PLEISTOCENE MAMMALS IN THE GREATER YELLOWSTONE ECOSYSTEM

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Introduction

The Pleistocene, which generally corresponds to the Ice Age, is characterized by fluctuating climates that started around 3-2 million years ago and ended about 10,000 years ago, after a short, cold interval called the Younger Dryas. The Pleistocene is especially important in the application of ecological principles because it is associated with the evolution and extinction of a variety of mammals (Barnosky et al. 2004; Barnosky, 2005). In North America, the last part of the Pleistocene coincides with climate change, glacial advance and retreat, and the Rancholabrean land mammal age. The end of the Pleistocene also coincides with the earliest presence of humans in North America.

Southwestern Montana, which includes the northwest part of the Greater Yellowstone Ecosystem and adjacent areas, contains evidence for extinct Pleistocene mammals. These include herbivores such as mammoth, camel, and horse, and, more rarely, carnivores such as scimitar cat, cheetah, and dire wolf. The Greater Yellowstone Ecosystem consists of parts of southwestern Montana, northwestern Wyoming, and southeastern Idaho (fig. 1). The drainages of streams that are part of the Upper Missouri River basin (such as Red Rock River, Beaverhead River, Jefferson River, Ruby River, and Madison River) are part of this landscape in southwestern Montana (fig. 2). The broad character of the Rancholabrean communities in this region is known from isolated discoveries in fluvial gravels and sands (chiefly of mammoth), fossils collected from caves, and more detailed studies of late Pleistocene stratigraphic sequences. Besides fossil vertebrates, some localities contain evidence, based on the presence of artifacts, for prehistoric human groups in the region by 11,000-10,500 radiocarbon (14C) years ago.

The landscape of southwestern Montana is to a great degree the product of tectonic events and climatic change during the late Pliocene and Pleistocene (roughly the last 3 million years). Tectonic processes in the form of regional faulting have led to the formation of the basin-and-range physiographic character of the region. Volcanism centered on the area of the Yellowstone Plateau over about the last 2 million years is connected to regional tectonic events extending over the last 15 million years or so on the Snake River Plain. Volcanism in the Pacific Range resulted in the deposition of several tephra (volcanic ash) deposits which serve as useful regional stratigraphic markers.

Climatic fluctuations have also played an important role, both in forming the present-day landscape and influencing the Pleistocene paleobiotic communities of the region. Late Pliocene or early Pleistocene through Holocene glacial episodes have been documented. Most
of the mountain ranges contain evidence for multiple glaciations during the late Cenozoic, while alluvial fans and terraces within the valleys reflect the interplay between fluctuating climatic regimes and tectonic processes.

Although Pleistocene fossils have been collected from the area for over a hundred years, extensively studied stratigraphic sequences containing Pleistocene vertebrate remains are relatively uncommon in southwestern Montana. Early collections include *Mammuthus* (mammoth) fossils found in the drainage of the Ruby River obtained as part of the Hayden Survey in 1871. A significant Pleistocene locality is in Centennial Valley, east of Lima, Montana, along the Red Rock River. Mammal fossils in-

Figure 2. Location of major Pleistocene localities in southwestern Montana.

clude *Mammuthus* (cf. *M. columbi*), *Homotherium serum* (scimitar cat), canids (wolf and coyote), *Equus* (horse), *Bison* (bison), and *Camelops* (camel). Elsewhere in the Jefferson drainage, in the vicinity of Blacktail Deer Creek, *Equus*, *Camelops*, *Bison*, *Ovis* (sheep), and *Canis dirus* (dire wolf) have been recovered from Sheep Canyon-Orr Cave, while *Mammuthus* and *Equus* fossils have been recovered within the Ruby River drainage, and *Acinonyx trumani* (cheetah), *Equus*, *Camelops* and *Ovis canadensis* (mountain sheep) are known from the Sheep Rock Spring locality west of the Boulder River.

**Plio-Pleistocene Geologic Background**

Climate change and tectonic activity during the late Pliocene and Pleistocene have affected the physical and biotic environments of the region. A series of volcanic explosions occurred in the area centered on Yellowstone National Park. The three major explosions date to about 2.0, 1.3 and 0.6 million years ago (cf. Hamilton, 1965; Walsh, 1971; Christiansen and Blank, 1972; Witkind, 1976; Weinheimer, 1979; Mannick, 1980; Christiansen, 1982; Sonderegger et al., 1982; Pritchett, 1993; Gansecki et al., 1998; O'Neill and Christiansen, 2004). These events resulted in the emplacement of igneous rocks. The products of this local volcanic activity and volcanic ash beds originating from the Cascade region serve as useful local stratigraphic markers. For example, the late Pleistocene Glacier Peak ash dated to about 11,200 14C years B.P. and the early-middle Holocene tephras Mount Mazama ash dated to about 6,900 14C years B.P. are visible in road cuts or natural exposures, and have
also been documented in stratigraphic cores. Both the Glacier Peak and Mazama volcanic ashes are present in a stratigraphic core collected from Kearns Basin, within the Beaverhead drainage in the southern Pioneer Mountains (Foit et al., 1993). The Glacier Peak and Mazama tephras are exposed along the Jefferson, Madison, and Gallatin Valleys (cf. Montagne, 1965:51; Kellogg, 1992) and have also been documented in the Yellowstone Plateau area (cf. Whitlock, 1993), and elsewhere in the upper Missouri basin (Lemke et al., 1975; Davis and Greiser, 1992).

The mountains within southwestern Montana supported glaciers at various times during the Pleistocene (Alden, 1953; Hall and McMannis, 1960; Paul and Lyons, 1960; Hall, 1961; Sloan, 1960; Montagne, 1960; Reshkin, 1963; Richmond, 1965; Hadley, 1969; Jacobs, 1969; Montagne, 1972; Pierce, 1979; Gary, 1980; Roy and Hall, 1981; Hall and Heiny, 1983; Richmond, 1986a, 1986b; Locke, 1989; Hall, 1990; Locke 1990; Schneider, 1990a, 1990b; Locke and Schneider, 1990; Lundstrom, 1990; Pritchett, 1990; Ritter et al., 1990; Pritchett, 1993; Ritter et al., 1993; Sturchio et al., 1994; Bartholomew et al., 1999). Moraines within many of the tributary valleys show the extent of past glacial events. Alluvial fans and terraces on the flanks of the mountains and in the valleys are composed of sediments of glaciofluvial origin, deposited as outwash from glacial meltwater. Late Cenozoic lacustrine, paludal, and spring (e.g. tufas) sediments are present in the valleys, as are aeolian silts (loess) and sands. Vertebrate remains have been recovered from some of these depositional contexts and have also been found in caves and rock shelters. Stratigraphic and geomorphic relationships of these various deposits can be linked to both paleoclimatic chronologies and tectonic events. This geochronologic-paleoenvironmental framework serves as a basis for evaluating the late Pliocene and Pleistocene paleobiotic communities of the region.

Pleistocene Mammal Localities

The climate and physical environmental changes that occurred during the Quaternary provided a variety of contexts that can be related to paleobiotic patterns in southwestern Montana. Pleistocene mammal fossils have been recovered in the vicinity of the Red Rock River (the Merrell Locality), Blacktail Creek (Sheep Canyon Cave), South Everson Creek, Alder Gulch, Dry Boulder Creek, Sheep Rock Spring, and Point-of-Rocks Cave (fig. 2). These localities contain a record of biodiversity that can be related to changes in physical landscapes and biotic habitats associated with regional Quaternary tectonic and climate events.

The most extensively studied Pleistocene paleontological locality in the Greater Yellowstone Ecosystem is near Red Rock River, a major stream in the southern area of the Jefferson River drainage (fig. 3). The locality is east of Lima, which is about 45 miles south of Dillon. Red Rock River flows from east to west through the Centennial Valley, surrounded to the north by the Snowcrest and Gravelly Ranges and to the south by the Centennial Mountains. Four classes of animals have been recovered: Osteichthyes (bony fish), Aves (waterfowl), Amphibia (amphibians), and Mammalia (Dundas 1990, 1992; Dundas et al., 1996; Hill, 1999; Hill and Davis, 2005; Hill 2006a, 2006b). Table 1 provides a list of the mammals recovered from Centennial Valley, while table 2 is a list of radiocarbon dates. Finite radiocarbon ages range from about 49,350 14C years B.P. (Beta-116519) to about 19,310 14C years B.P. (Beta-77826). Several measurements indicate some remains are older than 52,800 14C years B.P. The faunal assemblages are from several sedimentary units and appear to have been affected by a variety of taphonomic processes reflecting the dynamics of pre-burial deposition, burial, and post-burial events.

Stratigraphic contexts and sedimentologic facies associated with the Centennial Valley mammal fossils reflect a variety of depositional and post-depositional processes. These contexts provide information on the factors leading to the accumulation of the fossils. Five strata have been designated (figs. 4-7). The oldest set of deposits is stratum A which contains alluvial, lacustrine, and possibly colluvial sediments.
Table 1. Mammal species from Centennial Valley, southwestern Montana.

<table>
<thead>
<tr>
<th>TAXON</th>
<th>STRATUM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carnivora</td>
<td></td>
</tr>
<tr>
<td>Canis latrans (coyote)</td>
<td>Stratum C</td>
</tr>
<tr>
<td>Canis lupus (gray or timber wolf)</td>
<td>Unknown context</td>
</tr>
<tr>
<td>Ursus sp. indet. (bear)</td>
<td>Unknown context</td>
</tr>
<tr>
<td>Homotherium serum (scimitar-tooth cat)</td>
<td>Unknown context (beach)</td>
</tr>
<tr>
<td>Rodentia</td>
<td></td>
</tr>
<tr>
<td>Spermophilus sp. indet. (squirrel)</td>
<td>Unknown context</td>
</tr>
<tr>
<td>Castor canadensis (Canadian beaver)</td>
<td>Unknown context</td>
</tr>
<tr>
<td>Lemmiscus curtatus (sagebrush vole)</td>
<td>Stratum C</td>
</tr>
<tr>
<td>Ondatra zibethicus (muskrat)</td>
<td>Strata A-B or B</td>
</tr>
<tr>
<td>Perissodactyla</td>
<td></td>
</tr>
<tr>
<td>Equus sp. indet. (horse)</td>
<td>Stratum C, D</td>
</tr>
<tr>
<td>Artiodactyla</td>
<td></td>
</tr>
<tr>
<td>Camelops sp. indet.</td>
<td>Strata C, D</td>
</tr>
<tr>
<td>Cervidea sp. indet. (deer)</td>
<td>Stratum C</td>
</tr>
<tr>
<td>Odocoileus hemionus or O. virginianus (mule deer or white-tailed deer)</td>
<td>Unknown context</td>
</tr>
<tr>
<td>Antilocapridea americana (pronghorn)</td>
<td>Unknown context</td>
</tr>
<tr>
<td>Bison sp. indet.(bison)</td>
<td>Stratum D</td>
</tr>
<tr>
<td>Proboscidea</td>
<td></td>
</tr>
<tr>
<td>Mammuthus columbi (Columbian mammoth)</td>
<td>Strata A, A-B or B, C, D</td>
</tr>
<tr>
<td>Age</td>
<td>Lab Number</td>
</tr>
<tr>
<td>-----------</td>
<td>------------</td>
</tr>
<tr>
<td>&gt;52,800</td>
<td>SR-6012</td>
</tr>
<tr>
<td>&gt;52,800</td>
<td>SR-6013</td>
</tr>
<tr>
<td>&gt;52,800</td>
<td>SR-6016</td>
</tr>
<tr>
<td>&gt;52,800</td>
<td>SR-6017</td>
</tr>
<tr>
<td>49,350 +/-1,500</td>
<td>Beta-116519</td>
</tr>
<tr>
<td>43,970 +/-370</td>
<td>Beta-110647</td>
</tr>
<tr>
<td>&gt;41,940</td>
<td>Beta-83614</td>
</tr>
<tr>
<td>36,520 +/-710</td>
<td>Beta-74032</td>
</tr>
<tr>
<td>&gt;33,990</td>
<td>Beta-36206</td>
</tr>
<tr>
<td>32,470 +/-270</td>
<td>Beta-111325</td>
</tr>
<tr>
<td>30,400 +/-590</td>
<td>SR-6018</td>
</tr>
<tr>
<td>26,630 +/-190</td>
<td>SR-6015</td>
</tr>
<tr>
<td>25,030 +/-510</td>
<td>Beta-36205</td>
</tr>
<tr>
<td>23,120 +/-1190</td>
<td>SR-6014</td>
</tr>
<tr>
<td>21,530 +/-100</td>
<td>Beta-118755</td>
</tr>
<tr>
<td>19,290 +/-90</td>
<td>Beta-77826</td>
</tr>
</tbody>
</table>
Stratum B consists of dark, organic-rich sediments deposited in a swamp or bog. Silts, sands, and gravels from stratum C mostly represent alluvial deposition. Stratum D is chiefly composed of a debris flow. It overlies a sandy facies of stratum A. After strata A-D were deposited, they were affected by soft-sediment deformation-liquefaction, and faulting, perhaps linked to local tectonic events. The youngest depositional unit, designated stratum E, consists of colluvium. There is evidence of extensive bioturbation (biologic mixing) in stratum E and in parts of stratum C.

Vertebrate remains found within stratum A are usually rare and isolated, except near its upper contact with stratum B (fig. 4). One example of an isolated find within stratum A is a patella of a proboscidean (probably from *Mammuthus*). It is likely that some of the fossils found within stratum A, especially near its upper contact with stratum B, have been moved by post-depositional events.

The first taphonomic context in which there are higher frequencies of mammal fossils is along the interface of strata A-B and in the lowest part of stratum B (fig. 5). There are no articulated specimens, but there are concentrations of bones, tusk and teeth of mammoth (fig. 6). Other faunal materials from this taphonomic context include *Ondatra zibethicus* (muskrat) and bivalves. These may include bones that accumulated on the surface of stratum A and then were buried within stratum B, as well as elements that accumulated during the deposition of the stratum B organic-rich sediments. Radiocarbon measurements, if reliable, suggest that this taphonomic context contains a temporally mixed fossil assemblage. Fragments of mammoth teeth were dated at >52,800 ¹⁴C years B.P. (SR-6012, SR-6013), while radiocarbon ages on tusk fragments are 32,470 ¹⁴C years B.P. (Beta-111325) and 23,120 ¹⁴C years B.P. (SR-6014). These could reflect a taphonomic or formational context associated with surface exposure within a small basin, and burial in or incorporation into a marsh.

The alluvial deposits of stratum C also contain...
Figure 4. Stratigraphic profile in Centennial Valley showing Pleistocene strata A-C and Holocene colluvium.

Figure 5 (above). Stratigraphy at Centennial Valley vertebrate locality. Dark layer is stratum B. It over lies stratum A and underlies stratum C.

Figure 6 (left). Mammoth tooth in stratigraphic context.
vertebrate remains. These include including limb bone, tooth, and tusk fragments of mammoth, and fragments from *Camelops* (camel), *Equus* (horse), *Canis latrans* (coyote), a large artiodactyl, *Lemmiscus curtatus* (sagebrush vole), *Pices* (fish), and *Anatidae* (duck). The radiocarbon age on camel is about 30,400 $^{14}$C years B.P. (SR-6018). These fossils are distributed throughout the sequence of stratum C, within fluvial gravels and sands interbedded with silts. Thus, these vertebrate remains represent a taphonomic context primarily associated with stream transport and burial.

A third sedimentological setting is associated with the fossils from stratum D, consisting of a fine-grained matrix with limestone and quartzite cobbles and bones, interpreted as a debris flow (fig. 7). Most of the faunal material consists of remains of mammoth (tusk, teeth, and bones, fig. 8) as well as some elements of *Equus* (horse) and *Bison* (bison). Based on the radiocarbon ages, this assemblage is temporally mixed. Fragments of mammoth and horse bone have measurements indicating ages of $>$52,800 (SR-6016, SR-6017) and finite ages of 26,630 $^{14}$C years B.P. (SR-6015) and 19,310 $^{14}$C years B.P. (Beta-77826). Thus, the youngest fossils from Centennial Valley appear to date to around the Last Glacial Maximum.

The depositional variability reflected in the stratigraphic record indicates that the Centennial Valley vertebrate assemblages are the result of at least three different taphonomic contexts. The dispersal, scattering, and accumulation of bones associated with the strata A-B appears to have occurred in a marsh-pond basin. Transport, deposition and burial of skeletal parts recovered within stratum C was the result of hydraulic events associated with fluvial conditions. The concentration of mammoth fossils in stratum D occurs within a debris flow. Subsurface movements—post-depositional crushing by sediment overburden along with liquefaction and faulting—have also affected the character of the fossil record. Horse remains are associated with both fluvial and debris flow deposits. Camel and wolf re-
mains have been identified from alluvial contexts, while bison were recovered only in association with the debris flow. All three sedimentologic contexts contain evidence of mammoth.

Two terraces are present along the Red Rock River Valley southeast of Lima (Scholten et al., 1965); they have been interpreted as being connected with Pleistocene mountain glaciation. Red Rock River flows northwest, between the Tendoy Mountains to the southwest and the Blacktail Mountains to the northeast and merges with Horse Prairie Creek to form the Beaverhead River at the Clark Canyon Reservoir, about 11 miles south of Dillon (fig. 2). Blacktail Deer Creek flows into the Beaverhead River from the east and is bounded by the Blacktail Mountains to the southwest, the Snowcrest Range in the southeast and the Ruby Range to the north. Along the south side of Blacktail Deer Creek valley, south of Dillon, Pleistocene vertebrate remains were recovered from Sheep Canyon Cave. The locality was excavated by P. Orr between 1925 and 1930 (Campbell, 1978). Faunal remains include Equus, Camelops, Bison and Ovis. The remains of Canis dirus (dire wolf) have been identified from Orr Cave (Kurten, 1984), which is probably another designation for Sheep Canyon Cave.

Southwest of Dillon, studies in the Horse Prairie Creek and Grasshopper Creek Basins and along the adjacent slopes of the Beaverhead Mountains indicate at least six pre-Bull Lake age glacial advances (Turner et al., 1988). Sixteen terraces are recognized near South Everson Creek (fig. 2), which flows from the foothills of the Beaverhead Mountains into Horse Prairie Creek (Bonnichsen et al., 1987, 1992). The lowest terrace contains what is probably Glacier Peak volcanic ash (ca. 11,200 $^{14}$C years B.P.) as well as flaked mammoth bone (Bonnichsen et al., 1987). Possible fragments of mammoth bone were associated with sediments consisting of cobbles and boulders embedded in clays (Bonnichsen et al., 1990; Bonnichsen et al., 1992). The clays may be late Pleistocene paludal or lacustrine deposits (Turner et al., 1987; Turner et al., 1988).

Pleistocene vertebrate remains have been recovered east of Dillon from the Alder Creek area, within the Ruby River drainage (fig. 2). The Ruby River flows northeasterward into the Beaverhead-Jefferson Valley. It is bounded to the south by the Ruby Range and to the north by the Tobacco Root Mountains. F.V. Hayden obtained Pleistocene fossils from the vicinity of Virginia City, at Alder Gulch (Hayden, 1872; Merrill, 1999). The remains were assigned to Elephas (= Mammutthus) primigenius by Hayden (1872). Later some of the proboscidean remains were identified as E. columbi (Hay, 1924). Other mammoth fossils from Alder Gulch were recovered during placer mining prior to 1894 and are in the collection of the Virginia City Museum and Library. Along the northern flanks of the Ruby Range, fossils of Pleistocene horse have been collected from gravels at the mouth of Dry Boulder Creek, and from silts near Dry Georgia Creek (Petkewich, 1972).

A late Pleistocene vertebrate assemblage was collected west of the Boulder River on the flanks of the southern end of Bull Mountain, at the Sheep Rock Spring locality (Wilson and Davis, 1994; Davis, 1997). The (Northern) Boulder River flows southward from the Elkhorn Mountains and joins the Jefferson River near Whitehall and Cardwell, about 55 miles northwest of Dillon (fig. 2). At least three terraces can be recognized in the Boulder River Valley north of Cardwell. These were assigned to the early to middle and late Pleistocene ("second and third sets") by Alden (1953:80). Five stepped pediments levels were studied by Morgan and Hall (1982). Faunal remains include cheetah (Miracinonyx trumani), horse (Equus sp.), camel (Camelops sp.), and large mountain sheep (Ovis canadensis cataclawensis). The lowest part of the sequence has radiocarbon dates slightly older than 10,000 $^{14}$C years B.P. (Hill, 2006a).

Point-of-Rocks Cave (Davis and Johnson, 1988) is situated on the slopes of the Tobacco Root Mountains adjacent to the Jefferson River, south of Whitehall and east of Renova. Fossils
recovered from the cave include a possible Blancan age *Meganteron* sp. (Machairodontinae) (personal comm. to D. Rasmussen from L.D. Martin, 1999) and *Equus* (Davis, 1997).

**Evidence for Late Pleistocene Humans**

The earliest well-documented evidence for humans in North America come from discoveries associated with Clovis and Folsom artifacts. These types of artifacts are considered to be time indicators for the end of the Pleistocene and have been discovered with extinct Rancholabrean mammals. Clovis artifacts have been found in stratigraphic contexts with mammoths, while Folsom artifacts are associated with extinct forms of bison. In eastern Idaho, Folsom artifacts have also been found with mammoth fossils (Miller and Dort, 1978). Clovis artifacts may date to about 11,100-10,800 ¹⁴C years B.P. (Waters and Stafford, 2007), while Folsom artifacts may range from about 10,900-10,100 ¹⁴C years B.P. (Holliday 2000). A stratified sequence at Indian Creek on the flank of the Elkhorn Mountains in western Montana contains a Clovis component (Davis and Greiser, 1992; Hill and Davis, 2005). Folsom artifacts have also been found regionally. One example was found north of Lima Reservoir in Centennial Valley (fig. 9). Slightly younger artifact forms dating to about the Pleistocene-Holocene transition have been discovered in the region. These range in age from about 10,500-10,000 ¹⁴C years B.P. for Agate Basin (fig. 10) as well as 10,200-8,800 ¹⁴C years B.P. for Alberta, Scottsbluff and Eden artifact forms (fig. 11) (Holliday, 2000). These discoveries suggest that humans were present in this region of North America during the Younger Dryas (from about 10,900 to 10,200 ¹⁴C years B.P.) or slightly earlier and appear to have persisted throughout the Pleistocene-Holocene transition.

**Ecological Interpretations and Conclusions**

Large and small mammals in the Greater Yellowstone Ecosystem include both carnivores and herbivores (Bailey, 1930; Hadly, 1986; Streubel, 1989; National Research Council, 2002; Cannon and Cannon, 2004). Carnivores present today include *Ursus arctos* (grizzly bear), *Ursus americanus* (black bear), *Felis concolor* (mountain lion), *Canis latrans* (coyote), and *Canis lupus* (wolf). Herbivores include *Cervus elaphus* (elk or wapiti), *Odocoileus hemionus* (mule deer), *Bison bison* (bison), *Alces alces* (moose), *Ovis Canadensis* (bighorn sheep), *Antilocapra americana* (pronghorn), and *Odocoileus virginianus* (white-tailed deer).

The Pleistocene mammals for southwest Montana fall into the two categories: those that are extinct and those that are still present. This seems to suggest some ecological relationships that exist today may have persisted in the region since the Pleistocene. It also implies that some aspects of the Greater Yellowstone Eco-system in southwestern Montana have changed since the Pleistocene. This pattern is illustrated by the carnivores. For the canids, *Canis dirus* is extinct, while *Canis latrans* (coyote) and *Canis lupus* (gray or timber wolf) appear to have been present in the region prior to the Last Glacial Maximum (centered on about 20,000 years ago). Other extinct carnivores include the feld *Homotherium serum* (scimitar cat) and *Miracinonyx trumani* (American cheetah), while *Ursus* (bear) has been present since the Pleistocene. Herbivores show a pattern similar to the carnivores. Some, like *Mammuthus* (mammoth), *Equus* (horse), and *Camelops* (camel) did not survive the end of the Pleistocene, while other animals such as *Odocoileus* (mule or white-tailed deer), *Ovis canadensis* (bighorn/mountain sheep) and *Antilocapridae americana* (pronghorn), and *Bison* (bison) persisted regionally. In contrast to the larger mammals, rodents appear to have persisted without major extinctions during the last glacial to interglacial transition, although some range changes may have occurred. This is illustrated by the Merrell Locality in Centennial Valley where *Castor canadensis* (Canadian beaver), *Lemmiscus curatus* (sagebrush vole), and *Ondatra zibethicus* (muskrat) are found in late Pleistocene sediments. In terms of patterns of extinctions, there appears to be a dichotomy between some large mammals, regardless of whether they are herbivores or carnivores, and small mammals. The extinction of large mammals near the end of the Pleistocene has been linked to both climate change and interactions with humans (Barnosky et al., 2004).

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...saw several bald Eagles and two large white headed fishing-hawks both these birds were the same common to our country. From the number of rattle snakes about the Cliffs at which we halted we called them the rattle snake cliffs. This serpent is the same before described with oval spots of yellowish brown. The river below the mountains is rapid rocky, very crooked, much divided by islands and withal shallow. After it enters the mountains its bends are not so circuitous and its general course more direct, but it is equally shallow less divided more rocky and rapid.

Capt. Lewis, August 10, 1805