

## Chapter 17

# Clovis-era Subsistence: Regional Variability, Continental Patterning

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### ABSTRACT

Clovis-era subsistence varied from site to site and region to region, but large mammals numerically dominate at archaeological sites with food remains. Plant remains are extremely scarce in Clovis sites. The lack of specialized processing and storage technology suggests seeds and nuts were not prominent in the diet, as they became in later times. Sites dated to a possible proto-Clovis phase, 1,000–3,000 years older than the generally accepted age of Clovis, also contain mostly or exclusively large-mammal remains. Many (perhaps most or all) of the largest animals were probably killed and butchered by Late Glacial foragers; they were not found dead and scavenged by people. Proboscidean carcass utilization by Clovis butchers was often incomplete, because Clovis foraging bands were small in number, very mobile, and most likely could predict where to find vulnerable prey.

**KEYWORDS:** Clovis subsistence, Late Glacial, large mammals

### Introduction

In this paper we summarize the evidence about Clovis-era subsistence. We also refer to other sites dated earlier than the fairly narrow Clovis interval proposed by Waters and Stafford (2007; see Haynes et al. 2007 for disagreement), thereby stretching out the time span to include what we designate a proto-Clovis period (as suggested by Haynes 2002:253 and Ferring 2012). We examine data for North America south of the continental ice sheets, leaving aside Alaskan fluted-point assemblages, because the far northern fluted points may be significantly younger than those in the lower 48 states (Goebel 2011; Graf et al. 2011; Keene et al. 2009). Clovis or Clovis-like fluted bifaces have been found in Central and South America, but their chronostratigraphic contexts and associations are less clear than in the United States. Our sample includes one

site from northern Mexico that was recently discovered and excavated, but no others south of the USA–Mexico border. Our focus is on the animal and plant foods that people procured or processed just before and during the Clovis era. By necessity we examine only mammals. The evidence about human use of birds, reptiles, amphibians, fish, and invertebrates is extremely slim. Only five sites with adequate evidence that humans utilized such animals are listed in Cannon and Meltzer (2004); these should be closely examined in future studies of the Clovis era.

### Research History

The first speculations about a preferred Clovis-era diet began with the earliest discoveries of associated animal bones and fluted projectile points, specifically Dent, CO (Bilgery 1935, as cited in C. V. Haynes et al. 1998 and Saunders 2007; Figgins 1933), Blackwater Draw, NM, and Miami, TX (Sellards 1938, 1952). At the time, these finds hinted that big-game animals were the major part of the diet. Some archaeologists chal-

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lenged the likelihood that Clovis foragers specialized in megafauna hunting, although such a limited specialization was not usually claimed in the professional literature, except perhaps as a strawman or caricature. The generally accepted model of subsistence allowed for variety in the diet. For example, a textbook by Harvard professor Gordon Willey (1966:38), which every student of American prehistory had to read, stated positively that Paleoindian “livelihood did not depend on the big Pleistocene animals of the hunt” for subsistence.

The paleoecologist Paul Martin’s publications (e.g., 1967, 1973, 1984, 2005; Martin and Steadman 1999) blamed Clovis-era hunting for the apparently synchronous extinction of many megafaunal taxa, and thus strengthened the possibility that Clovis hunting efforts were especially directed to the largest animals. Martin’s idea has been regularly attacked over the years (e.g., Grayson 1988, 1989; Grayson and Meltzer 2002, 2003; Meltzer 1993).

Other writers have disagreed with the view of Clovis-era people as megafauna specialists. For example, Hemmings (2004: xi) proposed 116 species of plants and animals had “clear evidence of utilization by Early Paleoindians,” out of a total of 352 different species recorded in 246 sites. Although acknowledging that “Clovis people had a clear preference for mammoth and mastodon” (Hemmings 2004: xi), Hemmings concluded that Clovis people had a generalist foraging adaptation.

Several writers (e.g., Grayson 1991, 2001; Grayson and Meltzer 2002, 2003) underscore that there is no empirical evidence (such as bones associated with lithics) proving humans hunted most of the continent’s largest mammalian species in the late Pleistocene. A recurring argument is also put forward that the largest animals outnumber the smaller ones in the sample because their bones preserve better and are easier to find than small mammal bones. This may be true, but it does not prove that Paleoindian people chose small game more often than we see in the archaeological record (Surovell and Waguespack 2009: 96; Waguespack and Surovell 2003).

More recently, Cannon and Meltzer (2004, 2008) reviewed evidence about animals that “Early Paleoindian” people chose to exploit, and concluded that foragers of the Late Glacial hunted the most abundant or convenient faunal species found in different regions of the continent, and were therefore not big-game specialists. Referring to virtually the same body of data, Surovell and Waguespack (2009) concluded that Clovis-era people clearly decided to hunt big-game even when smaller animals must have been more abundant, implying a pattern that some might call “specialization” but which is not really an obligate self-limitation, rather a strong and rational preference.

This is the state of the discourse at present—no assignment of Clovis-era foragers as specialists or generalists satisfactorily explains the data. In this paper we present a sampling of evidence about subsistence, rather than each and every claim that has been advanced, and we discuss the implications.

## Materials and Methods

### *Clovis-era Diets: What Is the evidence?*

Three lines of evidence about Clovis-era dietary choices are summarized here (following Haynes 1998). First and most important is empirical evidence. Clovis-era sites sometimes contain remains of animals and plants used by people, such as bones with cutmarks or burned seeds in fire features. Another possible type of empirical evidence is protein/blood residue identified on stone tools, although analytical results of this method are subject to doubt by some scholars (e.g., Eisele et al. 1995; Fiedel 1996). We present some results of this method with caution.

A second line of evidence—more a line of reasoning than actual evidence—is based on ethnographic analogy. We briefly consider some potential issues after our description of the empirical data. Another line of reasoning, distinct from actual evidence, comes from the application of social theories when interpreting archaeological assemblages. We consider some possibilities below after discussing ethnographic analogy.

### *Empirical Evidence of Clovis-era Diet: Fauna*

For our sample, we start with the sites that Cannon and Meltzer (2008) listed as containing the strongest evidence of diet, but we have made additions and deletions after reexamining the available data. Cannon and Meltzer (2004, 2008) evaluated taphonomy in deciding which sites and assemblages to include and which to reject from their list of archaeological assemblages yielding compelling evidence about human prey choices. A possible problem they note is that earlier excavators of Clovis sites did not always screen sediments, so smaller faunal materials—if they had been present—would have gone unnoticed, potentially biasing species lists. Also, the supportability of claims about stone-tool-made cutmarks or human-made bone breaks should be rigorously examined. It is beyond the scope of our own paper to make a more rigorous and hands-on taphonomic analysis of every site in the list, but we think much more than desktop taphonomy must be done.

Two Cannon and Meltzer papers (2004, 2008) list several site faunules from an “Early Paleoindian” period. The 2004 paper includes several that are older than Clovis, while the 2008 paper includes only one older site, Hebior, which did not contain Clovis artifacts. Hebior does not belong in our Clovis-era list, although we do consider it and other older sites after first surveying only the Clovis era. We also deleted Pleasant Lake from the list because it contained no lithic tools and its dating is uncertain. Several other mastodons from Michigan similar to the Pleasant Lake find have been interpreted as butchered by people (Fisher 1984a, b), and some archaeologists have accepted the sites as Paleoindian. These other sites were not included on Cannon and Meltzer’s list and are not on our Clovis-era list.

Other sites on the Cannon and Meltzer (2008) list may not belong if they do not provide evidence about Clovis food remains. We refer here to Lewisville as an example, but we think all sites in the list need reexamination.

Lewisville has nine mammalian genera in its faunal list, including numerous small rodents, far more taxa than any other Clovis-era site. Only six lithic items were found at the site (Crook and Harris 1957), following earth removal during dam construction in the 1950s. A reworked Clovis point was stuck in a burned red clay feature interpreted as a hearth, an enormous hearth as it turns out, measuring 8 by 10 ft across and extending to a depth of 36 in., one of 21 burned sediment features mapped as hearths. The site fauna may not reflect human subsistence practices. Heizer and Brooks (1965: 228) wrote that “it would be hard to point to a more confusing instance of collecting, recording, and incompetent reporting” of such a potentially important site. Two radiometric dates in excess of 37,000  $^{14}\text{C}$  yr BP were much too old for Clovis, and the inferred original depth of the Clovis point, supposedly well below the original paleo land surface, led some authorities to wonder if the point was intrusive or planted and the so-called hearths were actually burned rodent nests (Graham and Heizer 1967; Heizer and Brooks 1965; Krieger 1962; Sellards 1960: 161–62). Another site situated on the same Trinity River terrace as Lewisville, Lagow Sand Pit (Crook and Harris 1957; Shuler 1923), contained a Holocene human skeleton intrusive into fauna-bearing Pleistocene sediments (Crook 1961; Oakley and Howells 1961), suggesting that a similar mixing of materials of very different ages may have occurred at Lewisville. The site was reexamined in 1979 and 1980 during a low-water period (Stanford 1983), and the burn features mapped by Crook and Harris (1957) were reinterpreted as Clovis hearths dug into older sediments containing pre-Clovis animal bones, mixing materials of different ages.

The inclusion of just this one site, Lewisville, with its unusually wide variety of small animal taxa, has a significant effect on any comparative analysis of the breadth of Clovis-era diets. We have kept Lewisville in our list without adding to or subtracting from species in the Cannon and Meltzer list, to avoid what Cannon and Meltzer (2008: 7) call a “myopic focus on megafauna when it comes to the Late Pleistocene.” Still, we contend the evidence from this site, and probably others such as Aubrey (Yates and Lundelius 2001), should be taphonomically reexamined to avoid an uncritical and equally myopic bias towards small (and potentially noncultural) fauna.

At this point we begin our reconsideration of Clovis diet with a list of 20 Clovis-era assemblages from 19 sites (Tables 17.1 and 17.2) deemed relevant by Cannon and Meltzer (2008). Including carnivores, there are 164 animals (121 large, 43 medium/small) represented from 19 genera. If we exclude the four carnivore genera and their 10 individuals, following Cannon and Meltzer, the sites in our list contain a minimum number of 117 large mammals from 7 genera (adult body weights over 100 lbs [44 kg]), and 37 medium/small mammals from 8 genera. Cannon and Meltzer (2008) analytically distinguished “large herbivore” (adult animal weighing over 44 kg) from “megafauna” (equated only with proboscideans, bison, horse, and camel) in their analysis of regional differences in diets. The mean proportions of large herbivores and mega-

fauna in the Eastern sites discussed by Cannon and Meltzer (2008) were 77% and 49% respectively, while the proportions of large herbivores and megafauna in the Plains were 100% and 100%, and in the Western sites the proportions were both 95%. In our edited list, the mean Eastern proportions are 72% large herbivores and 37% megafauna, and the mean Plains and Western proportions are unchanged. Deleting Heibior and Pleasant Lake significantly lowers the proportion of megafauna in eastern sites, but has less notable effect on large-herbivore proportion. If we deleted Lewisville, the proportions of megafauna and large herbivores in Eastern sites would be higher.

If Lewisville’s unusual faunal list does provide Clovis-era dietary evidence to the extent that Cannon and Meltzer (2008) believe, the wide variety in the Eastern diet may result from the greater biotic diversity in the sites’ geographic locations. Many sites in the East (and some in the other regions) are located within transitional, ecotonal environments where different physiographic provinces meet and where biotic diversity would be relatively higher than deeper within the provinces. Some Eastern sites are also near the Great Lakes and the Atlantic and Gulf of Mexico coasts (Cannon and Meltzer 2008: 12, their fig. 3), subregions with relatively higher biotic diversity than in the Plains and West.

At first sight the numbers certainly suggest that Clovis foragers, in general, disproportionately ate the largest animals, at least in the West and Plains. Surovell and Waguespack (2009) proposed on several grounds that the largest animals were deliberately selected. A statistical analysis of Paleoinian faunas shows that smaller animals with predictably higher taxonomic diversity and encounter rates must have been deliberately passed up. The appearance of size-related hunting is *prima facie* evidence of a preference for the largest animals. Surovell and Waguespack do not label this Clovis-era preference for megafauna a “specialization,” except insofar as it shows deliberate hunting choices were made on the basis of body size; but Clovis-era people were also apparently willing to change their hunting behavior (that is, switch prey) when larger mammals were seasonally difficult to locate, when the megafauna became extinct, or when risks of hunting failure had to be reduced.

Other sites not included in the Cannon and Meltzer (2004, 2008) lists may contain useful evidence about human involvement with the animal carcasses. Some of the additional sites are not well published, or the publications provide equivocal evidence, but we consider them here to avoid overlooking all possibilities. Table 17.3 lists the sites (and references) brought forward for an expanded inventory relevant to Clovis-era subsistence.

The first site added to the list is Coats-Hines, TN, interpreted as a mastodon-butcherer locus created in pond deposits. At least two mastodons were found in apparent association with undiagnostic stone tools, lithic flakes, a possible bone point tip, an antler tine, and bones of deer, muskrat, canid, rodent, turkey, and turtles. One mastodon vertebra is said to be cutmarked, but the specimen has not been pub-

**Table 17.1** Sites with occurrences of mammalian taxa showing possible evidence for human subsistence use in the Clovis-era, edited from Cannon and Meltzer (2004, 2008, where references can be found). The two Blackwater loci are included as parts of a single site. In most cases, we have used the MNI counts in Cannon and Meltzer (2008), or estimated an MNI of 1 based on very low bone counts; however, in the cases noted, we have used MNI counts from other sources. Question marks indicate incomplete or unclear data.

Site/assemblage	Taxa (MNI)	Notes
Alexon (Wacissa River), FL	Bison (MNI=1)	May post-date Clovis (Cannon and Meltzer 2008)
Aubrey, TX	Gopher (MNI=1?); deer (MNI=1?); bison (MNI=1?)	Numerous other taxa were also found in the Clovis camp areas (Yates and Lundelius 2001)
Blackwater BSW and Blackwater GS, NM	Mammoth (MNI=7?); bison (MNI=1?); horse (MNI=1)	Hester (1972:170) refers to seven mammoth kills with artifacts
Bull Brook, MA	Caribou (MNI=1); beaver (MNI=1)	
Colby, WY	Mammoth (MNI=7)	
Dent, CO	Mammoth (MNI=14)	Saunders (2007) counted 14 mammoths
Domebo, OK	Mammoth (MNI=1)	
Escapule, AZ	Mammoth (MNI=1)	
Jake Bluff, OK	Bison (MNI=15)	
Kimmswick, MO	Mastodon (MNI=2?); deer (MNI=1?)	Numerous other taxa were found in two Clovis levels (Graham et al. 1981; Graham and Kay 1988)
Lange-Ferguson, SD	Mammoth (MNI=2)	The fluted points were not excavated within the mammoth bonebed (Hannus 1990), but were found nearby in a comparable stratum
Lehner, AZ	Mammoth (MNI=13); camel (MNI=3); bison (MNI=4); bear (MNI=2)	
Lewisville (1950s), TX	Horse (MNI=8); deer (MNI=9); wolf (MNI=2); cottontail (MNI=13); prairie dog (MNI=8); woodrat (MNI=4); vole (MNI=1); Deer mouse (MNI=8); raccoon (MNI=5)	
Lubbock Lake, TX	Mammoth (MNI=3)	Johnson (1987:121-123) also interprets as butchered one <i>Camelops</i> (camel), one <i>Arctodus</i> (short-faced bear), and two <i>Equus</i> (horse) individuals
Miami, TX	Mammoth (MNI=5)	
Murray Springs, AZ	Mammoth (MNI=2); bison (MNI=11) <sup>1</sup>	The MNI counts are from C. V. Haynes and Huckell 2007)
Naco, AZ	Mammoth (MNI=1)	
Udora, Ontario	Caribou (MNI=1?); hare (MNI=1?); Arctic fox (MNI=1?)	
Whipple, VT	Caribou (MNI=1?);	

<sup>1</sup> A skull of a 12th bison was also found, separated from the area 4–5 main concentration of bison bones

lished and described adequately. The mastodon may represent human subsistence, but perhaps some of the other taxa may be natural (“background”) occurrences, which would be common in pond deposits. Radiometric dates from above, within, and below the marked mastodon bones range from  $10,260 \pm 240$  <sup>14</sup>C yr BP to  $14,750 \pm 220$  <sup>14</sup>C yr BP.

The second site is El Fin del Mundo in northern Mexico, with two buried bone beds and several other loci, including an upland campsite. The upper bone bed included the remains of two disarticulated juvenile gomphotheres, buried under diatomaceous deposits in valley fill, along with five lithic flakes. Two Clovis points were found nearby. Dates on the upper bone bed have been published as about 13,000 calendar years. The lower and older bone bed, containing bones of horse, tapir, bison, and mastodon, yielded no artifacts, and does not represent human subsistence. The camp locus contained hundreds of lithic tools, including fragmentary Clovis points, blade cores, and scrapers. More detailed information about this important locality should be forthcoming.

Pleasant Lake, MI, is the third site we add to the list. Can-

non and Meltzer (2004, 2008) had included it in their “Early Paleoindian” sites showing acceptable evidence about subsistence. A single mastodon’s bones exposed by dragline excavation were surface marked and broken, interpreted as done by people, but no artifacts were associated with the bones. We have doubts that the skeleton actually does provide evidence of human butchering practices, but as with Lewisville we include the site to give it the benefit of the doubt. No direct radiocarbon dates are available, but a post-Clovis date (roughly 10,400 <sup>14</sup>C yr BP) came from wood within a tusk pulp cavity and a pre-Clovis date (roughly 12,000 <sup>14</sup>C yr BP) came from organics below the bones.

The fourth site added is Lindsay, MT, a single adult mammoth buried in loess, directly dated variously from 9,500 to 12,500 <sup>14</sup>C yr BP. The more recent dating is at the oldest end of the range, but prior dates averaged  $11,210 \pm 190$  <sup>14</sup>C yr BP. Some bones were interpreted as stacked, battered by stones, and cutmarked, but no flaked-stone artifacts were found with the bones. Some breaks appeared to have been made when the bones were fresh or near fresh, possibly by trampling or

**Table 17.2** Summary of data from Table 1, showing numbers of occurrences of mammals (arranged roughly by decreasing body size) in Clovis-era sites with evidence for human diet choices, based mostly (see text) on Cannon and Meltzer (2004, 2008). Note that carnivores are included in this and Table 1; bear and wolf are counted as “large mammals.”

Taxon (common name)	Number of sites (occurrences)	Minimum number of individuals (MNI)
Mammoth	11	56
Mastodon	1	2
Horse	2	9
Camel	1	3
Bison	6	33
Caribou	3	3
Deer	3	11
Bear	1	2
Wolf	1	2
Raccoon	1	5
Arctic fox	1	1
Beaver	1	1
Prairie dog	1	8
Gopher	1	1
Hare/cottontail	2	14
Woodrat	1	4
Deer mouse	1	8
Vole	1	1

animal gnawing, although humans cannot be ruled out as agents of some breakage. A few marks may have been made by stone tools, although others appear to have been created by steel tools (Krasinski 2010).

The fifth site added to the Clovis list is DUEWALL-NEWBERRY, TX, containing the partial skeleton of a single adult mammoth eroding out of stratified alluvial sediments in a cutbank of the Brazos River. Some elements apparently had been broken by impact (or trampling) when in fresh or near-fresh condition; others had weathered before breaking; some had carnivore gnaw damage on them; and some may have been cut by stone tools (Krasinski 2010). No lithic artifacts were found, and the bones could not be directly dated, although a terminal Pleistocene age is suggested by the stratigraphic position.

A sixth site (actually a locality with several find spots) is WALLY’S BEACH, ALBERTA, where one set of *Equus* bones was cutmarked and partly articulated and six other *Equus* bone loci were lithic-associated (Kooyman et al. 2006). Also found in the locality were cutmarked, partly articulated bones of one *Camelops* and nondiagnostic lithic implements (Kooyman et al. 2012). Several dates on bones establish a Clovis-era age for various large-mammal taxa at the locality, ranging between 11,000 and 11,350 <sup>14</sup>C yr BP (Kooyman et al. 2001). The locality also yielded fluted points, two of which tested positive for horse-protein residue and one for bovid, interpreted as either bison or helmeted musk ox (discussed below) (Kooyman et al. 2001:687).

Other sites with cutmarked or broken bones may be worth considering, but we do not include all of them in our revised list because the evidence is still equivocal. Examples are the mastodons from Michigan, as mentioned above, interpreted as killed by humans, based on certain characteristics of the bones and the season of death. Another example is the Stolle mammoth found in 1977 in a New Mexico playa, not far from the Clovis type site Blackwater Draw. No lithic tools were found in association, although a caliche boulder and cobble were near the single animal’s partly articulated bones, and one bone fragment had unusual deep cuts (C. V. Haynes pers. comm. 2012). The stratigraphic position of the bones below a black mat indicates a Clovis age.

Another kind of empirical information about Clovis-era diets may come from protein- or starch-residue analysis. In theory, animal and plant proteins and starch on lithic specimens should be detectable by recording the residue morphologies or by measuring protein reactions with specific antibodies. Lab procedures have been developed to identify biotic taxa from certain kinds of residues, but some may be prone to misidentification (Haslam 2006) or to giving false positives, especially the more sensitive protein-detection methods (Eisele et al. 1995; Fiedel 1996; Jähren et al. 1997; Wadley and Lombard 2007; see Gundy 2008 and Vish 2008 for more recent reviews). Many researchers think this kind of analysis is valid and acceptable, so we present some results here, although with a note of caution. Table

**Table 17.3** Other Clovis-era sites with possible evidence for mammal hunting.

Site	Animal (common name)	Archaeological evidence	References
Coats-Hines, TN	Mastodon (MNI=2)	Nondiagnostic lithics; purported cutmarks on bones	Breitburg et al. 1996; Deter-Wolf et al. 2011
El Fin del Mundo, Sonora, Mexico	Gomphothere (MNI=2)	Fluted points near bones bedded with flakes	Holliday et al. 2009; Mentzer 2009; Sanchez and Carpenter 2013; Sanchez et al. 2009
Pleasant Lake, MI	Mastodon (MNI=1)	Broken and marked bones; no lithic tools	Fisher 1984a,b
Lindsay, MT	Mammoth (MNI=1)	Broken bones; no lithic tools; possible cutmarks	Davis & Wilson 1985; Hill and Davis 1998; Krasinski 2010
Duewall-Newberry, TX	Mammoth (MNI = 1)	Broken bones; no lithic tools; possible cutmarks	Steele and Carlson 1989
Wally’s Beach, Alberta	Camel (MNI = 1); Horse (MNI = 7)	Cutmarked bones, lithics	Kooyman et al. 2001, 2006, 2012

17.4 lists positive results for the presence of protein residue on lithic materials, which may be subsistence evidence. Not all the lithic items in this list have been unambiguously identified as part of Clovis technology. The items labeled “Gainey” may have been manufactured rather later than classic Clovis points. Similarly, two other specimens often thought to postdate Clovis have positive results for “elephant” (presumably mammoth or mastodon); these are a stemmed point from Utah and an unfluted lanceolate from Oklahoma. If the results on each of these possibly post-Clovis specimens are not false positives, the items may indeed date to the Clovis era, before proboscidean extinctions; or, alternatively, mammoths and mastodons did not become extinct until later than Clovis when the points were in use. Other examples that could have been added to the list but were left off to avoid overemphasizing residue analysis are: Fluted points from two sites in the Great Basin with positive results for deer, bear, bighorn sheep, and turkey or goose (Mullins and Herzog 2008); two unstratified Alaskan microblade assemblages (Gerlach et al. 1996) of uncertain ages, with positive results for deer, human, rabbit, sturgeon, bear, cat, and mouse; Alaskan fluted points (Dixon 1993; Loy and Dixon 1998), which may postdate the Clovis era, with positive results for mammoth, bison, and sheep; and, from Paisley Cave No. 2 (OR), a smooth cobble excavated from a level dated >200 years older than Clovis, which had elephant protein identified on it, according to a public presentation made at the University of Nevada, Reno, by D. Jenkins (2011 pers. comm.), but which has not yet appeared in a print publication. Our list should be considered only a sampling of the reports available about residue analysis.

Yet another set of sites may provide further evidence about a long-lasting pattern of large mammal hunting in the

Late Glacial. These occurrences may be part of a proto-Clovis phase of early human dispersal in North America just before the invention or earliest archaeological visibility of fluting. They date 1,000–3,000 years before the oldest Clovis date ( $\sim 11,550 \pm 14\text{C yr BP}$  from Aubrey, TX). Sites dating significantly earlier than this, such as localities with mammoth limb bones interpreted as broken by humans 40,000–20,000 years ago (during the Middle Wisconsin) or 20,000–15,000 years ago (during the Last Glacial Maximum) (Holen 2006, 2007, 2012, and this volume) are not included here; their temporal separation from the Clovis era seems excessive, and they do not have associated cultural materials that could link them technologically or behaviorally to Clovis.

The possible existence of a span of time with a lithic technology lacking fluted bifaces, a proto-Clovis phase such as proposed by Haynes (2002:253) and others (e.g., Ferring 2012), is suggested to us by three sets of evidence:

- (1) the lithic assemblages recovered from the deepest levels at the Debra Friedkin site in Texas (Waters et al. 2011b), OSL-dated with large standard errors to up to 3,000 years older than the site’s presumed Clovis level, and which contain lithic materials very much resembling Clovis in manufacturing and implement classes, hinting at an ancestral relationship to Clovis;
- (2) mammal hunting/butchering sites with non-Clovis artifacts and dating up to 1,500 years older than Clovis;
- (3) indirect indications that localized megafaunal populations may have suffered abrupt collapse between about 2,500 and 1,000 years before Clovis in the eastern United States.

In this last case, data come from buried stratified sediments in New York State and Indiana (Gill et al. 2009; Rob-

**Table 17.4** Positive identifications from residue studies of possible/probable Clovis-era materials, arranged alphabetically. Note that “human” identified from East Wenatchee has not been included in any discussion of subsistence. “Bovid” is entered as Bison.

Site/locality	Taxa with “positive ID”	References
34BV177, OK (unfluted lanceolate [Plainview] point) <sup>1</sup>	Elephant	Puseman 2004
42T05135, UT (Haskett stemmed point) <sup>1</sup>	Elephant	Duke 2013 pers. comm.; Yost 2013
East Wenatchee, WA	Human, bison, [other?] bovine, deer, rabbit	Gramly 1991, 1993
Mahaffy cache, CO (Clovis?)	Sheep, bear, horse, camel	Yohe and Bamforth In Press
Martins Creek, OH [undiagnostic lithics, mastodon and deer bones]	Elephant, deer	Brush & Smith 1994; Brush & Yerkes 1996; Brush et al. 1994
Nobles Pond, OH (Gainey tools, mostly endscrapers)	Deer, bear, caribou, elk, rabbit, cat, dog, guinea pig, mouse, chicken <sup>2</sup>	Seeman et al. 2008
Shoop endscrapers, PA	Cervid (for 1 of 15 tested endscrapers)	Hyland et al. 1990
Wally’s Beach, Alberta	Bovid (either bison or helmeted musk ox?), horse	Kooyman et al. 2001
Western Iowa northern loess hills Gainey point	Cervid	Molyneaux 2000

<sup>1</sup> Point type previously thought to postdate Clovis.

<sup>2</sup> Some genera at Nobles Pond were identified on small numbers of tested items and may be false positives or soil contamination, such as “guinea pig” and “chicken” (Seeman et al. 2008:Table 2).

inson et al. 2005; Robinson and Egan 2012), where the relative abundance of *Sporormiella* dramatically declined before changes in fire regime or climate occurred; *Sporormiella* is a fungus that thrives in megafaunal dung (Davis and Shafer 2006) deposited in and around ponds and wet areas. Although changes in salinity and water depth could have affected the *Sporormiella* concentrations, another possible inference is that megafaunal numbers collapsed locally due to human hunting. We note that numerous other sites in New York State have yielded mastodon and mammoth skeletons that postdate the time of the *Sporormiella* drop-off (Feranec and Kozlowski 2012), possibly because low-density and very mobile human hunting before Clovis affected only some of the region's proboscideans.

Table 17.5 lists four additional sites with artifacts and megafaunal bones that predate Clovis, within our suggested proto-Clovis phase, specifically

- (1) Manis, WA, a mastodon site several centuries older than Clovis, which contained a bone splinter or point embedded in a rib (Waters et al. 2011a);
- (2) Hebior; and
- (3) Schaefer, two mammoth sites in Wisconsin about 1,500 years older than Clovis, with nondescript lithics in association (Joyce and Blarina-Joyce 2002; Overstreet and Kolb 2003). A third mammoth discovery from Wisconsin, Mud Lake, is not included here because proposed butchering marks (Johnson 2007) have not been verified (Krasinski 2010).
- (4) Firelands, OH, with a cutmarked femur from a Jefferson's ground sloth, dated  $11,740 \pm 35$  <sup>14</sup>C yr BP, which is 200 <sup>14</sup>C years or more older than Clovis (Redmond et al. 2012).

If these four Late Glacial sites, all older than Clovis, are indicative of human-foraging behavior, they show that human choices to hunt and process the very largest land mammals began centuries before the Clovis-era and continued through it, a patterned foraging choice with a long history.

Table 17.6 is the expanded list of sites (n=37, MNI=202, or 190 without carnivores) showing possible evidence of

**Table 17.5** Sites dating up to 1,500 years before the Clovis era, interpreted as containing subsistence remains. These are considered to belong to a proto-Clovis period, when human populations directly ancestral to Clovis had not yet developed the distinctive biface fluting.

Site	Evidence, date	References
Manis, WA	Mastodon (MNI = 1), bone splinter/point embedded in rib	Waters et al. 2011a
Hebior, WI	Mammoth (MNI = 1), associated lithics	Overstreet and Kolb 2003
Shaefer, WI	Mammoth (MNI = 1), associated lithics	Joyce and Blarina-Joyce 2002
Firelands, OH	Jefferson's Ground Sloth (MNI = 1), no lithics, cutmarked bone	Redmond et al. 2012

proto-Clovis and Clovis-era utilization of mammalian taxa, including the Cannon and Meltzer (2004, 2008) sites plus other large-mammal sites mentioned above, and the protein-residue sites.

If we apply the same analysis as Cannon and Meltzer (2008) did to this larger list (Table 17.7), distinguishing "large herbivores" from "megafauna," the mean proportions for the East site faunules are 80% large herbivores and 55% megafauna; for the Plains, the mean proportions are 100% and 94%; and for the West, the mean proportions are 82% and 90%. Cannon and Meltzer (2008) performed a multifactor analysis that incorporated presence of hearths and recovery method and calculated the (weighted) means as 2.4 genera per site in the East, 1.29 in the Plains, and 1.8 in the West, which differ significantly. Without the multifactor analysis, the variety in mammalian taxa eaten per site in the three different regions is a bit more similar; the mean number of genera is 2.21 per site in the East, 1.78 per site in the Plains, and 1.67 per site in the West. The mean number of mammal genera per region is significantly different (p = 0.751), but we note that the possibly questionable small genera from just two sites, Lewisville and Nobles Pond, are strongly influencing the calculations.

**Table 17.6** Complete list of mammalian taxa, arranged roughly by decreasing body size, and numbers of occurrences dated to the proposed contiguous proto-Clovis to Clovis periods; data sources are Cannon and Meltzer (2004, 2008), the blood residue cases, and published information about the additional archeological sites mentioned in the text. Note that "bovid" and "bovine" are included here as Bison, although they may be musk ox (or cattle?); the taxon "human" (from Table 4) is not included.

Taxon	Number of sites	Minimum number of individuals (MNI)
Mammoth	15	60
Mastodon	4	6
Gomphothere	1	2
"Elephant"	3	3
Jefferson's Ground Sloth	1	1
Horse	4	17
Camel	3	5
Bison	9	36
Elk	1	1
Caribou	4	4
Deer	6	14
Cervid (indeterminate)	2	2
Sheep	1	1
Bear	3	4
Wolf	1	2
Raccoon	1	5
Arctic fox	1	1
Beaver	1	1
Prairie dog	1	8
Gopher	1	1
Hare/cottontail	3	15
Woodrat	1	4
Deer mouse	1	8
Vole	1	1

**Table 17.7** Numbers per site of all mammal genera, large herbivore genera, and megafauna genera in the combined proto-Clovis and Clovis sites, organized by region (East, Plains, West), following Cannon and Meltzer (2008).

Assemblage	Region	Mammal genera	Large herbivore genera	Large herbivore proportion	Megafauna genera	Megafauna proportion
34BV177, OK	East	1	1	1.00	1	1.00
Alexon (Wacissa River), FL	East	1	1	1.00	1	1.00
Aubrey, TX	East	3	2	0.67	1	0.33
Bull Brook, MA	East	2	1	0.50	0	0.00
Coates-Hines, TN	East	1	1	1.00	1	1.00
Duewall-Newberry, TX	East	1	1	1.00	1	1.00
Domebo, OK	East	1	1	1.00	1	1.00
Firelands, OH	East	1	1	1.00	1	1.00
Hebior, WI	East	1	1	1.00	1	1.00
Kimmswick, MO	East	2	2	1.00	1	0.50
Lewisville (1950s), TX	East	9	2	0.22	1	0.11
Martins Creek, OH	East	2	2	1.00	1	0.50
Nobles Pond, OH	East	9	4	0.44	0	0.00
Pleasant Lake, MI	East	1	1	1.00	1	1.00
Shaefer, WI	East	1	1	1.00	1	1.00
Shoop, PA	East	1	1	1.00	0	0.00
Udora, Ontario	East	3	1	0.33	0	0.00
Western Iowa northern loess hills	East	1	1	1.00	0	0.00
Whipple, VT	East	1	1	1.00	0	0.00
Mean		<b>2.21</b>		<b>0.80</b>		<b>0.55</b>
Blackwater BSW and Blackwater GS, NM	Plains	3	3	1.00	3	1.00
Dent, CO	Plains	1	1	1.00	1	1.00
Jake Bluff, OK	Plains	1	1	1.00	1	1.00
Lange-Ferguson, SD	Plains	1	1	1.00	1	1.00
Lindsay, MT	Plains	1	1	1.00	1	1.00
Lubbock Lake, TX	Plains	1	1	1.00	1	1.00
Mahaffy cache, CO	Plains	4	4	1.00	2	0.50
Miami, TX	Plains	1	1	1.00	1	1.00
Wally's Beach, Alberta	Plains	3	3	1.00	3	1.00
Mean		<b>1.78</b>		<b>1.00</b>		<b>0.94</b>
42T05135, UT	West	1	0	0.00	1	1.00
Colby, WY	West	1	1	1.00	1	1.00
East Wenatchee, WA	West	3	2	0.67	1	0.33
El Fin del Mundo, Sonora, Mexico	West	1	1	1.00	1	1.00
Escapule, AZ	West	1	1	1.00	1	1.00
Lehner, AZ	West	4	3	0.75	3	0.75
Manis, WA	West	1	1	1.00	1	1.00
Murray Springs, AZ	West	2	2	1.00	2	1.00
Naco, AZ	West	1	1	1.00	1	1.00
Mean		<b>1.67</b>		<b>0.82</b>		<b>0.90</b>

***Another Possible Consideration besides Empirical Data: Ethnographic Analogy as a Guide to Diet***

Studies of historic-period hunter-gatherers may or may not provide useful models for understanding human dietary choices in the past, keeping in mind the possibly unknowable differences between modern peoples and late Pleistocene human populations. Ethnographies are snapshots of recent foragers who live in a developed world, and their behavior may be different from that of prehistoric foragers

whose ability to disperse and explore was far less limited. Except for Inuit whalers, subsistence hunters of very large mammals can almost never be found in the world anymore. Modern foragers, many of them hunting and gathering only part-time, usually target medium and small game animals, which are more abundant than larger animals, and they may rely more on collected plant foods than on hunted game animals (see Lee 1968; Silberbauer 1981; Tanaka 1976 for discussion of Central Kalahari San subsistence). By developing



these sorts of observations into a line of reasoning, some prehistorians may be inclined to believe that fluted-point-makers rarely tried to kill the very large Pleistocene mammals, instead choosing to forage entirely for smaller game animals, plant foods, and aquatic resources, in proportion to patchy occurrences. Even so, recent foragers in temperate and northern latitudes hunt and gather in regionally distinct ways, depending on seasonality of resource availability, abundance of preferred resources, abilities to move freely in the landscape, and other contingencies. For example, some male hunting is as much for show as for procuring meat (Bliege Bird and Smith 2005; Bliege Bird et al. 2001; Hawkes and Bliege Bird 2002; Smith et al. 2003), and large mammals may be actively pursued in spite of high risks and costs. Significant differences may have existed between the hunting behaviors of recent foragers and the predicted behavior of Pleistocene foragers, as suggested by the preponderance of large mammals in the Late Glacial sites.

#### *Yet Another Possible Consideration: Theoretical Models as a Guide to Diet*

Several general and middle-range theories can be applied to the study of Late Glacial hunter-gatherers, including, for example, theories of optimization, human behavioral ecology (Bettinger 1991; Kelly 1995), and nutritional ecology (Haws and Hockett 2004; Hockett 2012). Optimization Theory may be used to predict that mammoths would not have been deliberately hunted, because mammoths were rapidly becoming extinct at the time fluted-point-makers were seeking food. Disappearing species are suboptimal choices to hunt since they are hard to locate, as Marginal Value Theorem has sometimes been interpreted to predict. Based on this reasoning, and taking into account the ethnographic snapshots of foraging behavior mentioned above, a belief may be widespread among archaeologists that fluted-point-makers foraged only for the more commonly encountered game animals, plants, and aquatic resources locally and did not regularly or frequently hunt large mammals that were on their way to extinction. It has also been argued that rational human beings do not optimally forage only by balancing caloric returns against temporal and caloric expenses (Haws and Hockett 2004; Hockett 2012), because they also have taste preferences, nutritional needs besides energy, and cultural constraints such as taboos.

Byers and Ugan (2005) argued that very large mammals are too costly to hunt and process, and that it would have been impractical for Paleoindians to specialize in hunting them. Byers and Ugan compared a range of animals, from mammoth size down to small squirrels and waterfowl, and made a case that the per-hour returns from pursuing, killing, and processing the largest animals (e.g., mammoths, bison, and even deer) would be outweighed by the returns from the smaller animals to be found in greater abundance and requiring much less search and processing times. As Surovell and Waguespack (2009) have argued, the Byers and Ugan optimization modeling implies a negative correlation between prey

body size and archaeological abundance in sites, yet Clovis-era sites show a positive correlation, as do other archaeological finds around the world. A potential fault in the Byers and Ugan modeling is the model's suite of predicted encounter rates, estimated using allometric scaling of body size and spatial density, which may be much different from actual encounter rates in different parts of the real world. Animals are not randomly or evenly distributed in space, especially herding species. Another weakness is the estimation of carcass-handling times—Clovis-era people did not fully utilize the carcasses of many mammoths they killed, which means the costs of processing were much reduced (and the energy yield was also reduced). We discuss this possibility below.

#### *Discussion of the Faunal Evidence*

The total number of archaeological sites or localities containing mammals is 37 in our combined Clovis-era and proto-Clovis list, with a minimum of 152 large mammals (not counting 6 large carnivores) and 38 medium/small mammals (not counting 6 small carnivores) (Table 17.6). Note that a number of other animals, such as a horse from Murray Springs (represented only by teeth) and a possible bison from Lange-Ferguson lacking descriptive data, have not been included in this list. Is this list useful or adequate for speculating about meat in the Clovis-era human diet in a continental area the size of southern Canada, the 48 continental United States, and northernmost Mexico?

The 37 sites or localities in the list are almost all open air (except for the underwater Alexon site), most dating to within 1,500 years of each other. This number of fauna-bearing sites is astonishing for the short chronometric range, especially because the sites are not protected within caves, and for the most part are not long-term camping localities like the Upper Paleolithic limestone caves of western Europe or the coastal cave sites in South Africa, which were occupied repeatedly for thousands of years. Especially unusual is the North American archaeological record of proboscidean kills (Surovell and Waguespack 2008), because a record this rich from such a limited time window is simply not to be found in other parts of the world where proboscideans exist(ed) (see also Surovell et al. 2005; Surovell and Grund 2012).

The proto-Clovis and Clovis-era sites are an adequate sample for validly speculating about human meat-procurement patterns, although the geographic spread of the sites would make a continental pronouncement about Late Glacial diet imprecise. This issue was a main theme in Cannon and Meltzer (2008), too. In other words, Clovis-era subsistence varied region by region, as most likely did proto-Clovis subsistence, but an important identifiable pattern overlies the variability.

One pattern mentioned above is the degree of large-mammal carcass utilization by Late Glacial foragers, which we think reveals another dimension to forager decisions, namely the desire or need to make greater or lesser use of animal carcasses that can be interpreted as reflecting relative hunger, competition for resources, ease of the hunt, or planning for

future needs during anticipated shortages of resources. Based on neo-taphonomic studies (e.g., Haynes 1982, 1991), some features of the mammoth and mastodon assemblages in Tables 17.2 and 17.6 can be seen to reflect the degree of human utilization of the carcasses. Foraging people had first access to proboscidean carcasses, and the carcasses were not merely scavenged by people after carnivore predation or other natural deaths of the animals. Cutmarks have been documented on at least three individual mammoths from Dent, one from Blackwater Draw, one from Naco, one from Lindsay, and one from DUEWALL-NEWBERRY, for certain (Krasinski 2010; Saunders 2007), while others have not been so rigorously examined. The cuts, along with the scarcity or low level of carnivore ravaging traces reported or illustrated in the literature (see Krasinski 2010; Steele and Carlson 1989) and the archaeologically recorded clustering of many skeletal assemblages (for example, closely associated skeletal elements mapped at Blackwater Draw, Domebo, and Colby) bedded with fluted points convince us that mammoths were killed and butchered by small groups of spear-wielding humans. Based on the fineness of cutmarks on some bone surfaces (Krasinski 2010; Saunders 2007), unmodified lithic flakes were likely used in much of the meat stripping or dismemberment. Saunders (2007: 178) has suggested that some butchering at Dent was done serially—partly when the carcasses were fresh and later when they were stiff, although the length of time needed for mammoth carcasses to stiffen in the late-Pleistocene Plains is unknown. Judging from our own experiences in butchering African elephant carcasses in all stages of post-mortem changes, we think the likeliest explanation for cutmarks made on a stiff mammoth carcass would be a frozen carcass, not a carcass dried out from post-mortem passage of time. Observations in Canadian winters of wolf-killed bison (Haynes 1982) have indicated that large animal carcasses do not freeze very quickly even in extreme air temperatures; the great bulk of mammoth carcasses may have prolonged their internal freezing over multiple days and nights. Certainly more experiments could be done in this regard to gain a better idea about stiff-carcass butchering and its implications for human-subsistence behavior.

Mammoth-carcass utilization by people was not heavy in Late Glacial North America, but was comparatively light. This is different from the full utilization made by modern people such as the Efe and Lese of the Ituri Forest, Democratic Republic of the Congo (formerly Zaire) (Duffy 1984; Fisher 1987, 1992). One informant (personal communication from R. Bailey 2004 to Byers and Ugan 2005:1627) described two elephant-butchery events involving 10 men defleshing an elephant in 2.5 hours and 30 people taking 24 hours to process the meat. In all, a total of 745 person-hours may have been expended in processing, not counting travel time to the carcass. Another ethnographic example (Fisher 1992) cited by Byers and Ugan (2005:1627) described three other Efe and Lese elephant butchery events involving 25–35 people taking >100 hours to process the meat, which does not include the time needed to build and tend fires for drying meat. Unlike these events, the Clovis mammoths were not processed to the same extent, and

Clovis group sizes were likely much smaller, judging from the limited cultural debris at many kill/processing sites.

The extreme degree of carcass use by recent elephant-hunters is similar in many ways to what has been documented at Upper Paleolithic Gravettian sites of the Pavlovian phase in central Europe such as Krems-Wachtberg (Austria) and Hohle Fels Cave (Germany) (Fladerer et al. In Press), where burned and extensively fractured mammoth limb bones, if they came from fresh carcasses, suggest full meat consumption and marrow procurement around hearths, perhaps in response to seasonal nutritional shortages. The Pygmy/Gravettian model of maximized use of carcasses contrasts with the Clovis-era model of very light utilization, or satisficing behavior, which is just sufficient to satisfy some immediate needs (Simon 1956). Immediate returns from proto-Clovis and Clovis carcasses were limited, and people abandoned much that was probably still recoverable at each carcass. Both satisficing and maximizing are examples of optimizing strategies, as would be any intermediate levels of carcass utilization. Intermediate utilization is expected if proto-Clovis and Clovis-era people, after weighing all costs and benefits, processed carcasses to satisfy immediate needs but still left usable resources such as meat and articulated body parts because further processing was too costly.

The Clovis-associated mammoths that have been adequately described were not fully utilized, and this may have been a continent-wide pattern. The proto-Clovis Hebior and Schaefer mammoth bones were in close anatomical position but have been described as extensively cutmarked (Johnson 2006, 2007), although the marks may not be butchering traces (marks often mistaken for butchering traces are discussed in Haynes and Krasinski 2012; Krasinski 2010; Krasinski and Haynes 2012). No fresh meat-stripped bones were broken for extracting marrow or grease during the carcass processing, unlike the common practice among modern tribal people when elephant carcasses are processed in Africa, and the mammoth body parts were not scattered as from redistribution of meat among different families or associates. Some Clovis-era mammoth skeletons retained partial or nearly complete anatomical order (such as multiple animals at Blackwater Draw), although others were jumbled from natural redeposition or perhaps discarded in midden heaps (e.g., Dent, Lehner). At Colby, a meat cache has been proposed (Frison and Todd 1986) to explain the mix of partly articulated and partly disarticulated mammoth bones.

Maximized carcass use would have involved extensive bone breakage, absent from almost all Clovis sites, although mammoth limb bones were occasionally broken by Clovis people to make artifacts, such as the Murray Springs bone wrench (a.k.a. spear-shaft straightener) (Haynes and Hemmings 1968). However, in one Clovis-associated mammoth skeletal site with broken but recognizable limb bones (Lange-Ferguson), the fragmenting occurred after the bones were meat-stripped, dried, and not pristinely fresh, sometime before weathering had progressed beyond stage 1 (Behrens-meyer 1978), as seen in Hannus's (1989, 1990) illustrations

of specimens and Pete Bostrum's online photograph of his casts of fragments (<http://lithiccastinglab.com/gallery-page/s/2001septemberlangefergusonpage2.htm>). On some of the Lange-Ferguson fragments there are linear fracture fronts directed by incipient drying cracks, but there is no discernible sign of fresh bone deformation or impact marks from a hammerstone, which experiments show are created whenever fresh bone is broken by dynamic impact (Haynes and Krasinski 2010). Another site with broken mammoth limb bones, Duewall-Newberry (Steele and Carlson 1989), does not have a Clovis association, but its estimated age of 10,000–12,000 <sup>14</sup>C yr BP places it in or near the Clovis-era, and it may be another example of dried/defleshed bone breakage by people. Lubbock Lake also has broken and putatively cutmarked mammoth elements, although large-mammal trampling and sediment abrasion probably account for many modifications that have been illustrated (Johnson 1987, 1989) from this and several other sites. Lange-Ferguson and Duewall-Newberry show a mix of different conditions of mammoth bone—near-fresh (only partly greasy after soft tissue had gone) and early weathering (few drying cracks). Other sites with broken elements, such as the mastodon site of Pleasant Lake, exposed by dragline excavation (Fisher 1984a, b), yielded no lithic tools, and the bone-surface marks and breaks may have been created post-depositionally. Therefore, among the reported Late Glacial sites having lithics associated with proboscidean bones, breakage is rare and did not occur as part of a fresh carcass processing event, reflecting less than maximal use of carcasses.

The incomplete utilization of Clovis-era mammoth/mastodon carcasses indicates the hunting of very large herbivores was not an act meant to provide maximum long-term nourishment, but rather a type of event that provided foraging people with ample immediate returns at deliberately low cost. Such behavior is expected at ecocenters or refugia where resources were locally abundant, and where the hunters were extremely mobile, perhaps in exploratory mode. A more intensive utilization, carrying the enormous costs that Byers and Ugan (2005) argue would have made mammoths too expensive to depend upon, did not occur in the proto-Clovis and Clovis eras.

#### ***Summary of Faunal Evidence: Late Glacial Choices of Animals to Hunt***

We have lumped the few proto-Clovis sites with those of the Clovis-era since they are not so clearly separate in terms of prey choice, carcass utilization, and even chronology. Most contain proboscideans. We think the emerging picture of faunal choices made by Late Glacial humans indicates an efficient subsistence pattern, even if utilization of the largest animals was less than optimal.

The largest animals were non-randomly aggregated (Haynes 2013, 2002:201) during the difficult and climatically unstable millennia following the Last Glacial Maximum, making them simple to track along well-used migration trails and easier for hunters to pursue. The effects of shifting climates

in the Late Glacial probably led to the structured distribution of large mammals, with them clustered around physiographic transitions and ecotones. Similar behavior has been observed in recent times, when large mammals adopt refugial habits (Haynes 2013, 2002). In the lean season, or during lengthy stress periods of drought or vegetation change following climate-change, animals gravitate to parts of their ranges or explore new ranges where resources remain adequate, particularly water, feed, and cover. Human foragers in refugia would rank the largest terrestrial mammals very highly, because of the promise of greatly lessened search cost and much lowered risk of search failure. In such situations, prey are spatially clustered, leave easily recognizable signs in the landscape such as dung or migration trails, and make predictable movements such as treks to water every day (Haynes 2012).

Giving up time for human foraging in particular refugial patches would be rationally extended if animals were perceived as spatially concentrated in those patches. Foragers would expect to continue encountering more animals if they found just one or a few in such patch types. The result in the long run would be opportunistic hunting, in which the largest mammals were actively pursued when their presence was noted, but switching prey to broaden the diet breadth during explorations or travel in non-refugial areas where large mammals were thought to be scarce.

Even under refugial conditions, human hunter-gatherers may have disproportionately selected the largest animals for reasons other than foraging efficiency. Speth (2010; Speth et al. 2013) has suggested socio-political or status-related motives and costly signaling (Bliege Bird et al. 2001; Smith et al. 2003) were possible factors—such as the hunters' desire to heighten status by taking greater than optimal risks and delivering unusual returns.

Eventually, as the largest mammals became scarcer everywhere, including in refugial patches, the effort of deliberately seeking them would have been more and more costly. Yet long-distance searching for relatively scarce large animals can still be an optimal foraging strategy. Grimstead (2010, 2012) showed that foraging up to 100 km from a central residential place is optimal when comparing returns from deer (a "large herbivore" in Cannon and Meltzer's 2008 terms, or "megafauna" in the standard definition of the word) against those from jack-rabbit (a small herbivore), according to Cannon's (2003) Central Place foraging model. That distance may have been no more than a two-day journey for a fit forager or family of foragers. If trails were as visible and habitually used for generations by game animals as they are in Africa's protected national parks, game reserves, and forestry lands, the long-distance tracking of large mammals would have been manageable and relatively uncomplicated. Water sources were important sites regularly visited by large mammals, making them useful places for human groups to monitor. We agree with Surovell and Waguespack (2009; also Waguespack and Surovell 2003) that by the Clovis era, encounters with large mammals, no matter how infrequent, were preferred by very mobile foragers, even if the foragers were not actively searching only for large mammals.

### Empirical Evidence of Clovis-era Diet: Flora

The proportion of plant food in the Clovis-era diet is very difficult to know. Tiny numbers of seeds and plant-food fragments from few sites may be all the evidence we ever have to work with. Hemmings (2004) listed the Early Paleoindian sites he thought had food remains (Table 17.8). The sites yield almost negligible levels of evidence, certainly not an indication of regular dietary intake. Extending the time range of this examination into proto-Clovis does not add more information because so few of the possible Late Glacial archaeological sites with acceptable evidence from the proto-Clovis period have

**Table 17.8** Clovis-era sites with plant remains that may be food items (references and more information are in Hemmings 2004:16-23, and Appendix 2, p. 266; also Haynes 2002: 179).

Site or locality	Spedes (number of occurrences)
Austin Cave, TN	Hickory nut (1)
Gault, TX	Hackberry (4)
Israel River complex, NH	Water lily (1)
Levi Rockshelter, TX	Hackberry (2)
Lewisville, TX	Hackberry (10)
Lubbock Lake, TX	Netleaf hackberry (5)
Shawnee-Minisink, PA	[see Table 9]

yielded botanical remains. Clovis-era Shawnee-Minisink (Dent 1999; Gingerich 2006, In Press) has yielded the most variety of possible plant food items (Table 17.9). However, as Gingerich points out, the amounts of seeds and nut fragments from Shawnee-Minisink would not have sustained anyone and cannot be considered enough for a meal. Hence, the plant food remains were only a supplemental part of the diet at the site, just as the smaller mammals (e.g., deer mouse, woodrat, vole) in the Clovis-era site Lewisville may have been.

This scarcity of plant remains may be a result of either the destructive nature of cooking and diagenic processes, or a signifier of the opportunistic and subordinate nature of botanical food choices. Plant foods must have featured regularly in Late Glacial diets (as they do in most hunter-gatherer diets), because meat and fat do not provide a balanced input of essential nutrients. An all-meat diet would

**Table 17.9** Names and numbers of Shawnee-Minisink edible plant remains (Gingerich In Press, 2006)

Common name	Totals
Acalypha	13
Amaranth	1
Blackberry	15
Buckbean	2
Chenopod, Lambs Quarter, Goosefoot	23
Grape	3
Hackberry	1
Hawthorn	150
Hickory (nut)	5
Smartweed	2
Winter Cress	1
Unidentified plant species	36

not have provided sufficient quantities of iodine, vitamins E, K, and C, and folic acid; hence, some plant foods must have been eaten, regardless of whether or not empirical evidence has been found. However, very little (probably no) specialized grinding technology was deposited at archaeological sites until after the Clovis era, implying little Clovis reliance on the use of small hard seeds or nuts. These kinds of plant foods, such as acorns or grass seeds, became the staples of many later (post-Clovis, Archaic) groups in both Eastern and Western regions. The plant-processing tools themselves should have been preserved even when more fragile plants parts were not, but such tools are rarer than the plant remains. The finds are: a polished food-processing stone from Paisley Cave, which was used once and discarded (Jenkins et al. 2012a, b); one possible grinding stone from Blackwater Draw (possibly used in flintknapping) (Hester 1972); items described as pulping planes or cleavers from Debert, Nova Scotia (MacDonald 1968); and modified cobbles from Michaud, ME (Spiess and Wilson 1987). Some of that scarcity may be a result of later people removing or recycling the tools, but we think the scarcity is a result of the meager need of such technology.

### Clovis-era subsistence: Conclusions

Late Glacial human groups left incomplete or sketchy evidence about their dietary choices, but the existing record from archaeological contexts is potentially more informative and useful than records from many other times and places in the world. We propose the following testable hypotheses about Clovis-era subsistence:

- (1) Fluted-point-makers ate the meat from large, medium, and small animals.
- (2) Very large animals were killed—at least some of them—and not scavenged after death, judging from the presence of cutmarks on bone surfaces that would have been stripped of meat by scavenging carnivores if humans had not been at the carcass very early after the animals' death. The pursuit of the largest mammals was an active venture.
- (3) Late Glacial people did not avoid hunting the largest mammals when extinction began to occur.
- (4) Late Glacial people were not obligate specialists in megafaunal hunting; but even if we deem them to be foraging generalists who hunted and gathered smaller animals and collected plant foods such as roots, berries, and nuts, they nonetheless also hunted megafauna.
- (5) The human use of very large mammal carcasses often reflects satisficing decision making, which was a way to achieve acceptably low levels of return while avoiding some costs.
- (6) Diet breadth was rationally determined from region to region, in keeping with the human practice of foraging for higher-ranked preferences as well as lower-ranked needs.

- (7) Prey-switching clearly occurred when necessary or beneficial.
- (8) Small animals, plant foods, and aquatic resources were procured after active searching.

#### *Variability within the Patterning*

The labeling of proto-Clovis and Clovis-era diets as “generalist” versus “specialists” cannot be supported from the data at hand. These words have different meanings to different researchers, and to brand this discourse as a debate is pointless. To us, the word specialist implies obligate limiting of diet, and the word generalist implies obligate variety in diet. Every human being is a generalist, although there are times when patterned preferences dominate the diet. Rarely or never are hunter-gatherer groups exclusively carnivorous or vegetarian, because such limited diets do not supply all necessary nutrition without the benefit of modern supplements. We accept the probability that proto-Clovis and Clovis-era populations had omnivorous diets—they ate whatever was available if those foods were acceptable or preferred. They made choices about what to pursue and procure, and we think the archaeological record tells us something about those choices, even though the record may be affected by preservational, discovery, and recovery biases. We point out, as did Cannon and Meltzer (2008), that diets varied place to place, although the variability is overlain with a dominance of large mammals when viewed continent-wide. The regional/local variability in diets was nested within what Surovell and Waguespack (2009) recognized as a larger-scale pattern—the opposite of variability. We think important sociological and cultural sense can be made of this seeming contradiction.

When viewed at the largest possible spatial scale, lithic technology is consistent by the time of Clovis, with central features shared over much of the continent south of the shrinking ice sheets for a relatively brief time interval near the end of the Pleistocene. The existence of 13,000 fluted points (Anderson et al. 2010; see the Paleoindian Database of the Americas online, <http://pidba.utk.edu/main.htm>) appearing within a very short time interval reflects the continent-wide human sharing of biface technology within a metapopulation whose component sub-populations shared not only lithic abilities and tastes, but also shared the ability to communicate, which explains the rapid spread of biface fluting. Different sub-populations probably also shared norms of social organization, belief systems, and other aspects of culture, including subsistence behaviors. Over time, founder effects and re-adaptations made fluted-point subpopulations less interested or able to imitate each other.

Diets varied season to season, region to region, and band to band in the Late Glacial interval, but persistent traditions and norms also carried through for centuries from the founding community of the proto-Clovis and Clovis-eras, producing an archaeological record that tells us something important about human subsistence preferences.

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