Cyr BP and several others that fall at 10,600 <sup>14</sup>Cyr BP

<sup>2</sup>The small mammal remains from Jaguar Cave are not included in Table 3 because Guilday and Adam (1967) do not list them by stratum.

or later, while Stratum 3 of Fort Rock Cave has produced a few dates of 10,200 <sup>14</sup>C yr BP or later along with one which is not widely accepted, of 13,200 <sup>14</sup>C yr BP (Bedwell, 1973; Grayson, 1979; Beck and Jones, 1997). In addition, a fluted point was recovered from the Connley Caves (Bedwell, 1973, Fig. 16; Beck et al., 2004), but it comes from the stratum above the one that produced the earliest dates. The dating of the early strata in these caves is thus imprecise, and the deposits here may be mixed (Beck et al., 2004), but also problematic is that taphonomic data are not available for the bones that might allow evaluation of the role of humans in their deposition, regardless of their age. Grayson (1979) has presented an in-depth analysis of the faunal remains from these caves, but because his focus was purely paleoenvironmental, he does not provide all of the taphonomic information that a paleoeconomic study requires. Given the problems of dating and insufficient data that exist for the bones from these sites, they cannot be used to address the issues of Early Paleoindian subsistence.

Orr (1956, p. 11) states that “the association of man, horse, and camel in Fishbone cave...is established”; he makes no claim for an association with marmots or birds, bones of which were also recovered from the lowest stratum of this cave. The evidence on which his statement is based includes camel and horse bones that are described as “split for the marrow” and “burned” (Orr, 1956, p. 6), a horse metapodial that has been manufactured into a tool, and the recovery of an unmodified horse mandible in direct spatial association with a mat made of sagebrush bark. All of these lines of evidence, however, are problematic as indicators of subsistence use. As we discussed above, bone breakage patterns do not provide unequivocal evidence of human activity, and it is unclear that the “burned” specimens, which are not illustrated or described in detail, truly are: in at least one other cave site in the Great Basin, woodrats have modified bones in a manner that resembles burning (Grayson, 1988b; see also Shahack-Gross et al., 1997). Likewise, the manufacture of a bone tool does not indicate that the animal from which that bone came was part of the diet. And finally, the spatial proximity of the horse mandible to the sagebrush bark mat may not reflect temporal proximity since the mat has been radiocarbon dated to 11,200 ± 250 <sup>14</sup>C yr BP, while the mandible has been dated to 12,280 ± 520 <sup>14</sup>C yr BP (Stafford et al., 1987); though these dates do overlap at 2-sigma, the probability that they come from items of identical age is small ( $p = 0.062$ , using the  $T'$  test of Ward and Wilson, 1978).

The best candidate for a site containing faunal evidence of Early Paleoindian subsistence practices from the Great Basin, or from anywhere in the far west for that matter, may be Smith Creek Cave. The Mt. Moriah occupation level in this cave has produced radiocarbon

dates that fall within the range of Clovis in the Southwest and on the Plains, as well as dates that fall both earlier and later in time (Bryan, 1979; Beck and Jones, 1997; the “pre-Clovis” dates from this level are generally regarded as problematic: see Thompson, 1985; Beck and Jones, 1997). However, as is the case with the assemblages from the Connley Caves and Fort Rock Cave, the faunal assemblage from the Mt. Moriah level of Smith Creek Cave suffers from problems of insufficient taphonomic data. Bryan (1979, p. 185) describes the large mammal bones from this level—the only identifiable specimens of which are from mountain sheep—as having been “macerated into small fragments, evidently to extract marrow and possibly [to boil out grease].” As intriguing as we find the possibility of Early Paleoindian sheep processing, the publications on the Mt. Moriah level fauna (Bryan, 1979; Miller, 1979) provide far too little taphonomic detail to allow evaluation of claims about human use of sheep or any other taxon. We also concur with Beck and Jones (1997, p. 183) that the presence of bovid and camelid hair in the Mt. Moriah level does not provide compelling evidence that people processed hides of such animals here, as has been suggested.

The final site that we consider from the far west is Henwood (CA), which is located in the Mojave desert. A fluted point was found in the early component at this site, along with the remains of several extant vertebrate taxa<sup>3</sup>. The two radiocarbon dates obtained from this component, however, fall well within the Holocene at 8470 and 4360 <sup>14</sup>C yr BP (Douglas et al., 1988). Given these dates, it is highly questionable whether any of the bones from Henwood are Early Paleoindian in age (Grayson, 1993, p. 237; Beck and Jones, 1997).

*San Pedro Valley:* The densest concentration in North America of Early Paleoindian sites with faunal remains occurs in the San Pedro Valley of southeastern Arizona. This concentration includes four well-known Clovis sites—Escapule, Lehner, Murray Springs, and Naco—at which there is convincing evidence of predation on extinct mammals, particularly mammoths (Grayson and Meltzer, 2002, pp. 333–337), and three of these sites have also produced the remains of other taxa.

Of these three, the assemblage from Lehner is the richest. This site has produced clear indications of human involvement with mammoths, as well as claims for the use of camel, the evidence for which is limited to a single fractured femur. Although there is some disagreement over this evidence for camel use (e.g., Saunders, 1977; Haynes and Stanford, 1984), we follow Grayson and Meltzer (2002, p. 334) in finding it marginally acceptable. There is much better evidence

<sup>3</sup>Twenty-three specimens identified as artiodactyl were recovered from the early component at Henwood, but these are not included in Table 3 because they were not identified to genus.

for human use of two extant mammal genera at this site: Saunders (1977, p. 51) notes that one of the Clovis points from Lehner was found “between *Bison* ribs”, which suggests that this taxon was hunted, and he also reports that calcined teeth from a bear cub (*Ursus*) were recovered “from a hearth context”, which likewise suggests subsistence use.<sup>4</sup> There is no direct evidence in the publications on the Lehner fauna (Lance, 1959; Saunders, 1977, n.d.) that people were involved with any of the other extant mammals or the non-mammalian taxa present here, and, as Grayson and Meltzer (2002, pp. 333–334) note, there is no good indication of involvement with extinct mammals other than mammoth and perhaps camel.

Murray Springs also appears to provide good evidence for bison and mammoth hunting, though this site is difficult to evaluate because only cursory reports on the fieldwork conducted here have yet been published. Area 3 of this site, which provides reasonably convincing evidence for mammoth use (Grayson and Meltzer, 2002, p. 336), also contained bones from a young bison that are described as burned (Hemmings, 1970, p. 75, 99). Likewise, numerous bison bones, some of which are described as burned, were recovered in and around apparent hearths in Area 4 (Hemmings, 1970, pp. 114–137). We accept the interpretation of this area as a “bison kill”, but we would place much more confidence in it were the work at Murray Springs published in greater detail. There is no good indication in the existing publications on this site of human involvement with any taxon other than mammoth or bison.

Bison and mammoth were also recovered at Naco, but the remains of the former are limited to a few “scraps of teeth” found across the arroyo from the mammoth skeleton that was excavated here (Lance, 1959, p. 37). Thus, unlike Lehner and Murray Springs, there is no compelling indication of bison use at this site, though the evidence for human involvement with mammoth is very convincing (e.g., Grayson and Meltzer, 2002, p. 337).

*Northern Plains:* The Sheaman (WY) site has produced several faunal specimens that have clearly been modified by humans, but none of these have been modified in ways that clearly show that the animals from which they come were used for subsistence. The sole mammoth specimen from Sheaman is a tusk fragment that was manufactured into a projectile foreshaft, which does not indicate that this taxon was part of the diet here, and the same is true of the unspecified number of

bison specimens from this site that were apparently intentionally coated in red ochre (Frison, 1982, pp. 144–146). Likewise, the single pronghorn specimen recovered at Sheaman is a metatarsal that was “cut in two” (Walker, 1982, p. 156), but the detailed description of this specimen suggests that the modifications that it shows are related to tool manufacture rather than to subsistence butchery. There is no direct evidence that people were involved with any of the other taxa recovered at this site or with any of the taxa present in the Clovis stratum at the nearby Agate Basin site (see Walker, 1982, p. 307; Grayson and Meltzer, 2002, p. 328).

Colby (WY) and Lange-Ferguson (SD) both provide compelling evidence for mammoth butchery (Frison and Todd, 1986; Hannus, 1990a, b), but at neither of these sites is there any indication that other recovered taxa were used for subsistence purposes. Walker and Frison (1986, p. 192, 196) state as much regarding the pronghorn and jackrabbit remains from Colby, and they mention nothing to suggest human involvement with the bison specimens found here. The specimen from this site that was provisionally identified as muskox is described as “modified into a deliberate tool” (Frison, 1986, p. 100), which does not provide direct evidence of subsistence use. As for Lange-Ferguson, Martin (1987) makes no suggestion that any of the small mammals recovered at this site were prey, but he does suggest that people processed bison here; this inference, however, is based solely on equivocal breakage of bison bones. Hannus (1990a, b) discusses the evidence from Lange-Ferguson for mammoth processing at great length but devotes almost no attention to any of the other taxa recovered.

*Southern Plains:* Of the many excavation areas that were opened at Blackwater Locality 1 (NM) over the years (Hester, 1972), at least three contain “mammoth kills” that provide convincing evidence of human predation and processing due in large part to close spatial associations between mammoth bones and Clovis artifacts (see also Saunders and Daeschler, 1994). A single “bison kill” excavated by Sellards in 1955 (Hester, 1972, pp. 46–47) is convincing for the same reason: Clovis points were recovered here in intimate association with bison bones. Less compelling, but nonetheless accepted by Grayson and Meltzer (2002, p. 332), and by us, is a horse metapodial that was found near mammoth remains associated with artifacts; this is the sole *Equus* specimen from Blackwater Locality 1 for which there is any good indication of subsistence use (cf. Warnica, 1966; Hester, 1972; Lundelius, 1972; Johnson, 1989). Hester (1972, p. 172) suggests that an extinct form of box turtle (identified as either *Terrapene canaliculata* or *T. carolina putnami*) was eaten at Blackwater Locality 1, and Johnson (1987, p. 122) discusses the evidence for human use of this taxon here,

<sup>4</sup>Grayson and Meltzer (2002, p. 334) reject any purported association with the blackened tapir mandible from Lehner because it may simply be stained rather than burned, but that cannot be the case for the bear teeth, which are described as calcined rather than merely blackened.

which includes plastron specimens that are said to exhibit cut marks on their exterior surfaces and “at least 18 shells...stacked next to a hearth”. We accept this as evidence for the use of turtles, along with the evidence that exists from this locality for the use of bison, mammoth and horse. There is no direct indication at Blackwater Locality 1 of human involvement with any other taxon.

Lubbock Lake (TX) has also produced a very rich Early Paleoindian faunal assemblage, and although there is good evidence from this assemblage for mammoth use (Johnson, 1987, p. 101), the evidence for human involvement with other extinct taxa is, for a variety of reasons, not compelling (Haynes and Stanford, 1984; Grayson and Meltzer, 2002, p. 335). Among the many extant mammals and non-mammalian vertebrates in the Lubbock Lake Clovis assemblage, Johnson (1987, pp. 121–123) describes possible indications of human use only for wild turkey (*Meleagris gallopavo*) and for “several turtle species”, which are not named. Unlike the situation at Blackwater Locality 1, the evidence for turtle use here is not very convincing, consisting solely of “many carapace sections that are broken across suture lines” (Johnson, 1987, p. 122). Because there are many reasons why turtle carapaces might break across suture lines, this does not provide a strong indication of human activity. Likewise, the evidence for human use of turkey is not very compelling since it consists only of two marks identified as “cut lines” (Johnson, 1987, p. 123), which, because they are not illustrated in the site monograph, are even more problematic than the proposed cutmarks on the bones of extinct mammals from Lubbock Lake (see Haynes and Stanford, 1984). Mammoth thus appears to be the only taxon at this site for which there is any good indication of Early Paleoindian subsistence use.

At the Jake Bluff site (OK), Clovis-like points and other artifacts have been found in close spatial association with bison bones in a context that has reasonably been interpreted as an arroyo trap, and radiocarbon dates obtained on some of these bones fall at, or shortly after, what is generally considered to be the end of the Clovis time period. Although a detailed description of the stratigraphy of the site has yet to appear, a preliminary written report (Bement and Carter, 2003) provides enough contextual information to make it clear that human activity is likely the best explanation for the co-occurrence of artifacts and bison bones in the arroyo bottom.

The final two southern Plains sites that we consider are Domebo (OK) and Midland (TX). Domebo provides convincing evidence for mammoth use, but the excavators of this site make no suggestion that humans were involved with the rodent and turtle taxa that were also recovered (Leonhardy, 1966; see also Hofman, 2001). We include Midland in our sample of

sites only because it is included in the sample used by Grayson and Meltzer (2002), who, following the original excavators (e.g., Wendorf et al., 1955), found no strong indication of human use of the extinct mammals recovered here. Midland also apparently produced much burned small mammal bone (Wendorf and Krieger, 1959, p. 68), but because it is unclear whether any of the faunal remains from this site date to the Early Paleoindian period—only later point types have been found here, and all of the chronometric dates are problematic (Holliday and Meltzer, 1996)—we do not take this as evidence of Early Paleoindian subsistence practices.

*Texas and New Mexico Caves:* In southern New Mexico and south-central Texas, four cave sites with faunal assemblages have been proposed to contain evidence of human occupation during the Clovis period, if not earlier. One of these is Kincaid Shelter (TX), which, as we mentioned above, failed to make our “first cut” because only very cursory discussions of its faunal remains and stratigraphy have been published to date. The remaining three, which we discuss here, are Bonfire Shelter (TX), Hermit’s Cave (NM), and Levi Shelter (TX).

Although Bonfire Shelter has produced a rich faunal record, only in the case of the upper bison bone beds—which are Folsom/Plainview (Bonebed 2) and late Archaic (Bonebed 3) in age—is there unambiguous evidence of human use of animals. The bones from the various pre-Folsom levels that comprise Bonebed 1, which lack unequivocal stone tools, display no clear evidence of human agency in their accumulation (Wyckoff, 1999, p. 349). Hermit’s Cave is problematic for much the same reason. Like Bonfire, no stone tools were recovered from the proposed early occupation level. Rather, the evidence offered for a late Pleistocene human presence here consists of some charred logs and a feature that is described as a hearth, both found in a stratum that contained extinct mammals and that produced radiocarbon dates ranging between 12,900 and 11,850 <sup>14</sup>Cyr BP (Ferdon, 1946; Harris, 1985, p. 234). As with the purported hearths in Jaguar Cave, discussed above, it is not clear that the one in Hermit’s Cave was created by people: it is described as merely “a deposit of ash and charcoal lying on top of a horizontal slab of rock” with “no definite outline of any fire pit or depression” (Ferdon, 1946, p. 6).

Levi Shelter contains much stronger evidence of an Early Paleoindian occupation because points identified as Clovis have been recovered here. It has also been suggested that this site was occupied prior to Clovis times based on the recovery, from the stratum below the one that contained the Clovis points, of lithic artifacts and of bones that are argued to have been modified by humans (Alexander, 1963, 1982). Both the Clovis stratum at this site (Zone II) and the “pre-Clovis”

stratum (Zone I) have produced the remains of several extinct and extant vertebrate taxa. The publications on this site assume that all of these taxa were deposited by humans (e.g., Alexander, 1963, p. 526, 1982, p. 138, 141), but they present no taphonomic evidence to support this assumption other than the above-mentioned “bone tools”, which, as is clear from the illustrations in Alexander (1982, p. 140), could have been produced by a variety of processes. Equally problematic is that it appears that the lower strata in this cave have experienced considerable mixing. Both Zone I, which is described as consisting largely of roof fall (Alexander, 1982, p. 136), and Zone II have produced dates that fall on either side of the Clovis period: Zone I has dates of 12,830 and 10,825 <sup>14</sup>Cyr BP, while Zone II has dates of 13,750 and 10,000 <sup>14</sup>Cyr BP (Alexander, 1982, p. 138). Due to these out-of-sequence dates and the lack of bone taphonomic data, the fauna from Levi Shelter is presently unacceptable as evidence of Early Paleoindian subsistence.

*North Texas:* Two sites found deeply buried in alluvial terraces in the upper Trinity River drainage have produced very rich Early Paleoindian faunal assemblages: Aubrey and Lewisville. The excavators of Aubrey explicitly state that there is no indication of human involvement with mammoth here, and they present no compelling case for the use of other extinct mammals (Ferring, 2001; Yates and Lundelius, 2001; see also Grayson and Meltzer, 2002, p. 328). On the other hand, they do report that burned specimens of many other taxa were recovered in and around hearths, which does provide convincing evidence of subsistence use. We note that the assemblage from Aubrey is not as useful as it might be, though, because it is not clear precisely which genera exhibit burning or which have been found in hearth contexts.

The two excavation units at Aubrey that have produced the best evidence for human use of vertebrates are Area A and Camp B; generalized assertions aside (e.g., Yates and Lundelius, 2001, p. 118), there is little indication of human involvement with the bones from Area C and Camp F (see also Ferring, 2001, p. 189, 242). Camp B contains features identified as hearths, around which bones and artifacts were clustered (Ferring, 2001, pp. 187–202), and the contact between strata C2 and E1 in the Pond portion of Area A was identified as a Clovis occupation surface. In Camp B, bone said to be burned comes from taxa identified only as “turtle”, “snake”, “rodent and other small mammal”, “rabbit”, and medium- and large-sized mammals (Yates and Lundelius, 2001, p. 117); of these taxa, burned specimens of “large mammal”, “turtle” and “snake” are specifically noted to have been recovered in or around hearths (Ferring, 2001, p. 125). Taxa reported to have blackened or calcined specimens recovered from unspecified strata in the Area A Pond include “large

mammal”, “deer”, and “fish, turtles, snakes, birds, rodents and other small and medium mammals”; of the rodents, the only genus mentioned by name is *Geomys*, from which most of the burned specimens in Area A come (Yates and Lundelius, 2001, p. 115, 117).

We accept the case for subsistence use of these taxa, due mainly to Ferring’s (2001, pp. 187–202) spatial analysis of the Camp B bones and to Yates and Lundelius (2001, p. 115) argument against a non-human cause for the burning of the specimens from the Area A Pond. However, since most of the specimens from Camp B and the Area A Pond that are burned and/or from hearths are not identified to genus, the number of mammal genera for which we find strong evidence of subsistence use at Aubrey (Table 3) is much lower than it would otherwise be.

Elsewhere at this site, three lithic blades were found in close spatial association with bison bones in the Red Wedge Surface portion of Area A; these blades apparently show signs of use-wear and have been interpreted as cutting tools used in bison butchery (Ferring, 2001, pp. 167–170). Although no cutmarks were observed on the bison bones (which Yates and Lundelius (2001, p. 110) suggest may simply be due to their eroded surfaces), one distal humerus specimen exhibits a break interpreted as a “hammer-anvil fracture” (Ferring, 2001, p. 239; Yates and Lundelius, 2001, p. 110). The spatial association between the blades and the bones in this part of the site, at least, provides a convincing indication of human involvement with bison.

As at Aubrey, faunal specimens described as burned have been found in and around hearth features at the Lewisville site. Also as at Aubrey, however, the assemblage from Lewisville suffers from a lack of taxonomic specificity, among other problems. Grayson and Meltzer (2002, p. 334) accepted a “burned and broken” horse metapodial recovered from a hearth that also contained a Clovis point as evidence of subsistence use of this taxon at this site, and we follow their lead here (see Crook and Harris, 1957, pp. 26–27). Other vertebrate taxa for which specimens described as “burned” or “charred” have been recovered from in or around this hearth or other hearths on the same stratigraphic level<sup>5</sup> include: “terrapin”, which is actually an extinct form of box turtle (identified as *Terrapene canaliculata*), “deer”, “small bird”, “wolf”, “large animal (the size of horse, bison, or camel)”, “*Sylvilagus floridanus*” (Eastern cottontail), “mouse”, “prairie dog”, “wood-rat”, “*Peromyscus* sp.”, “*Microtus* sp.”, “a large and a small snake of the Colubrid family”, “a

<sup>5</sup>The list of taxa that we present in Table 4 for the “1950s Assemblage” from Lewisville includes all taxa—including those for which no specimens are described as burned—that are reported from these hearths (those on Level 2); mammals are included here only if it is possible to determine the genus of the taxon reported.

frog or a lizard”, “rat”, and “raccoon” (Crook and Harris, 1957, pp. 24–35). Although not vertebrates, we note that burned pieces of snail shell, mussel shell and hackberry seeds have also been recovered from these hearths, as have burned bird eggshells.

The assemblage from this site is somewhat problematic due to the way in which it was excavated and reported (e.g. Crook and Harris, 1957, p. 17; discussed further in Grayson and Meltzer, 2002, p. 334). However, because the findings from Lewisville have essentially been replicated at nearby Aubrey, a reasonable case can be made for subsistence use of at least those taxa, listed above, for which specimens described as burned have been recovered from hearth contexts. In addition to the 1950s excavations that we have considered here, further work was conducted at Lewisville in the 1970s, but the fauna from this work (in Ferring, 2001, p. 241) is unfortunately of little use for present purposes due to a lack of contextual information.

*Central-East:* Kimmswick (MO) provides compelling evidence of mastodon use because Clovis-like points and other lithic artifacts were found tightly clustered with mastodon bones here (Graham et al., 1981; Graham and Kay, 1988; see also Grayson and Meltzer, 2002, p. 337). Also occurring in these clusters were deer bones and turtle shell fragments (taxonomically identified only as “turtle”), and the evidence for subsistence use of these taxa is similarly compelling. Of the extinct mammals other than mastodon at this site, Graham and Kay (1988) suggest without providing supporting evidence that *Mylohyus* was hunted, and they propose that the numerous *Glossotherium* dermal ossicles recovered may reflect the transport of ground sloth skins to the site for processing (no other elements of this taxon were found). These ossicles do occur in the same clusters as the artifacts and the remains of mastodon, deer and turtle, but even if the skin-processing argument is correct, this would not necessarily reflect the use of *Glossotherium* for subsistence purposes. Regarding the remaining taxa recovered from this site, Graham and Kay (1988, p. 239) state that “smaller vertebrates may or may not have been actively hunted”, but they provide no information that might allow this issue to be explored further.

At the Coats-Hines site (TN), it has also been proposed that a co-occurrence of artifacts and mastodon bones reflects a behavioral association between humans and this taxon (Breitburg and Broster, 1995; Breitburg et al., 1996). No projectile points were found at this site, and only broadly limiting radiocarbon dates are available for it, but it is argued that the tools that were recovered are “known only from Paleoindian kill or task-specific butchering sites” (Breitburg et al., 1996, p. 7). The argument for human use of mastodon here is based on the recovery of lithic artifacts from the area of the animal’s thoracic cavity in a context that is described as “relatively undisturbed”, and on the presence of bone

modifications that include purported “cut marks”. Although intriguing, it is not possible to evaluate the significance of the spatial association between the artifacts and the mastodon bones at this site because the stratigraphy has yet to be described in detail, and it is not clear why the few marks identified as “cut marks” were selected as such from among the many scratches that are evident on the specimens pictured in Breitburg and Broster (1995, p. 21). For these reasons, and because the site is not well-dated, we see no convincing reason to conclude that Coats-Hines provides evidence for the butchery of a mastodon by Early Paleoindian foragers. The excavators of this site make no argument that humans were involved with any of the other taxa found here except to suggest, without providing supporting evidence, that a single canid phalanx may be from a domestic dog (*Canis familiaris*).

Strata IIa, IIb and IIc in Sheriden Cave (OH) have produced several radiocarbon dates that fall within the Early Paleoindian range, and they have also produced the remains of numerous vertebrate taxa, both extinct and extant, as well as artifacts that include a bone foreshaft and a Gainey-type fluted point (e.g., Tankersley, 1999; Tankersley and Redmond, 1999; Tankersley et al., 2001). Proposed evidence for human involvement with the fauna from these strata include burned *Platygonus* bone in deposits that also contain “masses of wood charcoal”, a *Platygonus* ilium that is said to bear a “puncture wound”, and “a cervical vertebra of a snapping turtle (*Chelydra serpentina*) bearing distinctive chopping marks” (Tankersley et al., 2001, p. 63). More generally, Tankersley (1999, p. 70) states that “burned and calcined bone” suggests that “animal resources were procured and processed at the site”, but he does not specify from which taxa this burned bone comes. Because the “puncture wound” and the “distinctive chopping marks” have not been illustrated or described in detail, we are unable to evaluate whether these bone modifications provide unambiguous indications of human activity. Likewise, it is not clear that humans are the only possible cause of the burning of bones from strata that contain “masses” of charcoal, nor is it clear precisely which taxa exhibit this burning. For these reasons, Sheriden Cave does not presently provide any strong evidence for the subsistence use of vertebrates, even though the deposits here do seem to be well-dated and do contain Early Paleoindian artifacts.

Meadowcroft Rockshelter (PA) is best known for its proposed pre-Clovis occupation, but this site also contains bone-rich deposits (in a portion of Stratum IIA) with radiocarbon dates that fall within the established Early Paleoindian range (see FAUNMAP Working Group, 1994). However, the publications on the fauna from Meadowcroft (Adovasio et al., 1982; FAUNMAP Working Group, 1994) provide no taphonomic information, and an evaluation of the dating and

the context of any potential Early Paleoindian bones from this site must await full publication of the work performed here.

The final site that we consider from the central portion of eastern North America is Shawnee-Minisink (PA). The only faunal remains reported for this site are an unspecified number of calcined fish bones—which are not identified any more precisely than “fish”—that were apparently found very close to “Paleoindian artifacts and features” (Dent, 2002, p. 55; see also McNett, 1985). Given the context that is reported for these specimens and given that they are calcined, we agree with the excavators of Shawnee-Minisink that they provide good evidence for the use of fish during Early Paleoindian times (Dent, 2002). We also note that the features in the Early Paleoindian zone at this site have produced abundant charred plant remains.

*Northeast:* Three Early Paleoindian sites in the northeast have faunal assemblages that contain calcined caribou bones, and at least two of these also contain the remains of other taxa. At Whipple (NH), calcined specimens identified as caribou were recovered, as were calcined specimens that could be identified only as caribou or deer (Spiess et al., 1985). Curran (1984, pp. 12–14) makes a convincing case that these bones come from a hearth area, and the radiocarbon dates from this area that she considers to be most accurate have a weighted mean value of 10,680  $^{14}\text{C}$ yr BP. Faunal specimens from “Paleoindian activity loci” at Bull Brook (MA), all of which are calcined, have been identified as caribou, caribou or deer, and beaver (Spiess et al., 1985). Fluted points were also recovered here (e.g., Byers, 1954), and despite later radiocarbon dates from this site, which are described as “unsatisfactory”, it is thought for typological reasons that the occupation at Bull Brook is coeval with the one at Whipple (Spiess et al., 1985, p. 149). All of the bones from the Udora (Ontario) site are likewise calcined, and those that are identifiable come from caribou, caribou or deer, hare, and Arctic fox. These specimens were recovered from a feature that has been interpreted as a hearth, which also contained numerous artifacts including a fluted point fragment (Storck and Spiess, 1994). The more complete fluted points recovered elsewhere at this site include Gainey, Barnes and Crowfield types, and although no radiocarbon dates are available for Udora, it has been argued on paleoenvironmental grounds that the occupation here must pre-date 10,500  $^{14}\text{C}$ yr BP (Storck and Spiess, 1994; Ellis and Deller, 1997; Ellis et al., 1998). There is good evidence for human involvement with all of the taxa reported from these three sites since, in each case, all of the bones are calcined and come from what appear to be either hearths or activity areas.

At the Hiscock site (NY), the remains of several extant and extinct taxa have been recovered in the “Gravelly Clay” stratum, which has also produced

fluted points and radiocarbon dates that fall within the Early Paleoindian time range (Laub et al., 1988; Laub, 2002). The excavator of Hiscock does not believe that there is any evidence for a predator-prey association between humans and the mastodon material that has been found here (Laub, 2002, p. 113); instead, he suggests that Paleoindians used this site for scouting caribou herds and for processing the carcasses of caribou they killed. If this suggestion is correct, then the activities carried out at Hiscock would be entirely consistent with the caribou hunting activities for which there is direct evidence at the other northeastern sites we have discussed. However, despite the recovery of two antlers at this site, Laub (2002, p. 118) notes that “there is no clear evidence of caribou being exploited by the Hiscock Paleoindians”. For this reason, and because there is nothing to indicate that any of the other taxa recovered here were used for subsistence purposes, we do not consider Hiscock to provide strong evidence of human involvement with any vertebrate taxon.

The final northeastern site that we consider is Sandy Ridge (Ontario) (Jackson, 1994, 1997). A feature here that may be a hearth (Feature 1) produced many calcined bone fragments, five or six of which were identified only as caribou or deer (there are inconsistencies regarding the number of identifiable specimens in Jackson, 1994; we do not include the assemblage from this site in Table 4 because none of the specimens were identifiable to genus). No projectile points were found at Sandy Ridge, but the lithic assemblage is argued to be Gainey in age based on raw material type and the presence of *pièces esquillées*. However, the single radiocarbon sample run from this site, taken from an unidentifiable calcined bone specimen, returned an age of only 735  $^{14}\text{C}$ yr BP. Because, as Jackson (1994, p. 84) notes, “the relationship of Feature 1 to the Early Paleo-Indian occupation of Sandy Ridge may never be clear”, this site cannot provide any compelling faunal evidence of Early Paleoindian subsistence practices.

*Florida:* Finally, we consider two sites from Florida at which associations between early Americans and vertebrates have been proposed. The first, Little Salt Spring, we mention only briefly because it has been discussed in greater detail elsewhere (Grayson and Meltzer, 2002, p. 330, 2003, p. 590). The well-known alleged case of predation on an extinct tortoise at this site is highly problematic because there is, in fact, no clear evidence of human involvement with this animal, and the ground sloth specimens that are said to be burned are not documented well enough to allow independent evaluation of whether they truly are (see Dunbar and Webb, 1996 regarding the supposedly burned tortoise specimens here). The excavators of this site have made no argument that any of the other taxa recovered were deposited as a result of human activities except to note that some of them are eaten by people today or are

known to have been consumed during post-Paleoindian periods in the past (Holman and Clausen, 1984).

The evidence for human predation is much more compelling at the Alexon (or Wacissa River) site, where an object that appears to be part of a projectile point was found embedded in a bison cranium (Webb et al., 1983, 1984; Mithlbackler et al., 2000). This object is made of chert and has been identified based on its cross section as likely either “a Clovis, Simpson, or Suwannee point” (Mithlbackler et al., 2000, p. 56). We agree that human predation does seem to be the best explanation for the presence of this object in the bison skull (Mithlbackler et al., 2000, p. 56), but the age of the skull is unfortunately unclear, as its excavators admit. Two radiocarbon dates were obtained on bison specimens from this site, but neither of these specimens is clearly from the individual to whom the skull belonged, and only one of the dates falls within the Early Paleoindian range (the other date is later; see Mithlbackler et al., 2000, p. 55). The only other indication of the age of the skull is that it has been identified taxonomically as *Bison antiquus*, which suggests that it dates to the late Pleistocene or perhaps the very early Holocene. Assuming that this specimen does date to the Early Paleoindian period, which it may not, it would provide good evidence of Early Paleoindian bison hunting. The excavators of this site have made no suggestion that humans were involved with any of the other taxa recovered.

### 3.3. Discussion

Several points emerge from this review. First, many of the sites that presently lack good evidence for subsistence use of vertebrates—and this includes sites that have played prominent roles in shaping the idea that Early Paleoindian foragers were megafaunal special-

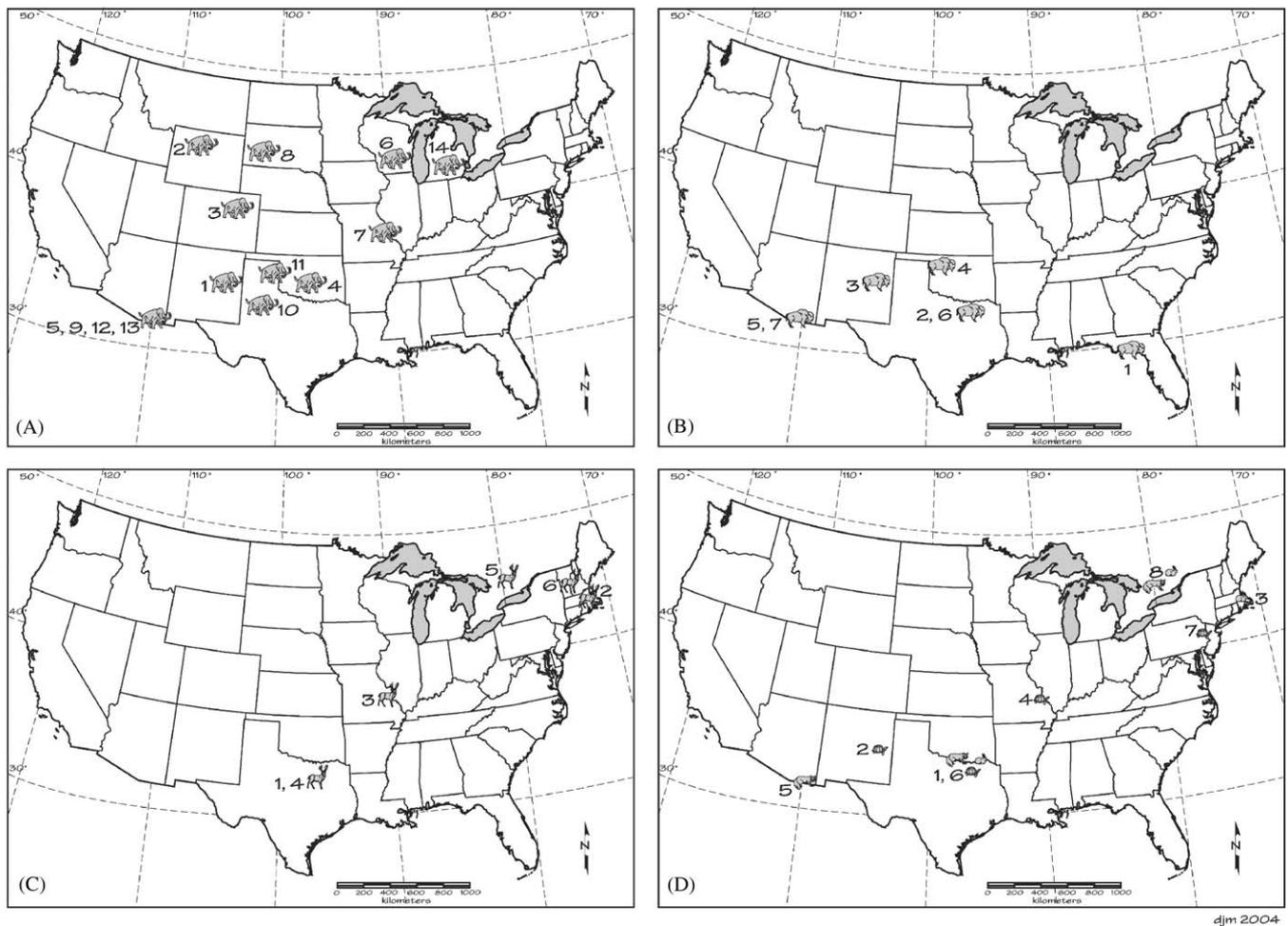
ists—may lack that evidence simply because too little information has been published about them. Moreover, among sites for which sufficient data are available, many of the purported associations are clearly very weak. And finally, as is apparent from even a cursory inspection of the literature, at many sites much effort has been directed at establishing subsistence associations with proboscideans, while other recovered taxa, which could just as well have been part of the human diet, have essentially been ignored. Taken together, and independent of taphonomic biases such as those that we discuss below, these points underscore how received wisdom about Early Paleoindian subsistence may be considerably off the mark.

Our review should not prompt the conclusion that simply because many of the proposed associations at well-documented sites cannot bear scrutiny, the same must be true of all sites that have yet to be published in detail: the potential associations at each of these sites must be evaluated independently once all the relevant data are available. However, our review does highlight the importance of making available detailed information on the stratigraphy and the faunal assemblages of all sites, with full attention given to the entire range of taxa recovered. Indeed, if anything is certain, it is that the list of secure subsistence associations between Early Paleoindians and vertebrates will surely grow as such information is published for more sites.

In the meantime, what might be said about the record that is presently available? Table 5 lists the sites at which there is strong evidence of Early Paleoindian subsistence use of various taxa, and these secure associations are mapped in Fig. 2. It should be apparent from these data that there is considerable geographic variability in the kinds of taxa for which secure associations exist, and that substantial portions of North America lack any such associations at all. This is illustrated, for example,

Table 5  
Summary of taxa for which there is strong evidence of Early Paleoindian subsistence use and the sites in which those taxa occur (also see Fig. 2)

<b>Mammoth</b>	<b>Bison</b>	<b>Deer</b>	<b>Carnivores</b>	<b>Birds</b>
Blackwater Loc. 1	Alexon	Aubrey	Lehner	Aubrey
Colby	Aubrey	Kimmswick	Lewisville	Lewisville
Dent	Blackwater Loc. 1	Lewisville	Udora	
Domebo	Jake Bluff			<b>Turtles</b>
Escapule	Lehner			Aubrey
Hebior	Murray Springs	<b>Caribou</b>	<b>Leporids</b>	Blackwater Loc. 1
Lange-Ferguson		Bull Brook	Aubrey	Kimmswick
Lehner		Udora	Lewisville	Lewisville
Lubbock Lake	<b>Horse</b>	Whipple	Udora	
Miami	Blackwater Loc. 1			<b>Other Herps</b>
Murray Springs	Lewisville			Aubrey
Naco			<b>Rodents</b>	Lewisville
			Aubrey	
<b>Mastodon</b>	<b>Camel</b>		Bull Brook	<b>Fishes</b>
Kimmswick	Lehner		Lewisville	Aubrey
Pleasant Lake				Shawnee-Minisink



djm 2004

Fig. 2. Sites for which there is strong evidence of Early Paleoindian subsistence use of vertebrates. (A) Sites with strong evidence for Early Paleoindian use of mammoth (1–6, 8–13) and mastodon (7, 14): (1) Blackwater Locality 1, (2) Colby, (3) Dent, (4) Domebo, (5) Escapule, (6) Hebior, (7) Kimmswick, (8) Lange-Ferguson, (9) Lehner, (10) Lubbock Lake, (11) Miami, (12) Murray Springs, (13) Naco, (14) Pleasant Lake. (B) Sites with strong evidence for Early Paleoindian use of bison (1, 2, 3, 4, 5, 7), camel (5), and horse (3, 6): (1) Alexon, (2) Aubrey, (3) Blackwater Locality 1, (4) Jake Bluff, (5) Lehner, (6) Lewisville, (7) Murray Springs. (C) Sites with strong evidence for Early Paleoindian use of deer (1, 3, 4) and caribou (2, 5, 6): (1) Aubrey, (2) Bull Brook, (3) Kimmswick, (4) Lewisville, (5) Udora, (6) Whipple. (D) Sites with strong evidence for Early Paleoindian use of carnivores (5, 6, 8), leporids and rodents (1, 3, 6, 8), and birds, reptiles, amphibians and fish (1, 2, 4, 6, 7): (1) Aubrey, (2) Blackwater Locality 1, (3) Bull Brook, (4) Kimmswick, (5) Lehner, (6) Lewisville, (7) Shawnee-Minisink, (8) Udora.

in Fig. 2A, which maps sites at which there is compelling evidence of proboscidean use, and Fig. 2B, which shows sites at which there is similar evidence for bison, horse and camel. Secure associations with proboscideans occur only in the central part of the continent, while secure associations with other megafaunal taxa occur only in the south. Moreover, as can be seen in Fig. 2, there are no secure associations with any vertebrate taxon in the far west, and other than the association with bison at Alexon, which may not be Early Paleoindian in age, there are none in the southeast.

These facts call into question the oft-made assumption that subsistence practices were essentially uniform across the continent during the Early Paleoindian period, with foraging everywhere focused on megafaunal hunting (e.g., Kelly and Todd, 1988; Haynes,

2002a, b; Waguespack and Surovell, 2003). At best, given the existing record of secure faunal associations, such an assumption is no more than a generalization from regions where there is good evidence for the subsistence use of megafauna (leaving aside for now the issue of whether there is also evidence for specialization on such taxa) to regions where there is none. There are reasons, however, to be highly skeptical of this type of generalization.

These reasons should be clear from a consideration of the record from northeastern North America. Even though proboscideans were available here, the largest-bodied taxa for which secure associations exist are caribou and perhaps deer, if the latter prove also to be present at sites in the region (Fig. 2C). Given that the faunal record thus suggests that Early Paleoindians in

the northeast made the greatest use of vertebrates other than megafauna, there is little reason to assume that Early Paleoindians in parts of the continent where there are no good associations with any taxa must have hunted megafauna. That is, there is no a priori reason why Clovis mammoth hunters of the plains and southwest, rather than, for example, early hunters of medium-sized artiodactyls in the northeast, should be used as a model for hunters in places where Early Paleoindian subsistence practices are, as of yet, largely unknown. Indeed, as we have noted, there is perhaps better faunal evidence to support the idea that the early inhabitants of the intermountain west focused their hunting on medium-sized artiodactyls like mountain sheep than there is to support a hypothesis of specialization on megafauna.

Thus, an assumption of continent-wide adaptive uniformity is not supported by the faunal record at hand. In fact, the notion that early North Americans were hunters of megafauna only finds strong empirical support in the portion of the continent from which this view of their subsistence practices was originally derived (e.g., Meltzer, 1993). Until Early Paleoindian subsistence associations with megafauna can be demonstrated in other parts of the continent, archaeologists should remain open to the possibility that there was considerable regional variability in the kinds of vertebrate taxa that were important to foragers during this period.

All that said, and even though there are presently more secure Early Paleoindian associations with smaller-bodied taxa (over 30) than there are with mammoth, mastodon, bison, horse and camel (23 or less; see Table 5 and Fig. 2), megafauna do figure prominently in the existing Early Paleoindian faunal record: the single taxon with the largest number of secure associations is mammoth, and the next most common taxon, occurring in half as many secure associations, is bison (Table 5; see also Waguespack and Surovell, 2003). But should this prominence be taken at face value?

Answering this question requires that we address issues of bias by asking another: is the Early Paleoindian faunal record providing an accurate picture of the kinds of taxa that people used and of the frequencies with which they used them? We have already mentioned one type of bias that has clearly influenced our understanding of this faunal record: the inordinate amount of attention that proboscideans have received, relative to other taxa, from archaeologists seeking to document Early Paleoindian subsistence use of vertebrates. We next turn to a quantitative evaluation of other factors that may also have biased our understanding of the subsistence practices of Early Paleoindian foragers. We conduct this evaluation so that we may ultimately address the hypothesis that these foragers were specialized large mammal hunters.

#### 4. Evidence for specialization and factors affecting assemblage richness and composition

In this section, we ask whether assemblages of bones from Early Paleoindian sites exhibit characteristics that are consistent with specialization on large mammals. We consider both megafauna and the more inclusive category of “large herbivores”, as defined above (see also Table 2). This allows evaluation of the possibility that various Early Paleoindian groups specialized on members of a broader class of large-bodied mammals, even if they did not specialize simply on megafauna.

Variables relevant to a test of the “large mammal specialization hypothesis” include the number of taxa present in faunal assemblages (i.e., assemblage richness) since specialists, by definition, have narrower diets than generalists, and the degree to which assemblages are dominated by the bones of large mammals, a characteristic that can be measured in several ways (e.g., Broughton, 1994; Mellars, 1996; Grayson and Delpech, 1998, 2002; Grayson et al., 2001; Waguespack and Surovell, 2003; Jones, 2004). However, there are many factors other than human prey choice that can also cause assemblages to vary in both richness and the degree to which they are dominated by large mammals. Here, we explore the effects that such factors may have had on the existing sample of Early Paleoindian faunal assemblages. Previous studies of faunal data from this period have not included analyses of this sort, but potentially confounding taphonomic factors must be controlled before bones can be used to draw meaningful conclusions about human subsistence. The data that we use to address such issues are presented in Table 6.

##### 4.1. Site discovery, recovery, and depositional environment

Grayson (1988a) has noted that many North American late Pleistocene sites are known to archaeology only because they contain bones of large mammals (most often bison or mammoth), the discovery of which led to excavation and subsequently to the recovery of artifacts. He has further suggested that this bias in the way the archaeological record has been sampled may be largely responsible for the notion that Early Paleoindians subsisted primarily by hunting megafauna (see also Meltzer, 1988, 1989). Here, we explore whether differences in the ways in which sites were discovered are reflected in their faunal assemblages. If discovery methods have produced a bias that favors the “large mammal specialist” view of Early Paleoindian subsistence, then, relative to sites that were excavated for other reasons, sites that were excavated only because they contain the remains of large mammals should have assemblages that are less rich and/or in which large mammals are more dominant. The events that led to

excavation are mentioned in the publications on most of the sites that we use; if we were able to determine that the excavation of a site was inspired by the discovery of large mammal bones, this is reported as “yes” in the column “bones found first?” in [Table 6](#).

To assess the effects of discovery methods on assemblage richness and composition adequately, however, two additional factors that might affect these variables must also be considered. The first of these relates to variability in depositional and erosional processes, which we capture in a gross fashion by grouping assemblages according to “deposit type”: i.e., whether they come from caves (including rockshelters), open sites, or sites that are presently underwater. Elsewhere, using a larger sample of terminal Pleistocene paleontological and archaeological faunal assemblages from North America, one of us ([Cannon, 2004](#)) has shown that assemblages from cave sites are significantly richer than those from open sites, and the reasons for such a difference should be obvious. Any analysis that incorporates assemblages from both caves and open sites must take this effect of deposit type into account.

We also consider another factor that relates to the manner in which archaeologists have sampled the archaeofaunal record. It is well known that decisions about the use of screens in excavation can affect both the richness of faunal assemblages and the relative abundances of different kinds of taxa within them (e.g., [Nagaoka, 1994](#); [Cannon, 1999](#)). The effects of these decisions must likewise be taken into account in any analysis that employs assemblages that were collected in a variety of ways. We have examined the publications on the sites that we use for any mention of any type of screening (including flotation) during excavation; [Table 6](#) notes whether we were able to determine with certainty that screens of any type were or were not used or whether this is unclear (because, for example, excavation methods are not discussed).

In evaluating the effects of these three factors on assemblage richness and composition, we present two kinds of analyses, one “liberal” and one “conservative”. In the liberal approach, we incorporate all of the mammal genera present in an assemblage regardless of whether there is any indication of human involvement with them. This is the approach taken by [Waguespack and Surovell \(2003\)](#), who, in their statistical analyses, treated the remains of all taxa found at early sites as if they were relevant to hypotheses about human subsistence. In our conservative approach, on the other hand, we use only genera for which there is good evidence of subsistence use by Early Paleoindian foragers, and sites that contain no such genera are excluded. Throughout this paper we have evaluated the Early Paleoindian faunal record conservatively, but we include discussions of both conservative and liberal approaches here in order to illustrate the analytical

consequences that might result from taking one approach rather than the other.

We consider only mammals in what follows because, as we have noted, they are reported much more thoroughly for most sites than are other vertebrate classes. The numbers of mammal genera that we use in the “liberal” and the “conservative” approaches to the analysis of richness, which are totaled from [Tables 3 and 4](#), are listed in [Table 6](#) as “number of mammal genera” and “number of genera with strong evidence of use”, respectively.

In our “liberal” analyses of assemblage composition, we measure the degree to which an assemblage is dominated by large mammals as the proportion of the genera in it that are large herbivores. We use the proportion of large herbivore genera, rather than a more traditional “abundance index” based on taxonomic abundance values (e.g., [Broughton, 1994](#); [Ugan and Bright, 2001](#)), because abundance values are not available, or are incomplete, for many Early Paleoindian assemblages (see [Table 4](#)). We note, however, that this measure correlates highly with a traditional abundance index among a larger sample of North American late Pleistocene paleontological and archaeological assemblages ([Cannon, unpublished data](#)), which indicates that it should be useful for present purposes. We also consider the proportion of the genera in assemblages that are megafauna specifically, in addition to the proportion that are large herbivores more generally. Numbers and proportions of both large herbivore and megafaunal genera are listed in [Table 6](#). In our “conservative” analyses of composition, due to the small numbers of genera in any assemblage for which there is strong evidence of subsistence use, we take a different approach to measuring dominance by large herbivores and by megafauna that we describe below.

We include in our “liberal” analyses all of the assemblages in [Tables 3 and 4](#) that contain mammal remains identified to genus with the exception of those from four sites: Gault, Jaguar Cave, McLean and Owl Cave. We exclude the assemblages from these sites because they contain mammal taxa in addition to those listed in [Table 4](#) that have not been reported in a manner that allows us to use them (the “other taxa” noted in [Table 4](#) for the Connley Caves are fishes). For the latter three of these sites, that this is the case is clear from the publications that we have cited for them. For Gault, this is suggested in a popular article by [Collins \(2002, p. 37\)](#), who states that “frogs, birds, and small mammals were on the Clovis menu” at this site.

The effects on assemblage richness and composition of the three taphonomic factors that we consider here can be seen in [Table 7](#). When the liberal approach to measuring richness is taken and all taxa present in assemblages are included, it appears that sites that were excavated due to the discovery of large mammal bones

Table 6  
Numbers of mammal genera reported for assemblages, with relevant taphonomic and archaeological data

Assemblage	Bones found first?	Deposit type	Screened?	Hearths?	Number of mammal genera	Number of genera with strong evidence of use	Number of large herbivore genera	Proportion large herbivore genera	Number of megafauna genera	Proportion megafauna genera
Agate Basin	Yes	Open	?	No	4	0	2	0.50	2	0.50
Alexon	?	Water	?	No	5	1	5	1.00	2	0.40
Aubrey	Yes	Open	Yes	Yes	20	3	5	0.25	4	0.20
Blackwater, BSW	Yes	Open	Yes	Yes	22	2	6	0.27	3	0.14
Blackwater, GS	Yes	Open	Yes	Yes	10	2	6	0.60	4	0.40
Boaz	Yes	Open	No	?	1	0	1	1.00	1	1.00
Bonfire Shelter	Yes	Cave	Yes	No	5	0	5	1.00	4	0.80
Bull Brook	No	Open	?	No	2	2	1	0.50	0	0.00
Burning Tree	Yes	Open	Yes	No	1	0	1	1.00	1	1.00
Carter/Kerr-McGee	?	Open	?	No	1	0	1	1.00	1	1.00
Coats-Hines	Yes	Open	?	No	5	0	3	0.60	2	0.40
Colby	Yes	Open	Yes	No	7	1	6	0.86	4	0.57
Connley Caves	No	Cave	Yes	No	17	0	3	0.18	1	0.06
Dent	Yes	Open	?	No	1	1	1	1.00	1	1.00
Domebo	Yes	Open	Yes	No	3	1	1	0.33	1	0.33
Duewall-Newberry	Yes	Open	Yes	No	1	0	1	1.00	1	1.00
Dutton	Yes	Open	?	No	1	0	1	1.00	1	1.00
Escapule	Yes	Open	?	No	2	1	2	1.00	1	0.50
Fishbone Cave	No	Cave	No	No	3	0	2	0.67	2	0.67
Fort Rock Cave	No	Cave	Yes	No	4	0	1	0.25	0	0.00
Gault <sup>a</sup>	No	Open	?	No	3	0	3	1.00	3	1.00
Guest	Yes	Water	?	No	3	0	3	1.00	2	0.67
Hebior	Yes	Open	?	No	1	1	1	1.00	1	1.00
Heisler	Yes	Open	No	No	1	0	1	1.00	1	1.00
Henwood	No	Open	?	No	6	0	0	0.00	0	0.00
Hermit's Cave	No	Cave	?	?	7	0	3	0.43	2	0.29
Hiscock	Yes	Open	Yes	No	4	0	4	1.00	2	0.50
Huntington Dam	Yes	Open	?	No	2	0	1	0.50	1	0.50
Jaguar Cave <sup>a</sup>	No	Cave	Yes	?	5	0	1	0.20	1	0.20
Jake Bluff	Yes	Open	?	No	1	1	1	1.00	1	1.00
Kimmswick	Yes	Open	Yes	No	16	2	4	0.25	2	0.13

Kincaid Shelter	No	Cave	?	No	6	0	2	0.33	2	0.33
Klein	?	Open	?	No	2	0	2	1.00	1	0.50
Lange-Ferguson	?	Open	Yes	No	15	1	3	0.20	2	0.13
Lehner	Yes	Open	?	Yes	12	4	5	0.42	4	0.33
Leikem	?	Open	?	No	1	0	1	1.00	1	1.00
Levi Shelter	?	Cave	Yes	No	9	0	4	0.44	2	0.22
Lewisville, 1950s	Yes	Open	?	Yes	20	9	7	0.35	5	0.25
Lewisville, 1970s	Yes	Open	?	Yes	16	0	3	0.19	2	0.13
Little Salt Spring	?	Water	?	No	3	0	2	0.67	1	0.33
Lubbock Lake	Yes	Open	Yes	No	24	1	8	0.33	4	0.17
Manis	Yes	Open	No	No	3	0	3	1.00	2	0.67
Martin's Creek	Yes	Open	?	No	2	0	2	1.00	1	0.50
McLean <sup>a</sup>	No	Open	?	No	1	0	1	1.00	1	1.00
Meadowcroft	No	Cave	Yes	Yes	11	0	0	0.00	0	0.00
Miami	Yes	Open	?	No	1	1	1	1.00	1	1.00
Midland	No	Open	Yes	No	13	0	6	0.46	3	0.23
Murray Springs	Yes	Open	?	Yes	8	2	5	0.63	4	0.50
Naco	Yes	Open	?	No	2	1	2	1.00	2	1.00
Navarette	?	Open	?	No	1	0	1	1.00	1	1.00
Owl Cave <sup>a</sup>	?	Cave	Yes	No	7	0	4	0.57	3	0.43
Pleasant Lake	Yes	Open	Yes	No	1	1	1	1.00	1	1.00
Schaefer	Yes	Open	?	No	1	0	1	1.00	1	1.00
Shawnee-Minisink <sup>b</sup>	No	Open	Yes	Yes	0	0	0	n.a.	0	n.a.
Sheaman	?	Open	Yes	No	6	0	3	0.50	2	0.33
Sheriden Cave	No	Cave	Yes	No	26	0	5	0.19	0	0.00
Sloth Hole	No	Water	?	No	1	0	1	1.00	1	1.00
Smith Creek Cave	No	Cave	Yes	Yes	9	0	1	0.11	0	0.00
Sunshine	No	Open	Yes	No	12	0	2	0.17	2	0.17
Udora	No	Open	Yes	Yes	3	3	1	0.33	0	0.00
Union Pacific	Yes	Open	?	No	4	0	4	1.00	3	0.75
Whipple	No	Open	Yes	Yes	1	1	1	1.00	0	0.00
Wilson Butte Cave	No	Cave	?	No	16	0	3	0.19	2	0.13

<sup>a</sup> Excluded from the analyses that follow due to insufficient reporting of all mammalian taxa recovered.

<sup>b</sup> Excluded from the analyses that follow because no mammals reported.

Table 7  
Mean numbers of mammal genera and proportions of large herbivore and megafauna genera per assemblage, grouped by taphonomic characteristics

Factor	Level	Mean number of mammal genera	Mean number of genera with strong evidence of use	Mean proportion large herbivore genera	Mean proportion megafauna genera
Bones found first?	Yes	6.21 ( $n = 33$ , S.D. = 7.09)	2.00 ( $n = 17$ , S.D. = 2.00)	0.760 ( $n = 33$ , S.D. = 0.309)	0.635 ( $n = 33$ , S.D. = 0.324)
	No	8.56 ( $n = 16$ , S.D. = 6.95)	2.00 ( $n = 3$ , S.D. = 1.00)	0.363 ( $n = 16$ , S.D. = 0.307)	0.180 ( $n = 16$ , S.D. = 0.286)
Deposit type	Cave	10.27 ( $n = 11$ , S.D. = 6.92)	n.a. ( $n = 0$ )	0.345 ( $n = 11$ , S.D. = 0.285)	0.227 ( $n = 11$ , S.D. = 0.280)
	Open	6.05 ( $n = 43$ , S.D. = 6.74)	1.95 ( $n = 21$ , S.D. = 1.83)	0.703 ( $n = 43$ , S.D. = 0.336)	0.554 ( $n = 43$ , S.D. = 0.372)
	Water	3.00 ( $n = 4$ , S.D. = 1.63)	1.00 ( $n = 1$ )	0.918 ( $n = 4$ , S.D. = 0.165)	0.600 ( $n = 4$ , S.D. = 0.304)
Screened?	Yes	10.00 ( $n = 24$ , S.D. = 7.71)	1.64 ( $n = 11$ , S.D. = 0.809)	0.488 ( $n = 24$ , S.D. = 0.347)	0.308 ( $n = 24$ , S.D. = 0.335)
	No	2.00 ( $n = 4$ , S.D. = 1.15)	n.a. ( $n = 0$ )	0.918 ( $n = 4$ , S.D. = 0.165)	0.835 ( $n = 4$ , S.D. = 0.191)

contain, on average, fewer genera (6.21) than do sites that were excavated for other reasons (8.56); however, the difference in means between these two groups is not statistically significant ( $t = 1.10$ , one-tailed  $p = 0.140$ ).<sup>6</sup> When the conservative approach is taken and only those taxa are considered for which there is strong evidence of subsistence use, there is no difference at all in observed mean richness between sites that were excavated due to the discovery of bones and sites excavated for other reasons (means for both are 2.00). There is thus no clear indication from the available data that assemblages from sites that were discovered and excavated due to the presence of large mammal bones are any less rich than those from sites discovered in other ways.

On the other hand, there does appear to be a difference in assemblage composition between the two types of sites. Sites excavated due to the discovery of bones tend to contain much higher proportions of large herbivore genera than do sites excavated for other reasons (means are about 76% and 36%, respectively), and the difference in means for this variable is highly significant ( $t = 4.23$ , one-tailed  $p < 0.001$ ). A highly significant difference also occurs if only megafauna are considered (means are about 64% and 18%, respectively;  $t = 4.78$ , one-tailed  $p < 0.001$ ). These results would seem to support the suggestion that the way in which the late Pleistocene archaeological record has been sampled has indeed introduced considerable bias into the sample of faunal remains that is available from this period (Grayson, 1988a; Meltzer, 1988, 1989). Given these results, it is reasonable to think that Early Paleoindian assemblages would not be so strongly dominated by large mammals, or by megafauna more narrowly, had sites been discovered in a more systematic manner.

However, the other two factors that we consider here—deposit type and screening—also need to be taken into account before too much is made of this result. As can be seen in Table 7, when all taxa present in assemblages are included, assemblages from caves tend to be much richer than those from open sites, and assemblages from the few underwater sites are the least rich of all. An analysis of variance indicates that mean numbers of genera do not differ significantly among these three groups at an alpha level of 0.05 (and a post-hoc Tukey test gives no significant result for any of the

<sup>6</sup>In evaluating differences in richness among sets of assemblages, it would, of course, be more appropriate to use a quantitative method that takes into account the effects of sample size on richness (Grayson, 1984, pp. 131–167; see also, e.g., Grayson and Delpech, 1998; Cannon, 2004). However, because taxonomic abundance values for all taxa present in assemblages—and thus sample sizes for those assemblages—are available for so few early sites, it is currently possible to conduct only a raw comparison of mean of numbers of genera. There is little reason to think that assemblage sample size will affect our analyses of assemblage composition (Cannon, 2001).

Table 8

Numbers of mammal genera with strong evidence of subsistence use in assemblages from open sites that are known to have been screened

Assemblage	Bones found first?	Hearths?	Number of genera	Number of large herbivore genera	Number of megafauna genera
Aubrey	Yes	Yes	3	2	1
Blackwater, BSW	Yes	Yes	2	2	2
Blackwater, GS	Yes	Yes	2	2	2
Colby	Yes	No	1	1	1
Domebo	Yes	No	1	1	1
Kimmswick	Yes	No	2	2	1
Lange-Ferguson	?	No	1	1	1
Lubbock Lake	Yes	No	1	1	1
Pleasant Lake	Yes	No	1	1	1
Udora	No	Yes	3	1	0
Whipple	No	Yes	1	1	0

pairwise differences), but it does produce a  $p$ -value less than 0.1 ( $F = 2.45$ ,  $p = 0.095$ ). More important, there are significant differences in mean proportions of large herbivore and megafaunal genera among the three groups: assemblages from cave sites tend to be least dominated by large mammal genera, while assemblages from open and underwater sites contain much higher proportions of them (for all large herbivores,  $F = 7.02$ ,  $p = 0.002$ , post-hoc tests give significant results for the pairwise differences between cave sites and each of the other two types of sites; for megafauna only,  $F = 3.94$ ,  $p = 0.025$ , post-hoc tests give a significant result for the pairwise difference between cave sites and open sites).

The way in which assemblages were recovered also makes a difference to richness and composition. When all taxa present are included, assemblages that are known to have been screened in some manner contain significantly more genera than do assemblages that are known not to have been screened ( $t = 4.77$ , one-tailed  $p < 0.001$ ). In addition, significantly lower proportions of those genera are either megafauna ( $t = 3.95$ , one-tailed  $p = 0.002$ ) or, more broadly, large herbivores ( $t = 3.04$ , one-tailed  $p = 0.002$ ). These results surely reflect higher recovery rates for smaller-bodied taxa that result when sediments are screened. We also note that none of the occurrences of genera with strong evidence of subsistence use come from sites that are known not to have been screened, although, disturbingly, there is no mention of whether screens were used in the publications on about half of the sites included in this analysis (see Table 6).

Of course, when evaluating the effects of multiple factors on a variable, single-factor tests such as those that we have so far discussed are less appropriate than a multi-factorial analysis due to the potential for interactions among the factors (e.g., Zar, 1999, pp. 231–245). When discovery method is combined with deposit type and screening in a multi-factorial ANOVA, its effect on the proportion of genera within assemblages that are megafauna remains significant ( $p = 0.002$ ), as does the

effect of screening ( $p = 0.006$ ), while the effect of deposit type becomes insignificant (0.523; there are no significant interactions in this model; model  $r^2 = 0.61$ , model  $p = 0.002$ ). Similar results occur when all large herbivores, rather than only megafauna, are considered (discovery method  $p = 0.013$ , screening  $p = 0.026$ , deposit type  $p = 0.936$ ; model  $r^2 = 0.51$ , model  $p = 0.012$ ), though this analysis is complicated somewhat by a nearly significant interaction between discovery method and deposit type ( $p = 0.063$ ; there are no other significant interactions in this model).<sup>7</sup>

These results are fully consistent with the hypothesis that the way in which most early sites were discovered has produced a faunal record that is biased in favor of the remains of large mammals. However, we have so far taken only a “liberal” approach to the analysis of assemblage composition. To treat the association issue “conservatively”, and to control for the effects of deposit type and screening, we use the data presented in Table 8, which come from all of the open sites that we use that are known to have been screened and for which there are also secure associations with one or more mammal genera. Among the eight assemblages in this table that are from sites known to have been excavated due to the discovery of large mammal bones, 12 of the 13 occurrences of secure associations with mammal genera involve large herbivores, and 10 involve megafauna more narrowly. On the other hand, in the 2 assemblages from sites known to have been excavated

<sup>7</sup>We note that the power of these multi-factorial tests is reduced because they exclude assemblages for which the value of any of the three factors is unknown, leaving a total sample size of only 25 assemblages. The results of a multi-factorial “liberal” analysis of richness do not differ substantively from those of the single-factor tests discussed above: discovery method  $p = 0.520$ , screening  $p = 0.083$ , deposit type  $p = 0.902$ ; no significant interactions; model  $r^2 = 0.21$ , model  $p = 0.427$ . It is not possible, or necessary, to conduct a multi-factorial “conservative” richness analysis because all of the assemblages with genera that have strong evidence of subsistence use for which values of all three factors are known come from open sites that are known to have been screened.

Table 9

Mean numbers of mammal genera and proportions of large herbivore and megafauna genera per assemblage, grouped according to whether hearths are present

Hearths?	Mean number of mammal genera	Mean number of genera with strong evidence of use	Mean proportion large herbivore genera	Mean proportion megafauna genera
Yes	12.00 ( $n = 11$ , S.D. = 6.90)	3.25 ( $n = 8$ , S.D. = 2.49)	0.377 ( $n = 11$ , S.D. = 0.280)	0.177 ( $n = 11$ , S.D. = 0.177)
No	5.44 ( $n = 45$ , S.D. = 6.25)	1.14 ( $n = 14$ , S.D. = 0.363)	0.714 ( $n = 45$ , S.D. = 0.341)	0.566 ( $n = 45$ , S.D. = 0.366)

for reasons other than the discovery of bones, 2 of the 4 secure associations involve large herbivores, none of which are megafauna. Though sample sizes are small, the difference between these two groups of assemblages in the percentage of secure associations that involve megafauna (77% vs. 0%) is significant ( $\chi^2 = 7.47$ ,  $p = 0.006$ ), and the difference in the percentage of secure associations that involve large herbivores (92% vs. 50%) is nearly so ( $\chi^2 = 3.77$ ,  $p = 0.052$ ; for both chi-square tests, mean expected frequency is 4.3).

The available data, therefore, provide considerable support for the suggestion that the manner in which most early sites were discovered has introduced a bias that favors the “large mammal specialist” view of Early Paleoindian subsistence. Sites that were excavated due to the discovery of large mammal bones do not seem to have assemblages that are any less rich than those from other sites, but their assemblages are much more strongly dominated by the bones of megafauna, and this result holds regardless of whether the issue of association between humans and vertebrate remains is treated liberally or conservatively. It thus appears that the Early Paleoindian faunal record would be less dominated by megafauna—and by large mammals more broadly—were more sites excavated for reasons other than the discovery of bones.

#### 4.2. Site function

In addition to the post-depositional taphonomic factors that we have just addressed, there is a pre-depositional factor that might also have an important effect on the richness and composition of archaeofaunas: these assemblage characteristics may vary among sites that served different functional roles in subsistence and settlement systems (LaBelle, personal communication, 2003; see also, e.g., Szuter and Bayham, 1989; Grayson and Cannon, 1999, p. 150). For example, faunal assemblages from kill and butchery sites are likely to consist primarily, if not completely, of the taxa killed or processed at those sites, while assemblages from residential sites may consist of a much wider variety of taxa brought in from different locations (e.g. O’Connell et al., 1992). Given that many of the Early Paleoindian sites with faunal assemblages have been, or easily could be, interpreted as kill or butchery sites, it is quite possible that the traditional “large mammal

specialist” image of Early Paleoindians is one that has come through a lens aimed at only a limited subset of the subsistence activities that they actually carried out.

As an indicator of whether or not a given site likely fulfilled functions beyond that of kill or butchery locale, we use the presence or absence of hearths, as identified in the publications on that site (Table 6; we treat this as an unknown for the two sites where we are skeptical about the features identified as hearths). It can be seen in Table 9 that assemblages from sites with hearths are much richer than assemblages from sites without them, and, regardless of whether richness is measured “liberally” or “conservatively”, this difference is statistically significant (all genera:  $t = .06$ , one-tailed  $p = 0.002$ ; only genera with strong evidence of use:  $t = 2.38$ , one-tailed  $p = 0.025$ ).<sup>8</sup> A “conservative” analysis that also controls for deposit type and screening by including only assemblages from open sites that are known to have been screened likewise gives a significant result ( $t = 2.69$ , one-tailed  $p = 0.012$ ; hearth mean = 2.20, no hearth mean = 1.17).

As for assemblage composition, when all mammal genera reported are considered, the mean proportion of those genera that are large mammals is significantly lower at sites with hearths than at sites without hearths (large herbivores: 38% vs. 71%,  $t = 3.42$ , one-tailed  $p = 0.002$ ; megafauna only: 18% vs. 57%,  $t = 5.10$ , one-tailed  $p < 0.001$ ). When the association issue is treated conservatively and when deposit type and screening are controlled by using only the assemblages listed in Table 8, a difference in the degree of dominance by large mammals also appears: among the five assemblages in this table from sites with hearths, eight of the 11 secure associations involve large herbivores, and five involve megafauna more narrowly, while all seven of the secure associations from sites without hearths involve large herbivores, and six involve megafauna more narrowly. The differences between these two groups of

<sup>8</sup> Since the recovery of burned specimens from hearth contexts is one of the criteria that we employ as evidence for subsistence use of the taxa included in the “conservative” analysis of richness, it might be argued that the higher richness values for sites with hearths are merely an artifact of this criterion. It is unlikely that this is the case, though, because the “liberal” analysis, in which we use all taxa present in assemblages regardless of the context in which they were found, produces results that are entirely consistent with those of the “conservative” analysis.

assemblages in the percentage of secure associations that involve large mammals are not significant (large herbivores: 75% vs. 100%,  $\chi^2 = 2.29$ ,  $p = 0.130$ ; megafauna only: 46% vs. 86%,  $\chi^2 = 2.92$ ,  $p = 0.088$ ; mean expected frequency is 4.5 for both chi-square tests), but the direction of these differences is consistent with the significant ones that occur when the association issue is treated liberally.

It thus seems clear that the received wisdom about Early Paleoindian subsistence practices is based mainly on large mammal—and primarily megafaunal—kill and butchery sites that may reflect only a portion of the foraging activities that Early Paleoindians pursued. Such sites do tend to contain few taxa, most of which are megafauna, but this is not at all the case at sites where a much wider range of activities are likely represented. In other words, when site function is taken into account, support for the “megafauna specialist” view of Early Paleoindian subsistence diminishes rapidly.

## 5. Conclusions

Our evaluation of Early Paleoindian faunal assemblages sought to determine what empirical support exists for the long-held belief that all early North American foragers were specialized hunters of megafauna, or even of large mammals more broadly. It should be clear from our consideration of purported associations between those foragers and vertebrates that, in many cases, the traditional view of Early Paleoindian subsistence has influenced interpretation of the empirical record much more than the empirical record has influenced ideas about early subsistence. This is evident, for example, in that subsistence use of proboscideans is frequently assumed in the absence of any direct evidence for it, while the possibility that other recovered taxa were consumed is often never considered. Despite this disparity in the amount of attention that different kinds of taxa have received, however, there are, as we have noted, fewer secure Early Paleoindian associations with megafauna than there are with smaller-bodied taxa.

In addition to this bias in the amount of attention devoted to different taxa, we have also provided quantitative evidence that other biases have affected the existing sample of Early Paleoindian archaeofaunas. We have shown that the depositional context of these assemblages and the manner in which they were recovered have effects, not surprisingly, on taxonomic richness and composition. Moreover, when an effort is made to control for these effects, it appears that the manner in which most early sites were discovered has produced a sample of faunal assemblages that is strongly biased in favor of the “megafauna specialist” image.

It also appears that this image is based mainly on assemblages from limited-function kill or butchery locales because sites that were likely used for habitation provide little evidence that early North Americans subsisted primarily by hunting megafauna. Given this, it is quite likely that the discovery and excavation of additional habitation sites in the future will result in considerable support for the hypothesis that many, if not all, Early Paleoindian groups harvested a wide variety of both plant and animal resources. Such evidence for diets that were more generalized than is traditionally assumed will likely become especially clear if careful recovery techniques are used when these sites are excavated: we need only point to habitation sites like Aubrey that were excavated in such a manner and at which there is compelling evidence for the use of a wide variety of vertebrate prey.

When issues such as the ones that we have addressed here are taken into account, it becomes clear that the faunal record presently offers little compelling reason to think that all Early Paleoindians—or even any of them—were megafauna or large mammal specialists. There certainly is good evidence that Early Paleoindians in some parts of North America—most notably the Plains and a portion of the Southwest (Figs. 2A and B)—did hunt and kill megafauna. However, well-documented subsistence associations with such taxa simply do not exist for many regions of the continent, despite their frequent occurrences in the paleontological records of those regions. Moreover, even in regions where we know that Early Paleoindians did kill megafauna and other large mammals, we know that they also killed many smaller-bodied taxa, and there is good reason to think that such smaller-bodied taxa would be much more abundant in the existing sample of Early Paleoindian faunal assemblages if those assemblages had been discovered and recovered in a more systematic manner.

To conclude, we return to the question that we raised at the outset of this paper: if Early Paleoindian foragers were not routinely hunting extinct megafauna, then what resources were important to them? Unfortunately, given the present state of the Early Paleoindian archaeofaunal record, we cannot fully answer this question here. However, it appears there was regional variability among Early Paleoindian groups in the kinds of vertebrate prey they hunted. Most notably, the existing faunal record suggests that medium-sized artiodactyls, not megafauna, were the biggest of the “big game” hunted by Early Paleoindian foragers in northeastern North America, and perhaps in the intermountain west as well.

Based on the results of our review of the Early Paleoindian faunal record, we would surmise that, as this record is expanded through future research, particularly in parts of North America where little is

presently known about Early Paleoindian subsistence practices, the picture that will emerge will be one of even greater regional variability in prey choice. More important, we would hope that, as this occurs, stronger efforts will be made to make sense out of variability in Early Paleoindian vertebrate prey choice by attempting to account for it in terms of environmental variability. This will require doing two things: paying greater attention to the ever-growing body of research into variability in faunal communities across North America during the terminal Pleistocene (e.g., Lyons, 2003; Cannon, 2004; Webb et al., 2004), and employing theoretical structures that will allow us to explain why Early Paleoindian foragers made the foraging decisions that they did, given the environmental settings in which they lived.

Regarding this last point, we are encouraged to see that a growing number of archaeologists are beginning to apply models from foraging theory to questions about Early Paleoindian subsistence (for some recent applications see, e.g., Haynes, 2002a, b; Waguespack and Surovell, 2003). We note, however, that foraging theory has to date been invoked more often to pigeon-hole Early Paleoindians into categories like “specialist” or “generalist” than to explain the geographic variability in their prey choice that is increasingly becoming evident. Because the true strength of foraging theory lies in the fact that it allows variability in subsistence behavior to be explained in relation to variability in the ecological constraints that foragers face (see, e.g., Bird and O’Connell, 2004), the full benefit that might be obtained by applying it to Early Paleoindian archaeology has yet to be realized.

The Early Paleoindian archaeofaunal record is not yet up to either the task of providing a final resolution to the specialist–generalist debate or the task of showing precisely how prey choice might have varied among groups inhabiting different parts of the continent. To accomplish these tasks, many already-excavated assemblages will need to be studied—and published—in considerably more detail, regions of North America from which few assemblages exist will need to see the completion of much more fieldwork, and efforts will need to be made everywhere to ensure that sites are discovered and excavated more systematically. Perhaps most important, careful evaluations of the empirical record will need to play a greater role than received wisdom in shaping the conclusions that are derived from this future research.

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