Late Pleistocene/ Holocene Environmental Changes in Wyoming: The Mammalian Record

Danny N. Walker Office of the Wyoming State Archaeologist

INTRODUCTION

Although the Wyoming Basin is separate from the Great Plains to the east and the Basin and Range region to the west (Fenneman 1931), its faunal history is integrally related to both. Variable climatic, physiographic, and geologic regions (Fig. 1) create an ecological mosaic that is apparent in the distributions of modern mammals. In an attempt to explain this complexity, zoologists have frequently advanced ideas about the response of the mammalian species to past changes in climate. The discovery and analysis of numerous fossil sites in the past two decades provide a new perspective for the evaluation of these ideas.

For example, Long (1965) based past environmental reconstructions in Wyoming strictly on modern zoogeographical evidence. At that time, fossil mammal assemblages from late Quaternary paleontological and archeological sites had not yet been excavated. However, Long (1965) did not consider the extinct late Pleistocene species (e.g., *Camelops* [American camel], *Equus* [horse], *Mammuthus* [mammoth]) that had already been recorded by Hay (1924, 1927) and McGrew (1961).

Long (1965:729) proposed that "some of the cold-adapted species occurring in the Arctic regions of the Far North occurred in periglacial areas of Wyoming in the Pleistocene." According to Long (1965:729) fourteen extant species (Table 1) probably formed the core of the late Pleistocene Wyoming fauna and many of the extant residents immigrated into the state during the Holocene. Long (1965) further reasoned that boreal connections probably existed between major mountain ranges during the late Pleistocene but Holocene environmental changes isolated these populations on mountain tops (Long 1965).

Analysis of the Little Box Elder Cave fauna (Anderson 1968), the first well studied mammalian local fauna from Wyoming, provided Long (1971) with new insights into the zoogeography of Wyoming. The occurrence of boreal mammals at lower elevations suggested that coniferous forests occurred in basins that are now arid. Further, along with the presence of *Dicrostonyx torquatus* (collared lemming) and *Oreamnos americana* (mountain goat), displacement of these boreal

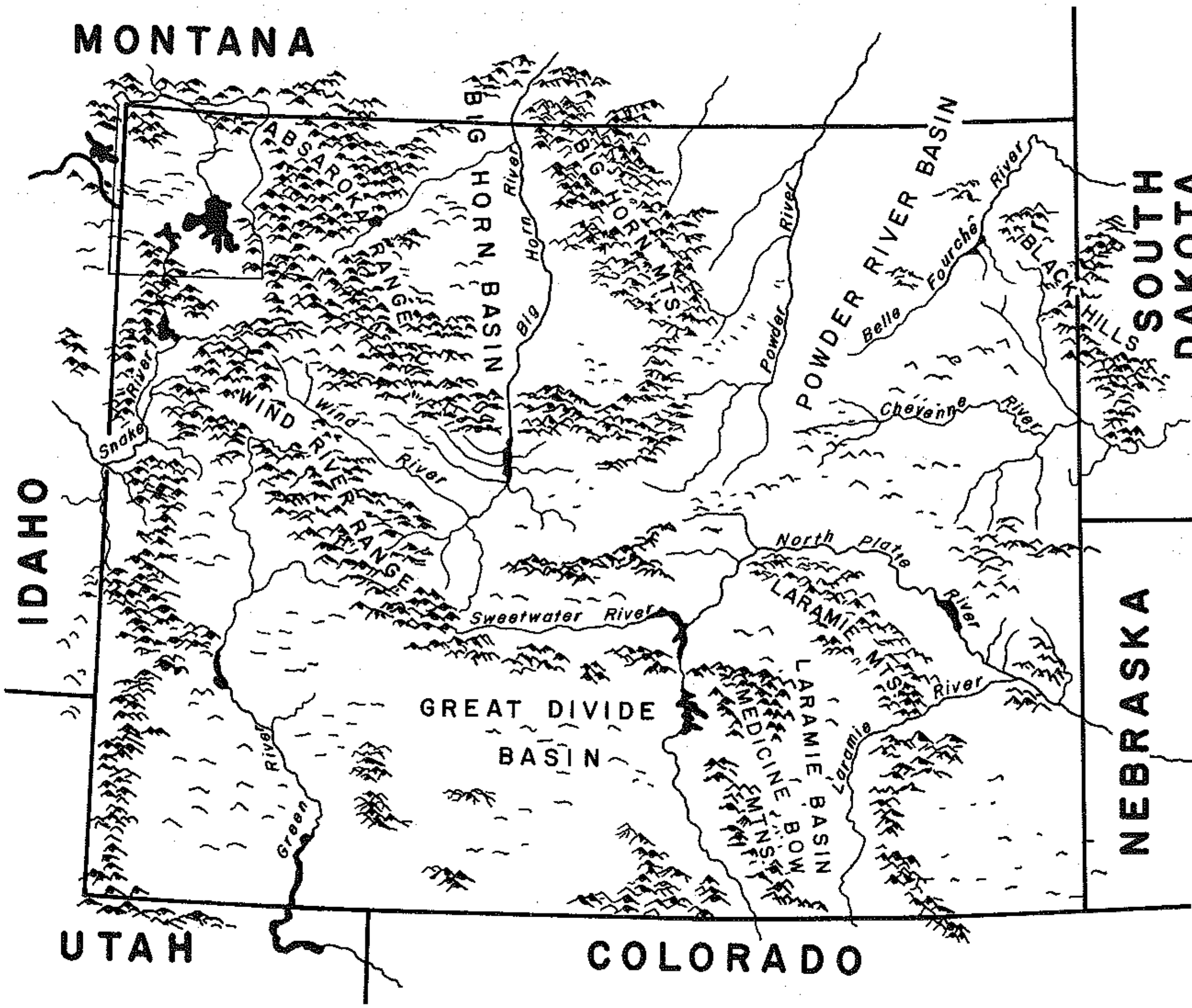

Figure 1. Physiographic regions of the Wyoming Basin (modified from Fenneman 1931).

Table 1. Fourteen basic species of the late Pleistocene fauna of Wyoming as proposed by Long (1965:729).

SCIENTIFIC NAME	COMMON NAME
Sorex cinereus	masked shrew
Sorex vagrans	vagrant shrew
Erethizon dorsatum	porcupine
Canis latrans	coyote
Canis lupus	gray wolf
Vulpes vulpes	red fox
Ursus americanus	black bear
Ursus arctos	grizzly bear
Mustela erminea	ermine
Mustela vison	mink
Gulo gulo	wolverine
Lutra canadensis	otter
Felis canadensis	lynx
Alces alces	moose

species indicates that late Pleistocene climates were cooler. Thereafter, climatic warming during the Holocene caused boreal plants and mammals to retreat to higher altitudes and latitudes. Southern species like *Cryptotis parva* (least shrew) and *Spermophilus variegatus* (rock squirrel) probably dispersed northward during the "Climatic Optimum" but they since have retreated southward in response to modern climatic conditions.

In another zoogeographical study, Jones (1964) believed that the distribution of both modern and Pleistocene mammals indicated a prairie/plains environment for Nebraska and other parts of the northern plains during the Pleistocene. Although there was little fossil evidence, Jones (1964) believed that there was no indication of extensive boreal forests fronting on the glaciers. Jones (1964) thought the landscape had a parkland appearance similar to those on the western slopes of the Rocky Mountains today. In these areas, boreal and other cold-tolerant species were mixed with species of wide-ranging or grassland affinities. All species were probably distributed in a mosaic in accordance with local ecological conditions. During early post-glacial (Pre-Boreal) times, some boreal species remained in western and southern Nebraska, but eastern and southern species advanced northward beyond their present limits. These "southeastern" species later retreated and appear only as relict populations in Nebraska today.

Later, Hoffmann and Jones (1970) presented another synthesis of northwestern plains zoogeography, again, based entirely on modern mammalian ranges. Hoffmann and Jones (1970:363) stated that the "... region has not yet yielded faunas from this period [Late Glacial], and interpretations of faunal and climatic shifts must be based on indirect biogeographical evidence." According to their synthesis either a boreal woodland or a cold loess steppe/tundra environment was present during the Full Glacial. Steppe or savanna areas were probably restricted to a limited area east of the Rocky Mountains and possibly in the Wyoming Basin. These biotic regions shifted in response to changes in local climatic conditions.

For Colorado, at least its northern regions, Armstrong (1972) proposed a prairie/plains environmental sequence similar to that of Jones (1964) for Nebraska. Armstrong (1972) pointed out that two species (*S. variegatus* and *Myotis thysanodes* [fringe-tailed bat]), which occur in the Little Box Elder Cave local fauna (l.f.) and still inhabit southern Colorado today, must have occurred over the entire state in the past. Relict populations of *Sorex hoyi* (pygmy shrew) in northern Colorado and southern Wyoming (Brown 1966), as well as its occurrence in the Little Box Elder Cave l.f. (Anderson 1968), reflect boreal connections between these areas and the present range of *S. hoyi* in northern Montana. Relict populations of *Zapus hudsonius* (northern jumping mouse) and *Microtus pennsylvanicus* (meadow vole) along the front range of Colorado are also probably remnants of more extensive moist grasslands or savannas during the late Pleistocene.

Turner (1974) discussed the modern mammals of the Black Hills of northeastern Wyoming and western South Dakota and presented evidence that the boreal forest connection between the Black Hills and the Bighorn Mountains, 162 km (100 mi) to the west, was indirect through the Laramie Range to the south. There was no evidence for extensive development of forests on the basin floors, and therefore, no access for small boreal mammals directly across the Powder River Basin.

Furthermore, in the last two decades, there has been a significant increase in multidisciplinary studies (e.g., geomorphological, pedological, palynological) concerning the late Pleistocene/early Holocene environmental history of the intermontane basins and mountain ranges of Wyoming. These studies reinforce the value of interdisciplinary efforts in the reconstruction of paleoenvironments. The compilation of a diverse array of data for the Wyoming Basin demonstrates the complex interactions involved in the evolution of mammalian communities for the last 20,000 years. Three Full Glacial, eight Late Glacial, and numerous Holocene fossil sites have now been investigated in the Wyoming Basin (Tables 2 and 3). These fossil faunas demonstrate that the late Pleistocene mammalian fauna of Wyoming was both more extensive and more complex than any proposed by zoogeographic studies. The purpose of this paper is to update and review the late Pleistocene and Holocene faunal record for the Wyoming Basin. In conjunction with the modern zoogeographic information and other paleoenvironmental indicators, the paleontological and archeological data will yield more accurate reconstructions of the late Pleistocene and Holocene environments.

GEOLOGICAL AND FLORAL EVIDENCE FOR PALEOENVIRONMENTAL CHANGE

Physical Geology and Geomorphology

The effect of alpine glaciation provides good evidence for environmental changes in Wyoming's mountain ranges during the late Quaternary. Richmond (1965), Burke and Birkeland (1983), and Porter *et al.* (1983) have shown that, while Blackwelder's (1915) basic concept of three glacial advances is still valid, numerous less extensive glacial advances also occurred, including several that are pre-Wisconsinan in age. In fact, there is even evidence for at least one small pre-Altithermal (early Holocene?) and three Neoglacial (late Holocene) advances.

These glacial/interglacial fluctuations suggest major changes in precipitation, temperature, or both. Porter *et al.* (1983) show a close correlation between the Pleistocene glacial threshold and modern snowpack and they, therefore, propose that the distribution of Pleistocene air masses was similar to those of the present. While an east-west gradient in glacial activity across the western United States was also apparent, the Yellowstone area exhibited two to three times as much activity as any other mountainous area (Porter *et al.* 1983).

From these data, Porter *et al.* (1983) do not believe that a major increase in precipitation is indicated as the cause of glaciation in the region. Instead, they think lowering of mean annual temperatures by as much as 12°C was probably the primary factor involved in glacial expansion during the Wisconsinan. The time of deglaciation also varied regionally. The Yellowstone Plateau was deglaciated by 14,000 years B.P., but other areas of the Colorado Front Range did not lose their ice until 10,000 years B.P. (Porter *et al.* 1983).

Mears (1981) has presented sand-wedge relicts or ice-wedge casts as evidence of permafrost in the basin floors of Wyoming. The ice wedges formed in moist sites, whereas sand wedges formed in areas that were higher, drier, and windswept. Both features are known to develop under low snow cover and windy conditions with mean annual temperatures 10° to 13°C lower than those today. Numerous localities in the higher mountain ranges of Wyoming could still contain alpine permafrost (Péwé 1983a, 1983b), however, the Wisconsinan alpine permafrost was at least 1000 m (3300 ft) below that of the present. None of the periglacial features studied by Mears can be dated radiometrically because of a lack of datable materials. However, Mears (1981) proposed a late Wisconsinan age for most of the basin floor features.

Recent investigations at the Sheridan Elks Cemetery site, initially thought to be a Clovis occupation, may result in dating at least some of these periglacial features. Excavations at this locality, which is on a high terrace overlooking the city of Sheridan in northern Wyoming (Fig. 2), have failed to yield definitive cultural associations. However, numerous remains of *Mammuthus* sp., a small number of *Camelops* cf. *hesternus* (camel) bones, and a basal fragment of a *Rangifer tarandus* (caribou) antler have been recovered from a buried paleoland surface. The fossil horizon is overlain by at least 4 m (13.2 ft) of loess that, in turn, has been cut by relict permafrost sand-wedge polygons (Figs. 3 and 4).

Since *R. tarandus* probably did not immigrate to lower latitudes south of the glacial ice sheets until the Wisconsinan (Graham pers. comm.), this stratigraphic relationship indicates a late Wisconsinan age for wedge formation. In addition, a calcareous soil with an argillic B-horizon, forming in well-drained conditions in the loess just above the bone layer, suggests that the probable time of

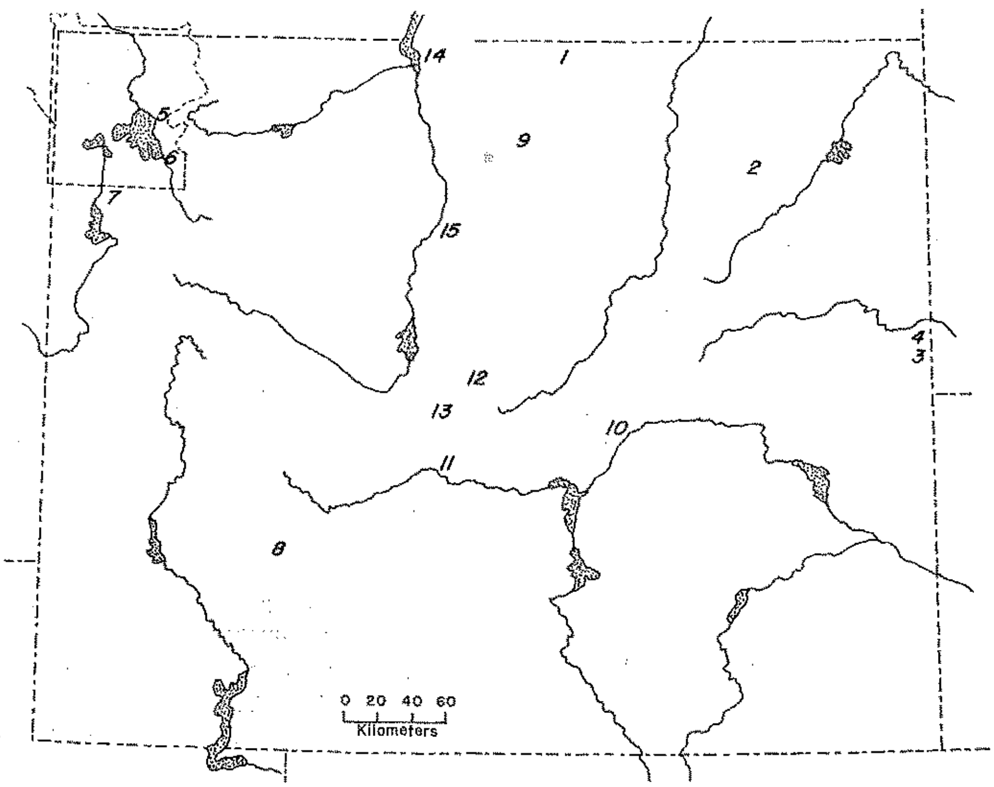

Figure 2. Location of pedological and paleobotanical (pollen and phytoliths) sites in the Wyoming Basin. 1: Sheridan Elks Club Cemetery site (this report); 2: Carter/Kerr McGee site (Reider 1980); 3: Agate Basin site (Reider 1982a); 4: Sheaman site (Reider 1982b); 5: Cub Creek Pond (Baker 1970); 6: Beaverdam Creek (Waddington and Wright 1974); 7: Grassy Lake Reservoir (Waddington and Wright 1974); 8: Finley Bison Kill (Hansen 1951); 9: Laddie Creek site (Beiswenger 1981); 10: Casper site (Beiswenger 1974); 11: Ice Slough (Beiswenger pers. comm.); 12: Copper Mountain (Scott 1980); 13: Castle Gardens (Beiswenger 1984); 14: Natural Trap Cave (Gilbert *et al.* 1980); 15: Colby Mammoth kill (MacDonald 1974).

the soil formation was near or at the end of the Pleistocene (R. Reider pers. comm.). Radiometric dates on charcoal associated with the fossil vertebrates and on samples of the mammoth bone should establish a minimum age for the formation of the periglacial features.

Pedology

Like the glacial record, pedological sequences in Wyoming document numerous environmental fluctuations. Highly calcareous soils on the higher terraces in the Laramie Basin are of pre-Wisconsinan age (Reider *et al.* 1974). Partially truncated soils near timberline in the Medicine Bow Mountains also probably date from pre-Wisconsinan time but they have younger soils developed on them (Reider and Gurley 1974). Furthermore, Sansom and Reider (1974) found that soils on Wisconsinan tills in the Medicine Bow Mountains do not have a maturity commensurate with the age of the tills. Multiple pedogenesis on these Wisconsinan tills thus reflects environmental changes since the late Wisconsinan and early Holocene.

Soils at intermediate elevations in the Medicine Bow Mountains formed at the end of the Wisconsinan glaciation, but these soils were calcified under grasses and possibly sagebrush during the Altithermal (Reider 1977, 1983). Later, during the Neoglacial, the same soils were podzolized by encroachment of conifers from higher elevations under a return of somewhat humid climates. Again, the polygenetic nature of these soils clearly demonstrates multiple environmental fluctuations of the late Quaternary.

Birkeland and Shroba (1977) and Miller and Birkeland (1974) examined high altitude Holocene soils developed on tills in the Temple Lake area of the Wind River Mountains of west-central Wyoming. They concluded that these soils developed under conditions with a mean annual temperature of about -4°C (24.8°F), mean annual precipitation of 70-100 cm (28-40 in.) and a vegetative cover of some type of tundra (probably alpine in nature) (Shroba and Birkeland 1983).

Other late Pleistocene soils in the Wind River Range suggested that the mean annual temperature was 2-6°C (35.6-42.8°F), the mean annual precipitation 20-30 cm (8-12 in.) and the area was

Figure 3. View of excavation trench at Sheridan Elks Club Cemetery site. Note mammoth bone lying on surface dissected by periglacial ice wedge casts.

covered with sagebrush vegetation (Shroba 1977, Shroba and Birkeland 1983). These data indicate the climate in the Wind River Mountains has become colder with more rainfall since the end of the Pleistocene, a conclusion differing from that reached by Porter *et al.* (1983). However, local climatic conditions may be contributing to this inconsistency in interpretations.

The Carter/Kerr-McGee archeological site (Frison 1984) in the central Powder River Basin of northeastern Wyoming (Fig. 2) contains stratified cultural deposits of which the oldest is Goshen (Frison 1986) and the youngest is Cody Complex. Reider (1980) examined the soils and found that during the Clovis/Goshen period (11,000-12,000 years B.P.) the soils formed under poorly drained conditions beneath grasses and sedges in a cool and moist climate. A well-drained calcareous soil was superimposed shortly after the beginning of the Holocene, indicating subsequent drier and probably warmer climatic conditions. Post-Altithermal soils were weakly developed in overlying alluvium and colluvium.

Similar conditions occur for correlative soils at the Agate Basin site (Reider 1982a) and the Sheaman site (Reider 1982b) on the eastern edge of the Powder River Basin (Fig. 2). Interestingly, this suggests that a diagnostic Clovis-age soil may be nearly ubiquitous. However, there are some sites where Clovis-age soils have not been recognized. For example, at the Colby Mammoth Kill site (Frison 1976, Frison and Todd 1986) the rates of aggradation were apparently too fast to allow sufficient time for pedogenesis.

These and other (Hayter 1981, Karlstom 1977, Moore 1976) pedological studies have shown that climatic changes occurred in the basins and mountain ranges of Wyoming throughout the Holocene. However, the type and extent of the climatic changes have not been detailed in many of these studies. Reider (1982b:199) summarized environmental changes indicated by some of these pedological studies as follows:

> "...the basins of Wyoming in this period of the late Pleistocene were more humid and probably cooler than at present. Water tables in arroyos now dry were higher and supported lusher vegetative growth, including perhaps some woodland. These conditions appear to have ended during the Altithermal and subsequent times by development of

desert and semiarid conditions within Wyoming basins."

Palynology

Significant palynological data have been recovered from Wyoming localities, although the number of actual sites is small (Baker 1983, Heusser 1983) and most of the studies are from high altitudes (Fig. 2). At Cub Creek Pond, elevation 2485 m (8200 ft), in Yellowstone National Park (Fig. 2), Waddington and Wright (1974) found high percentages of *Artemesia* (sagebrush), *Picea* (spruce), *Juniperus*-type (juniper), *Betula* (birch), *Salix* (willow), Graminae (grass), Cyperaceae, and other herbs from a level dated between 14,368 and 11,638 years B.P. This pollen spectrum was interpreted as indicating that an alpine tundra or a spruce-fir parkland was present and that the upper treeline was depressed by as much as 1200 m (4000 ft) (Baker 1983:114-115). A mosaic forest of spruce/fir/whitebark pine replaced the alpine tundra/spruce-fir parkland in the spectrum and lodgepole pine became dominant after 7000 years B.P. These vegetational changes suggest that climatic conditions were becoming more xeric. Baker's (1970, 1976) studies near Yellowstone Park document similar changes in climate and vegetation.

Baker and Richmond (1978) described two other pollen spectra, elevations of 2200 m (7260 ft) and 2366 m (7810 ft), from Yellowstone National Park (Fig. 2) that pre-date 70,000 years B.P. These profiles indicate that extensive alpine, not arctic, tundra was present above treeline for most of the Yellowstone Plateau before the Pinedale glaciation. The alpine tundra appears to have been a stable community that probably lasted several thousand years. The alpine tundra was replaced by spruce/fir/pine forests but then the environment again reverted to alpine tundra around 42,000 years B.P.

Younger profiles dating from the Wisconsinan (Baker 1970, 1976; Waddington and Wright 1974) suggest a short period of tundra development following the end of the Wisconsinan glaciation. Baker and Richmond (1978) attributed this to rapid invasion of coniferous tree species on the Yellowstone Plateau during the late Wisconsinan. This invasion did not allow the late

Figure 4. Profile of periglacial ice wedge cast at Sheridan Elks Club Cemetery site.

Wisconsinan alpine community to become as well established as the early Wisconsinan alpine tundra.

Few Holocene vegetation sequences have been described in Wyoming, mainly due to problems with pollen preservation (Beiswenger 1981). Markgraf and Lennon (1986) suggested that a pollen profile from the Powder River Basin in eastern Wyoming indicates the existence of moist conditions between 12,000 and 5000 years B.P., with modern communities established shortly after 6000 years B.P. Hansen (1951), based on pollen analysis of peat sections, concluded that the area around Farson (Fig. 2), in western Wyoming (presently a sagebrush-steppe), was dominated by a grassland community 10,000 years ago. Grassland species were preceded (> 10,000 years B.P.) by a predominance of conifer pollen in the profile. Development of the modern sagebrush-steppe occurred sometime after 10,000 years B.P.

Pollen from the Laddie Creek site (Beiswenger 1981) in the western Bighorn Mountains (Fig. 2) documents changes from the cool, moist postglacial to the present *Artemesia* steppe. Before 9000 years B.P., the pollen diagram was dominated by *Pinus* (pine) and then rapidly changed to a predominance of *Artemesia* (Beiswenger 1981). While finding pollen in postglacial deposits at the Casper (Fig. 2) and Agate Basin (Fig. 2) sites, Beiswenger (1974, 1982) was not able to propose definitive floral reconstructions because of oxidation of up to 49 percent of the pollen grains. These samples also contained redeposited Tertiary palynomorphs.

A pollen profile from the Ice Slough, in central Wyoming (Fig. 2) has shown that the area was dominated at an earlier, but unknown, time by a sagebrush community with little grass or sedge pollen present (Beiswenger pers. comm.). However, even sagebrush pollen is scarce compared to modern samples from the area. Scott (1980) found an *Artemesia* dominated community at Copper Mountain (Fig. 2) in central Wyoming during the Altithermal (5000-4000 years B.P.), followed by cooler and moister conditions. Another pollen profile at the Castle Gardens Petroglyph site about 50 km (31 mi) north of Ice Slough provides little or no evidence for major vegetational changes around 700 years B.P. (Beiswenger 1984). A slight increase in Chenopodiaceae was possibly due to the cultural occupation of the locality.

Opal Phytoliths and Mycoflora

Opal phytoliths are siliceous remains of plants, especially grasses, which are often preserved where pollen is not. However, Lewis's (1982) studies of phytoliths from prehistoric bison kill sites in Wyoming indicate that chemical destruction of phytoliths is common. The changes in the phytolith record usually paralleled the established concept of wetter conditions at the end of the Pleistocene, followed by drier conditions culminating in the Altithermal, and thereafter the development of the modern community (Lewis 1982).

Gilbert *et al.* (1980:86) reported "...fluctuations in relative frequencies of festucoid, chloridoid, and panicoid types..." of phytoliths through the sequence from 110,000 to 20,000 years B.P. at Natural Trap Cave (Fig. 2). Festucoid and panicoid phytoliths dominated the sequence until 12,000 years B.P. when chloridoid types doubled in comparison to other types. These authors proposed a more arid environment from 110,000 to 20,000 years B.P.

From phytoliths, MacDonald (1974) predicted the floral community around the Colby Mammoth Kill site (Fig. 2) to be dominated by grasses 11,200 years ago. The panicoid and festucoid phytoliths present indicated a higher percentage of tall grasses at the time of site occupation.

Studies by Christensen and Beiswenger (1982) indicated that subsurface soil microfungi of the Laramie Basin are more similar in species composition to microfungal communities of modern tundra than to short-grass prairie. Their laboratory studies show that the Laramie Basin microfungi have optimal growth below 15°C (59°F), and none grow at 37°C (98.6°F). None of the microfungi from the Pawnee Grassland shows optimal growth under 25°C (77°F), only two species grow appreciably at 10°C (50°F) but 30 to 40 percent grow at 37°C (98.6°F). Christensen and Beiswenger (1982) suggest that tundra affinities of Wyoming microfungi support Mears' (1981) hypothesis of a steppe tundra community on basin floors underlain by permafrost. They interpret the Wyoming microfungal community as containing relicts from a tundralike soil mycoflora that developed in the late Pleistocene.

SELECT LATE PLEISTOCENE/ HOLOCENE MAMMALIAN SPECIES

The Late Glacial/Pre-Boreal (13,000-9100 years B.P.) mammalian fauna of Wyoming is presently known from 70 localities (Fig. 5). It consists of 18 extinct taxa, ten taxa that survive in other (usually northern) regions and 53 taxa that still are extant in Wyoming today. In addition, there are ten taxa whose distributions during this time were more widespread in the state (Boyce 1980; Brown 1965, 1966; Brown and Metz 1966; Campbell *et al.* 1982; Long 1965; Tomasi and Hoffmann 1984). There are also 48 species in Wyoming today that have not been recorded from the Late Glacial/Pre-Boreal fossil assemblages (Tables 4-8).

Extralimital species of the Late Glacial/Pre-Boreal fauna of Wyoming consist of ten taxa whose modern distributions lie outside Wyoming and seven taxa, while still within Wyoming, which do not occur near their fossil localities. The ten taxa not found in Wyoming today inhabit a variety of regions from arctic tundra to arid deserts of the Southwest. Understanding modern habitats and ecological requirements of these species is fundamental to paleoenvironmental reconstructions.

The 18 extinct and 20 extralimital taxa in the Late Glacial/Pre-Boreal mammalian fauna of the Wyoming Basin are discussed below. Taxonomy follows Kurtén and Anderson (1980) for extinct species and Jones *et al.* (1979) for extant species. Climatic period terminology follows Hoffmann and Jones (1970). Unpublished or undescribed specimens referenced in the following discussion are reposited in collections held by either the Department of Anthropology or the Geological Museum at the University of Wyoming, Laramie. Range maps in Figures 8 through 12 are adapted from Hall and Kelson (1959), Hall (1981) and Long (1965).

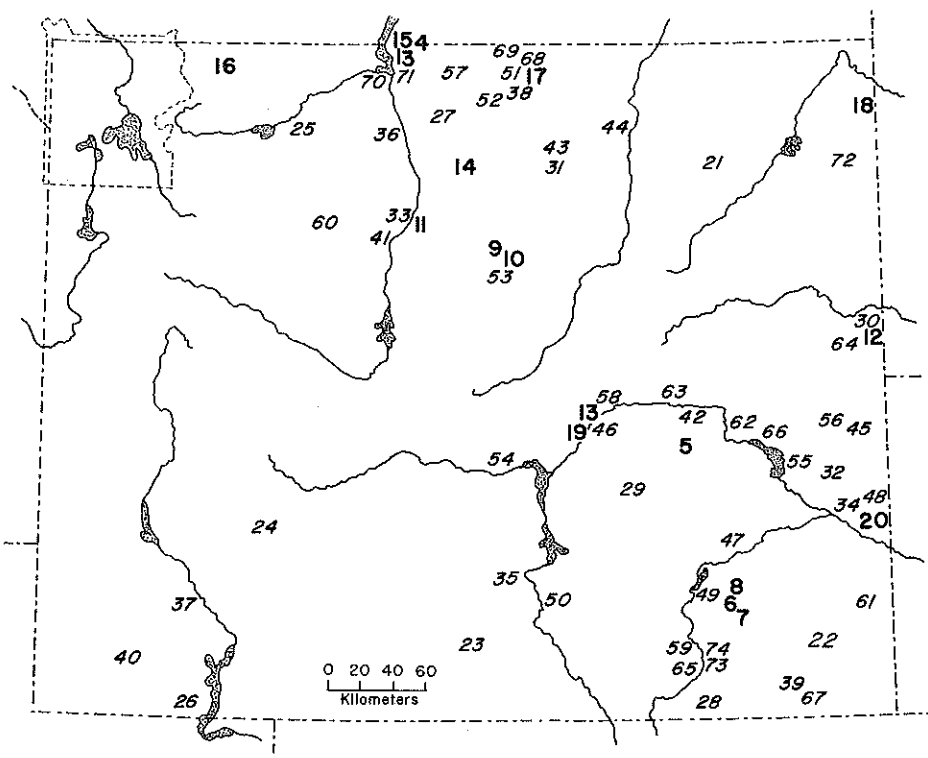

Figure 5. Late Pleistocene and Holocene faunal localities in Wyoming. Identification of sites with more than ten mammalian species (bold face numbers) are given in Table 2. Identification of sites with less than ten mammalian species (italicized numbers) are given in Table 3.

Extinct Species

Martes nobilis (noble marten)

The noble marten is known from Little Box Elder Cave (Anderson 1970), Little Canyon Creek Cave (Walker this report) and Bell Cave (Zeimens and Walker 1974) in Wyoming (Fig. 6a). *Martes nobilis* is slightly larger than *Martes americana* (American pine marten). This size difference, as well as numerous dental and cranial characters, serve to distinguish these two species (Anderson 1970:73-86). Anderson (1970) suggested that like *M. americana*, *M. nobilis* was adapted to cool, boreal environments. However, species associated with *M. nobilis* in Nevada (Grayson 1984) suggest that *M. nobilis* inhabited a variety of environments and should not be used as an indicator of Pleistocene boreal environments. Grayson (1984) found that *M. nobilis* did not become extinct until late in the Holocene and it probably did not compete extensively with *M. americana*.

Canis dirus (dire wolf)

The only Wyoming dire wolf record is from Natural Trap Cave (Martin and Gilbert 1978a) (Fig. 6a) where it occurred in Units 2 and 3 (Chomko and Gilbert this volume). The extant *Canis lupus* (grey wolf) was much more common at Natural Trap Cave (Walker in press), and it is frequently found in other Wyoming late Quaternary local faunas. Kurtén (1984) examined relationships between fore and hind legs in the dire wolf. The forelimb of the nominate subspecies (*C. d. dirus*) was elongated compared to the hindlimb, presumably a cursorial adaptation for open plains or savanna environments.

Arctodus simus (giant short-faced bear)

Arctodus simus is known only from Natural Trap Cave (Martin and Gilbert 1978a) and Little Box Elder Cave (Kurtén and Anderson 1974) in Wyoming, although it was widely distributed in North America during the Rancholabrean (Kurtén and Anderson 1980:180). The only known co-occurrence of *A. simus* and *Ursus arctos* (grizzly bear) in North America south of the continental ice sheets is at Little Box Elder Cave (Fig. 6a). Like *Miracinonyx trumani* (American cheetah) and *Felis atrox* (American lion), *A. simus* also had cursorial adaptations for open plains or savanna habitats. Kurtén (1967) feels that *Arctodus* was much more carnivorous and predatory than any living bear species.

Felis atrox (American lion)

This species was widespread in North America during the Pleistocene (Kurtén and Anderson 1980). Natural Trap Cave (Fig. 5) (Martin and Gilbert 1978b) produced remains of the American lion throughout its stratigraphic sequence (Chomko and Gilbert this volume). Additional Wyoming specimens are known from Little Box Elder Cave (Fig. 5) (Anderson 1968) and the Monolith Gravel Quarry near Laramie (Walker this report) (Fig. 5). The American lion was more cursorial than its modern African counterpart (Martin and Gilbert 1978b), again suggestive of open plains or savanna habitats.

Miracinonyx trumani (American cheetah)

This species is known from a large sample at Natural Trap Cave (Adams 1979, Martin *et al.* 1977). *Miracinonyx* has been recovered throughout the stratigraphic sequence that appears to span the Wisconsinan and Sangamonian stages. A single individual of *M. trumani* is represented by a fragmentary pelvis at Little Canyon Creek Cave (Shaw and Frison 1979) (Fig. 6a). The American cheetah was cursorial and well adapted to hunting on open plains and savanna.

Equus sp. (horse)

Horses are a common large ungulate found in late Quaternary deposits of Wyoming (Fig. 6b). Nine localities, all open sites, have been reported since Anderson's (1974) survey of Pleistocene vertebrates of Wyoming. None have been reported from post-Pleistocene/pre-Columbian cultural sites in Wyoming. *Equus conversidens* (Mexican horse) is the only specific name applied to any of the Pleistocene horses of Wyoming (see Anderson 1967, Walker and Frison 1980), although Gilbert (pers. comm.) reports the presence of four species of horse from the Natural Trap Cave collections. Chomko and Gilbert (this volume) do not distinguish between these species.

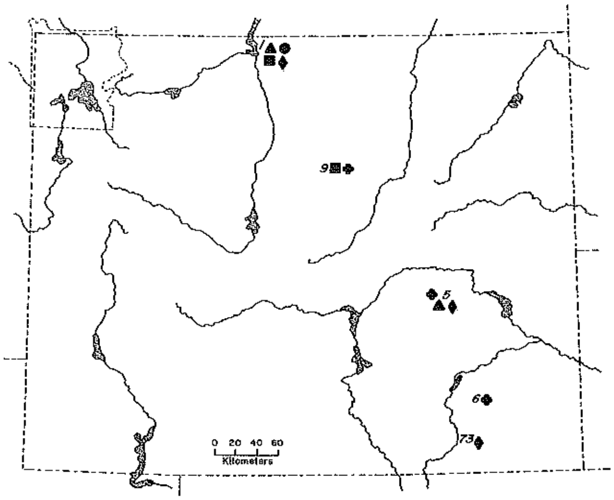

Figure 6a. Late Pleistocene *Miracinonyx trumani* (cheetah) (square), *Arctodus simus* (short-faced bear) (triangle), *Canis dirus* (dire wolf) (circle), *Martes nobilis* (noble pine marten) (cross), and *Felis atrox* (American lion) (diamond) localities in Wyoming. See Tables 2 and 3 for locality numbers and names.

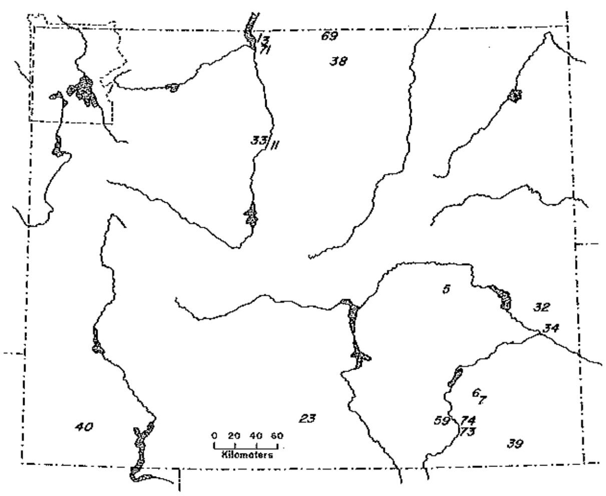

Figure 6b. Late Pleistocene *Equus* sp. (horse) localities in Wyoming. See Tables 2 and 3 for locality numbers and names.

Platygonus compressus (flat-headed peccary)

A single mandibular condyle from the Agate Basin site (Walker 1982a) (Fig. 5) is the only record of this species from Wyoming (Fig 7a). Association with the Folsom occupation at the site is one of the latest occurrences of *Platygonus* in North America. *Platygonus* was a cursorial peccary and the hypsodont nature of its teeth suggest that it was well adapted for grazing (Guilday *et al.* 1971).

Camelops sp. (American camel)

Twelve open sites have been added to the five *Camelops* localities published by Anderson (1974) (Fig. 7b). Four (and possibly five) of these are cultural sites (Frison, Walker, Webb, and Zeimens 1978; Frison and Zeimens 1980; Sharrock 1966; Walker 1982a; Walker and Frison 1980). These specimens are conditionally referred to *C.* cf. *hesternus*, but diagnostic material is usually insufficient to permit positive specific identifications. *Hemiauchenia* sp. (llama) from Little Box Elder Cave (Anderson 1974) is the only other camelid reported from Wyoming but this identification has not been confirmed (J. Indeck pers. comm.).

Navahoceros fricki (mountain deer)

This short-legged, stocky deer is only reported from Little Box Elder Cave (Kurtén 1975) (Fig. 7a), although identified elements are not listed. The genus was adapted to climbing in mountainous environments (Kurtén and Anderson 1980). This may account for its absence at other sites where cursorial species reflect open plains environments.

Ovis canadensis catclawensis (mountain sheep)

There are nine localities in Wyoming where mountain sheep have been recovered from either late Pleistocene or early Holocene deposits (Fig. 7a). Four of these records are isolated skulls (Hanson [Frison and Bradley 1980], Fort Laramie [McGrew 1963], Good Place [Walker this report] and Hot Springs [Rohrer 1966]) and four others are isolated post-cranial elements from either caves or Paleoindian occupation sites (Little Canyon Creek Cave [Shaw 1980], Little Box Elder Cave [Anderson 1968], Bell Cave [Zeimans and Walker 1974] and Pine Springs [Sharrock 1966]). The ninth locality (Natural Trap Cave [Martin and Gilbert 1978a]) contains the largest sample of mountain sheep known from the late Pleistocene in Wyoming.

The taxonomic status of the late Pleistocene mountain sheep in North America is in dispute. Harris and Mundel (1974) conclude that the species *O. catclawensis*, described by Hibbard and Wright (1956), should be considered an extinct temporal subspecies of the extant species *O. canadensis*. However, Martin and Gilbert (1978a) still believe that *O. catclawensis* is a valid species but Xiaoming (1984) has placed the Natural Trap material in *O. canadensis*. Whatever the eventual placement of the taxon, it has a slightly larger skull and appears to be more cursorial than any *O. canadensis* subspecies. Mountain sheep referable to modern forms of *O. canadensis* have been recovered from several Holocene sites in Wyoming (Little Canyon Creek Cave [Shaw 1980], Dead Indian Creek [Frison 1978, Scott and Wilson 1984], and Big Goose Creek [Frison, Wilson, and Walker 1978]).

Symbos sp. (extinct muskox)

This extinct muskoxen is not common in the late Pleistocene/early Holocene fauna of Wyoming. It has been recovered from Natural Trap Cave (Martin and Gilbert 1978a), Prospects Shelter (Chomko 1979a), and Little Canyon Creek Cave (Shaw and Frison 1979) (Fig. 7a). Only a single centrum of a thoracic vertebra was found at Little Canyon Creek Cave, associated with a pre-Clovis cultural occupation (Shaw and Frison 1979). *Symbos* is often considered an open woodlands or parklands inhabitant (Semken *et al.* 1964).

Bison antiquus and *Bison bison occidentalis* (American buffalo or bison)

Figure 7c shows the distribution of *Bison* where the remains were either identified to these taxa on the basis of morphology (primarily skulls) or where the deposits could be correlated with temporal intervals on the chronocline established by Wilson (1975, 1980; see also Walker 1986). Except for Natural Trap Cave, Prospects Shelter, Bell Cave, Little Box Elder Cave, and the C & M Gravel Pit, all localities are archeological sites. Thus, records of late Pleistocene/Holocene bison in Wyoming could be biased by selective human subsistence practices. However, *B. b. bison* was a dominant element in the historic mammalian fauna of Wyoming.

Mammuthus spp. (mammoth)

There are thirty records of *Mammuthus* from Wyoming (Anderson 1974) (Fig. 7d). Three can be attributed to human utilization (Colby site [Frison 1976, Walker and Frison 1980], Union Pacific Mammoth [McGrew 1961] and Sheaman site [Frison and Stanford 1982]) and a fourth, the Hunter Ranch, may also be culturally associated (Walker *et al.* 1984; Walker, Todd, and Frison 1985). All of these specimens, as well as most reported by Anderson (1974) are referable, or probably so, to *M. columbi* (see Madden 1978, 1981). The specimen found near Lingle, Wyoming (Fig. 5) is referred by Madden (1981) to *M. imperator* and therefore of Illinoian age.

Extralimital Species

Sorex hoyi (pygmy shrew)

The pygmy shrew, the smallest mammal in North America, occurs throughout the boreal forest zone, but appears to be most common within the grassy glades of the forest (Banfield 1974). It seasonally utilizes areas where wet and dry soils are associated (Long 1974). It was recorded from the Pleistocene of Little Box Elder Cave (Anderson 1968), far south of its primary distribution (Fig. 8a). However, three relict populations have been found over 800 km (500 mi) farther south of that limit in similar ecological situations at high elevations. The first of these was found west of Fort Collins, Colorado, in moist meadow, forest-meadow transitions, and coniferous forest (Pettus and Lechleitner 1963). Vaughn (1969) recorded the species farther west in a subalpine park and Brown (1966) found the species near Centennial, Wyoming, again in a boggy, sphagnum moss pond area. These relict populations and the fossil record suggest that *S. hoyi* had a much wider distribution during the late Pleistocene.

Cryptotis parva (least shrew)

Cryptotis parva is an eastern woodland species that was recovered from late Pleistocene deposits in the Little Box Elder Cave (Fig. 8b). This is the most northwestern distribution of this species during the late Quaternary, although it has been reported from caves in eastern and western New Mexico (Harris 1984).

The least shrew is presently most common east of the Mississippi River and rare on the Great Plains (Armstrong 1972, Jones 1964). *Cryptotis parva* prefers to live in grassy, weedy, or brush fields (Whitaker 1974) and generally avoids wooded areas. The least shrew is reinvading eastern Colorado today as a result of favorable habitat created by agricultural irrigation (Armstrong 1972). Like *Tamias striatus* (eastern chipmunk), westward expansion of *C. parva*

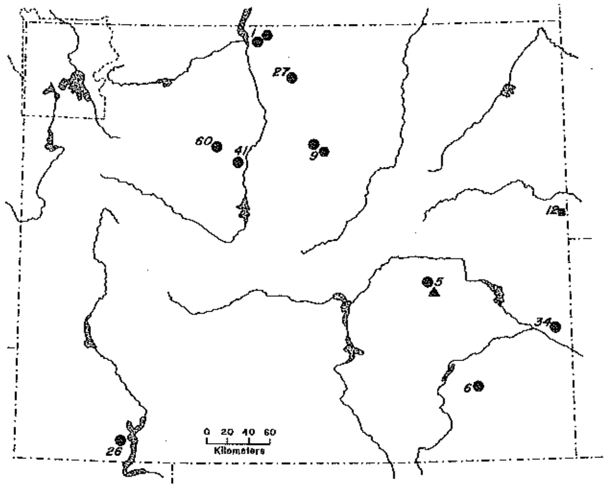

Figure 7a. Late Pleistocene *Symbos* (woodland muskox) (hexagon), *Ovis* (mountain sheep) (circle), *Navahoceros* (mountain deer) (triangle), and *Platygonus* (flat-headed peccary) (square) localities in Wyoming. See Tables 2 and 3 for locality numbers and names.

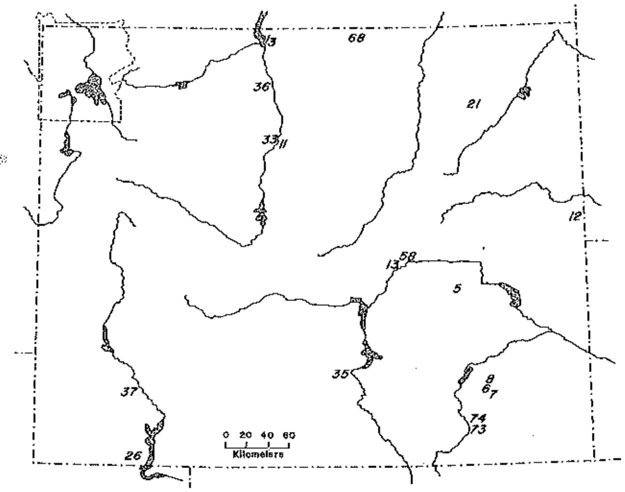

Figure 7b. Late Pleistocene and early Holocene *Camelops* sp. (camel) localities in Wyoming. See Tables 2 and 3 for locality numbers and names.

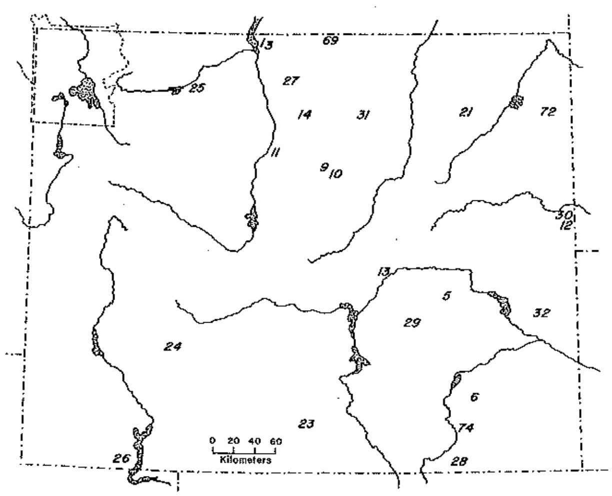

Figure 7c. Late Pleistocene and early Holocene *Bison bison occidentalis* and *Bison antiquus* (bison) localities in Wyoming. See Tables 2 and 3 for locality numbers and names.

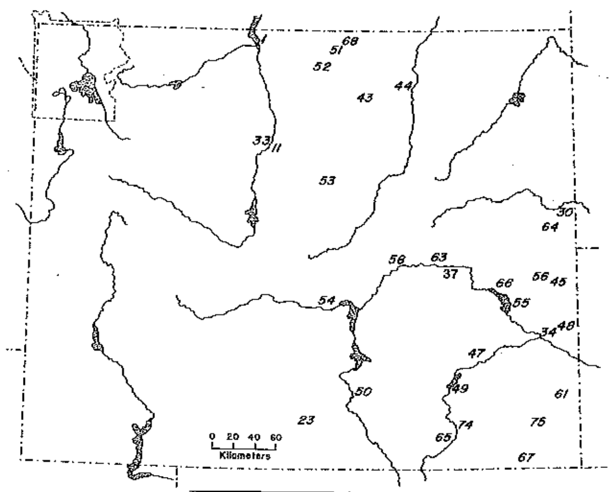

Figure 7d. Late Pleistocene *Mammuthus* sp. (mammoth) localities in Wyoming. See Tables 2 and 3 for locality numbers and names.

reflects moister climates and environments during the late Pleistocene.

Myotis thysanodes (fringe-tailed bat)

The modern range of this bat has recently extended into southeastern Wyoming (Boyce 1980), although it is rare throughout its range. A relict subspecies, which occurs in the Black Hills, prefers coniferous woodlands and desert scrub areas (Armstrong 1972, Jones and Genoways 1967). However, O'Farrell and Studier (1980:3) report that the species can be found from "low desert scrub associations up to fir-pine associations." Little Box Elder Cave, the only known late Pleistocene record, helps confirm, or at least suggests, a common range for populations of the Black Hills and those to the south and west during the late Pleistocene (Fig. 8c).

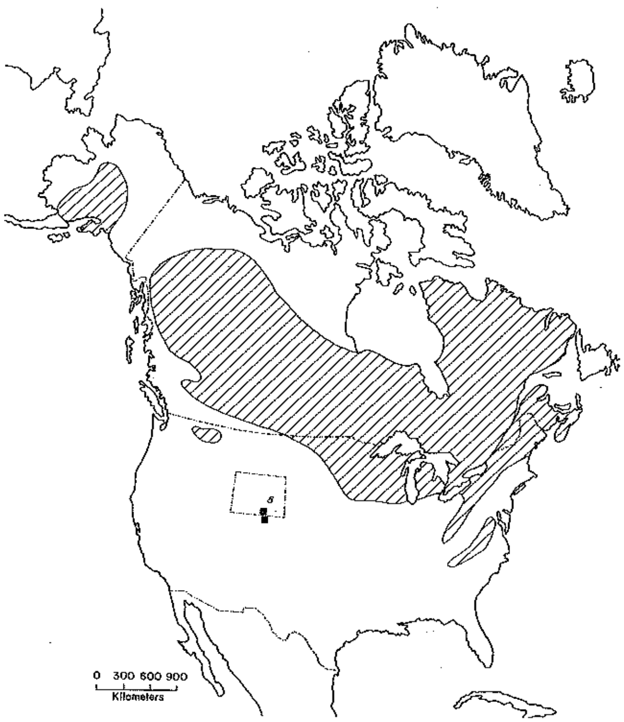

Figure 8a. Modern North American distribution (shaded area and squares) and late Pleistocene *Sorex hoyi* (pygmy shrew) locality in Wyoming. See Table 2 for locality numbers and names.

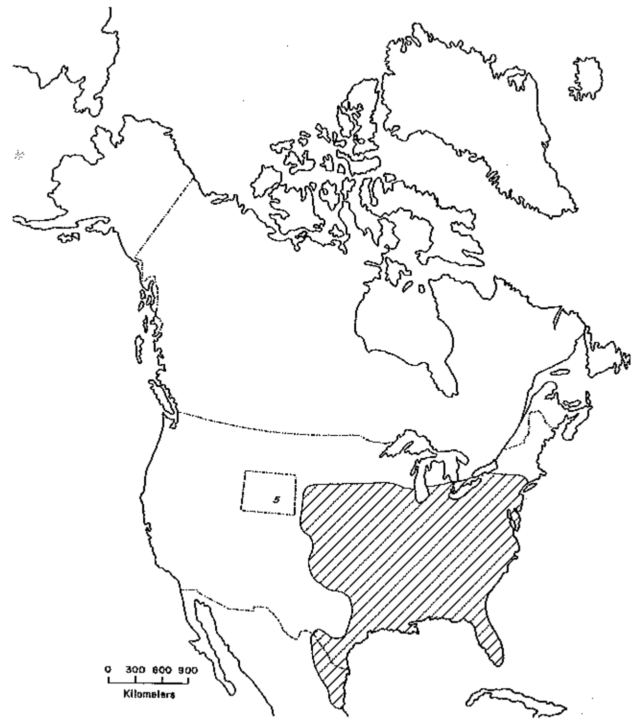

Figure 8b. Modern North American distribution (shaded area) and late Pleistocene *Cryptotis* sp. (least shrew) locality in Wyoming. See Table 2 for locality number and name.

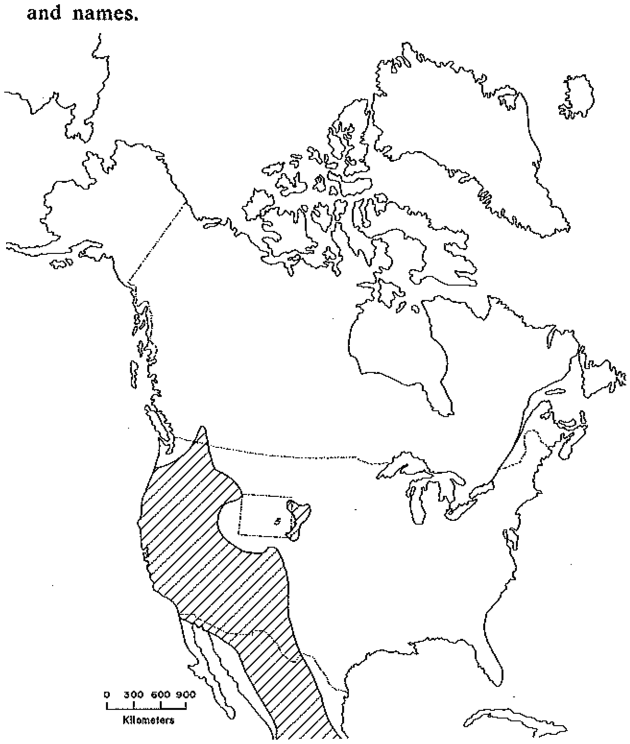

Figure 8c. Modern North American distribution (shaded area) and late Pleistocene *Myotis thysanodes* (fringe-tailed bat) locality in Wyoming. See Table 2 for locality number and name.

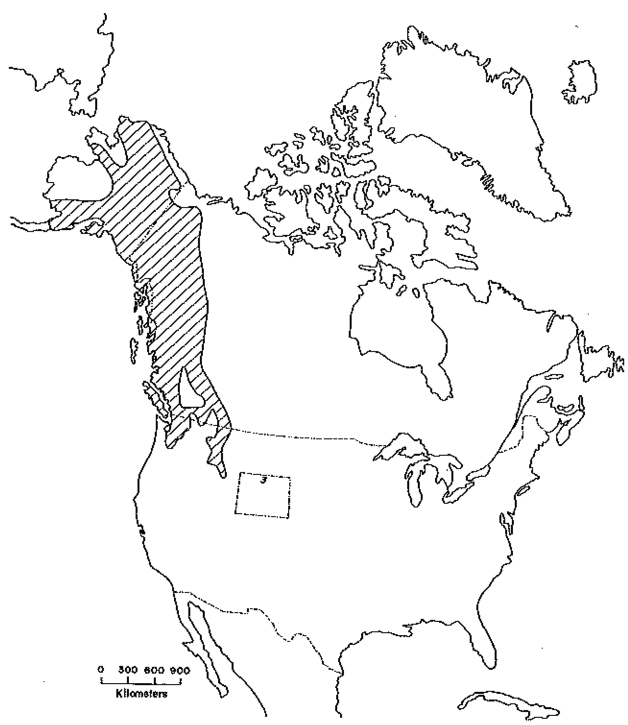

Figure 8d. Modern North American distribution (shaded area) and late Pleistocene *Marmota caligata* (hoary marmot) locality in Wyoming. See Table 2 for locality number and name.

Marmota caligata (hoary marmot)

This large marmot now is found in the alpine tundra of the northern Cordilleran region of North America (Banfield 1974). The only fossil record from Wyoming is from Prospects Shelter (Fig. 8d) (Chomko 1978, 1979a, 1979b). There also is a skull known from a locality near Superior, Montana (Hoffmann and Taber 1967). Thus, the hoary marmot had a different and probably more widespread range during the Pleistocene.

Spermophilus variegatus (rock squirrel)

The rock squirrel is primarily a southwestern species occurring in Utah, Colorado, New Mexico, Arizona, Texas, and Mexico (Hall 1981, Hall and Kelson 1959). Today, *S. variegatus* inhabits rocky canyons and foothills along the Front Range of Colorado, at least as far north as Fort Collins (Armstrong 1972). Although the identification has not been confirmed (J. Indeck pers. comm.), it has been recorded from Little Box Elder Cave, Wyoming (Fig. 9a) (Anderson 1968). Teeth of the rock squirrel have also been recovered from pre-14,000 year B.P. deposits in False Cougar Cave, Pryor Mountains, Montana (Woodman and Graham pers. comm.).

Spermophilus elegans (Wyoming ground squirrel)

This ground squirrel is found in mountain meadows and open grasslands above 1470 m (4900 ft) throughout southern Wyoming (Zegers 1984). Like *Lagurus curtatus* (sagebrush vole), the absence of *S. elegans* from the Bighorn and Powder River basins today is perplexing since excellent habitat appears to be present in both. This absence is even more confounding since *S. elegans* is the most common ground squirrel species in late Pleistocene sites in Wyoming (Fig. 9b).

Neuner (1976) suggests that *S. elegans* and *Spermophilus richardsonii* (Richardson's ground squirrel) evolved as isolated populations from an ancestral *S. richardsonii* complex no earlier than 11,200 years B.P. This evolutionary divergence was presumably caused by habitat differentiation at the end of the Pleistocene. If so, the Pleistocene populations of *S. elegans* from the Bighorn Basin would establish a link between the modern ranges of northern *S. richardsonii* and southern *S. elegans*. However, this still does not explain the species absence from the basin today.

Tamias striatus (eastern chipmunk)

The eastern chipmunk is known from only Prospects Shelter in Wyoming (Chomko 1978, 1979a, 1979b) (Fig. 9c). Today, *T. striatus* inhabits the forests of the eastern United States. The eastern chipmunk prefers open brushy areas in deciduous forest habitats (Snyder 1982), and it is extremely sensitive to moisture gradients (Graham 1984). Its occurrence, more than 800 km (500 mi) west of its present distribution, indicates significantly more moist climates during the late Pleistocene.

Dicrostonyx torquatus (collared lemming)

This microtine seems to be an obligate arctic tundra taxon (Walker 1984). However, it may also be considered an inhabitant of cold environments with heavy snow cover (Walker 1986). It presently is limited to well-drained tundra habitats north of the boreal forest (Banfield 1974), but it was widespread (Fig. 9d) south of the ice sheet during the late Pleistocene (Foley 1984). *Dicrostonyx torquatus* has been recorded from six sites in Wyoming (Natural Trap Cave and Prospects Shelter [Martin *et al.* 1979], Little Canyon Creek Cave [Shaw and Frison 1979], Little Box Elder Cave [Guilday 1968], Bell Cave [Zeimans and Walker 1974], and Bush Shelter [Walker 1984]). In addition, there is one late Pleistocene locality in eastern Idaho (Kurtén and Anderson 1972) and one from north-central Nebraska (Falk *et al.* 1980, Voorhies 1981). These records suggest that *Dicrostonyx* was widespread on the northern plains (Walker 1984) as well as other areas of the midcontinent during the late Pleistocene (Foley 1984).

The specimens from New Paris No. 4, Pennsylvania (Guildav *et al.* 1964). represent the only record of the other species, *Dicrostonyx hudsonius* (Hudson Bay collared lemming) south of the Pleistocene continental ice sheet. Thus, both species developed before their modern separation by Hudson Bay as proposed by Guilday (1968).

Synaptomys borealis (northern bog lemming)

This microtine rodent is found in the boreal forest region of North America (Fig. 10a) and mainly occurs in sphagnum/spruce bogs, but also may be found in deep, mossy spruce woods, wet subalpine meadows, and alpine tundra (Banfield

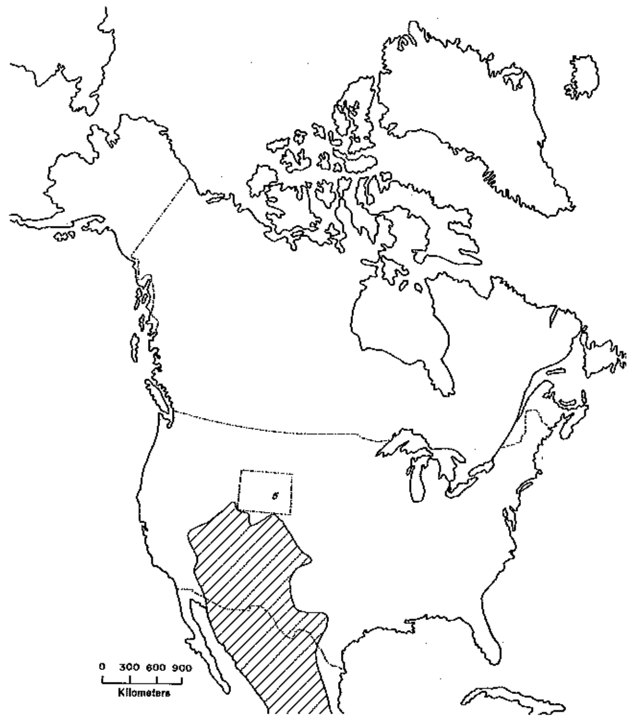

Figure 9a. Modern North American distribution (shaded area) and late Pleistocene *Spermophilus variegatus* (rock squirrel) locality in Wyoming. See Table 2 for locality number and name.

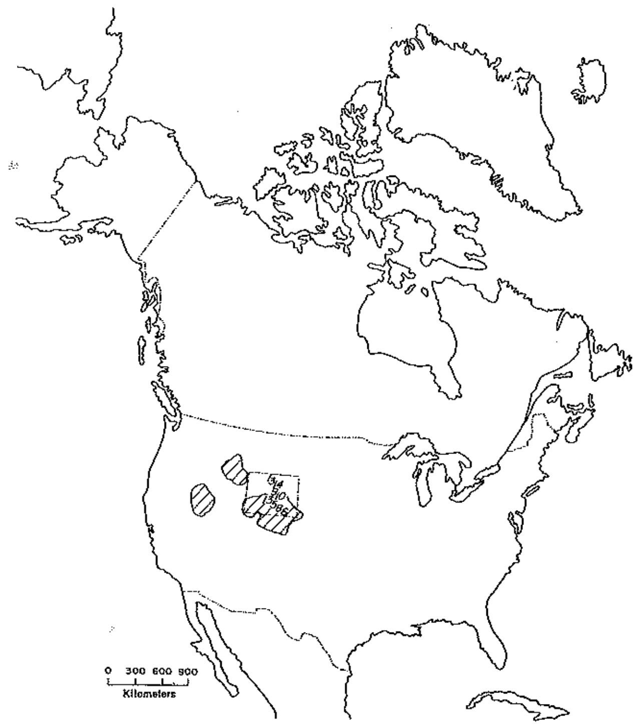

Figure 9b. Modern North American distribution (shaded area) and late Pleistocene/early Holocene *Spermophilus elegans* (Wyoming ground squirrel) localities in Wyoming. See Table 2 for locality numbers and names.

Figure 9c. Modern North American distribution (shaded area) and late Pleistocene *Tamias striatus* (eastern chipmunk) locality in Wyoming. See Table 2 for locality number and name.

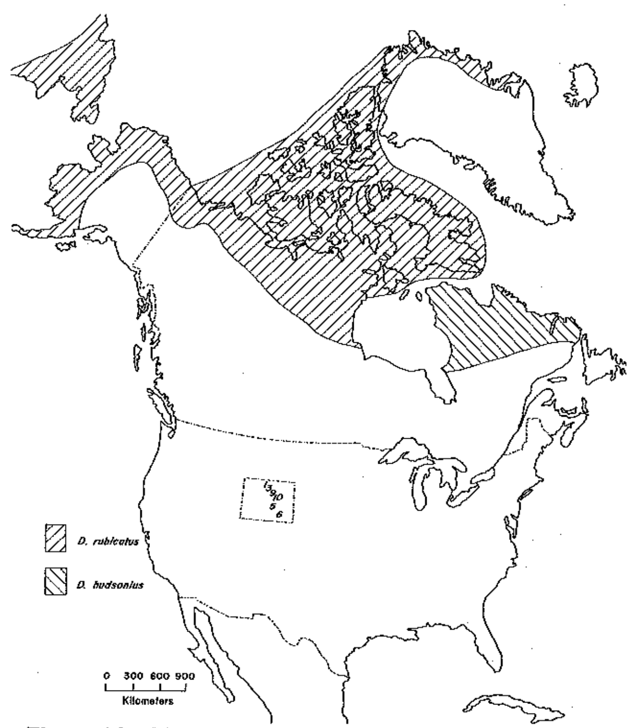

Figure 9d. Modern North American distribution (shaded area) and late Pleistocene *Dicrostonyx torquatus* (collared lemming) localities in Wyoming. See Table 2 for locality numbers and names.

1974). The species has been recorded only from Prospects Shelter (Chomko 1978, 1979a, 1979b), although with additional work on microfaunas, it may prove to be more common.

Phenacomys intermedius (heather vole)

While ubiquitous over its range, the heather vole is a rare member of modern mammalian communities (Armstrong 1972, Banfield 1974). Heather voles generally occur around marshes or streams in pine or spruce forests (Banfield 1974). Guilday and Parmalee (1972) concluded that the biostratigraphic value of *P. intermedius* is limited but the species is a good paleoclimatic indicator for boreal conditions. The heather vole, like many other boreal species, expanded its distribution during the late Pleistocene (Fig. 10b).

Clethrionomys gapperi (boreal red-backed vole)

This vole prefers moist habitats with abundant litter stumps and logs in coniferous forests but has been found in hardwood deciduous forests as well (Merritt 1981). The boreal red-backed vole is known from eight Wyoming sites outside its present range (Fig. 10c). The Pleistocene distribution reflects cooler and moister climatic conditions extended to lower elevations in the Wyoming Basin.

Microtus pennsylvanicus (meadow vole)

The meadow vole prefers low moist areas or high grasslands with rank vegetation (Reich 1981). Today, *M. pennsylvanicus* occurs throughout much of northern North America but during the late Pleistocene it extended much farther south (Lundelius *et al.* 1983). Relict populations along the North Platte River in Nebraska (Jones 1964) and the South Platte River in Colorado (Armstrong 1972) are probably the consequence of late Quaternary environmental changes. Widespread late Pleistocene distribution in southeastern Wyoming (Fig. 10d) supports such a contention.

Microtus xanthognathus (yellow-cheeked vole)

This boreal forest vole may occasionally occur in sphagnum bogs (Banfield 1974) or lake/forest borders (Douglass and Douglass 1977). The species was widespread in eastern North America during the late Pleistocene (Hallberg *et al.* 1974), but a single record from Prospects Shelter is the only known Wyoming locality (Fig. 11a) (Chomko 1978, 1979a, 1979b).

Lagurus curtatus (sagebrush vole)

Specimens of this microtine are rare in museum collections today. It now is limited in Wyoming to southern and central parts of the state in the Transition Zone between Upper Sonoran and Canadian life zones (Fig. 11b) (Long 1965). *Lagurus* is generally found in semi-arid prairies in areas of loose soil (Carroll and Genoways 1980) associated with sagebrush or sparsely covered grasslands mixed with sagebrush and *Sarcobatus* (greasewood) (Armstrong 1972, Banfield 1974). Most extralimital late Pleistocene records in Wyoming are in the Bighorn Basin of north-central Wyoming (Fig. 11b). Since excellent habitat apparently still exists there its absence in the basin today is not easily explained.

Ochotona princeps (pika)

This species is common along the talus slopes above timberline in the alpine tundra of Wyoming (Long 1965). During the late Pleistocene, *O. princeps* ranged to lower elevations (Fig. 11c) and probably remained there until after 7000 years B.P. (Walker, Frison, and Miller 1985). The late withdrawal to higher elevations is also confirmed by *Ochotona* remains from early-middle Holocene deposits in False Cougar Cave, Carbon County, Montana (Woodman and Graham pers. comm.). *Ochotona* is absent from the late Holocene and modern fauna of the Pryor Mountains.

Brachylagus idahoensis (pygmy rabbit)

The pygmy rabbit inhabits the arid Basin and Range province today (Durrant 1952, Green and Flinders 1980). A recent range expansion into the western basins of Wyoming has been recorded (Campbell *et al.* 1982). The species has also been recorded from one late Pleistocene locality in Wyoming, Natural Trap Cave (Fig. 11d) (L. D. Martin, pers. comm.), although Chomko and Gilbert (this volume) do not list the species from the site. *Brachylagus idahoensis* has been found in four late Pleistocene localities (Moonshiner Cave, Jaguar Cave, Middle Butte Cave, and Rainbow Beach) in Idaho (Kurtén and Anderson 1980, White *et al.* 1984).

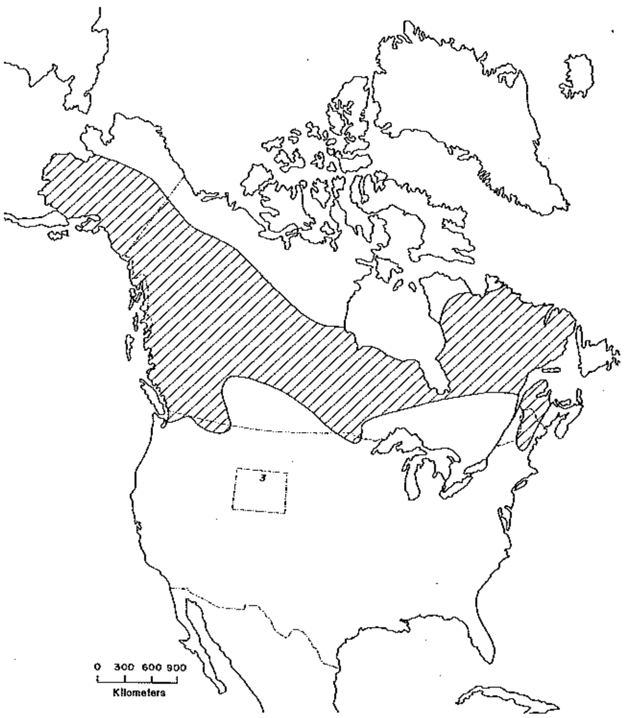

Figure 10a. Modern North American distribution (shaded area) and late Pleistocene *Synaptomys borealis* (northern bog lemming) locality in Wyoming. See Table 2 for locality number and name.

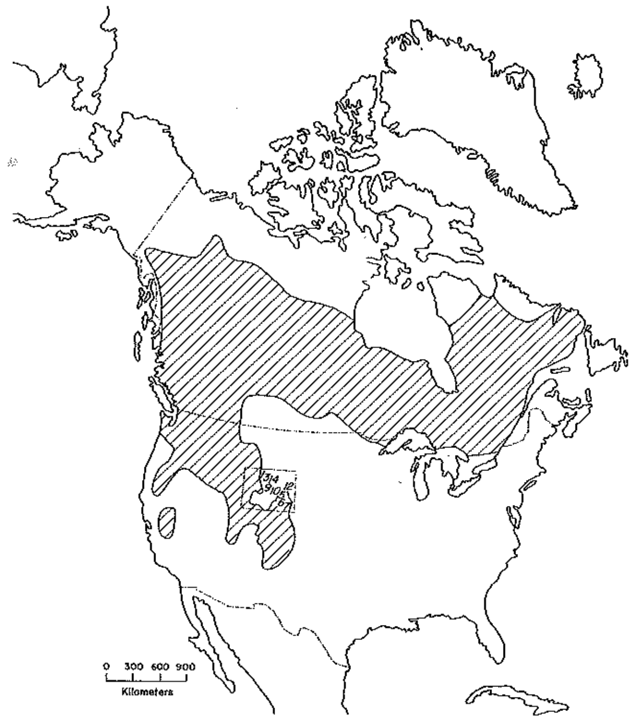

Figure 10b. Modern North American distribution (shaded area) and late Pleistocene/early Holocene *Phenacomys intermedius* (heather vole) localities in Wyoming. See Table 2 for locality numbers and names.

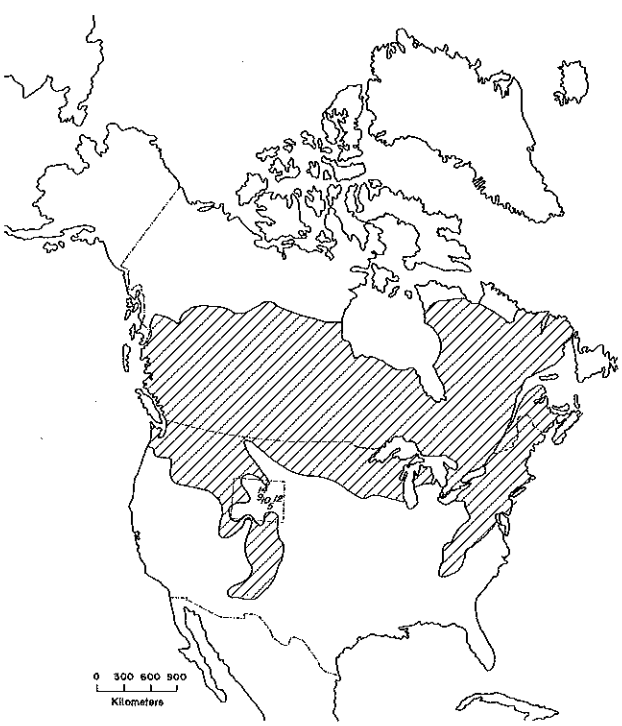

Figure 10c. Modern North American distribution (shaded area) and late Pleistocene/early Holocene *Clethrionomys gapperi* (red-backed vole) localities in Wyoming. See Table 2 for locality numbers and names.

Figure 10d. Modern North American distribution (shaded area) and late Pleistocene/early Holocene *Microtus pennsylvanicus* (meadow vole) localities in Wyoming. See Table 2 for locality numbers and names.

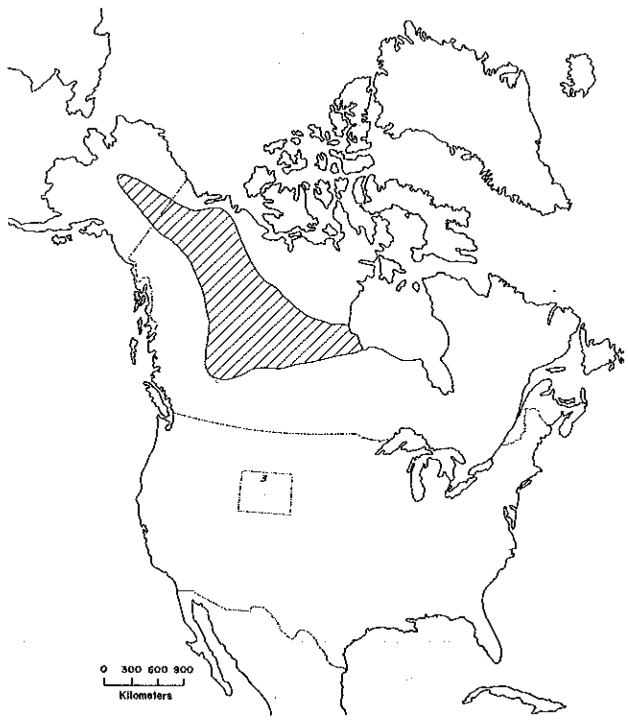

Figure 11a. Modern North American distribution (shaded area) and late Pleistocene *Microtus xanthognathus* (yellow-cheeked vole) locality in Wyoming. See Table 2 for locality number and name.

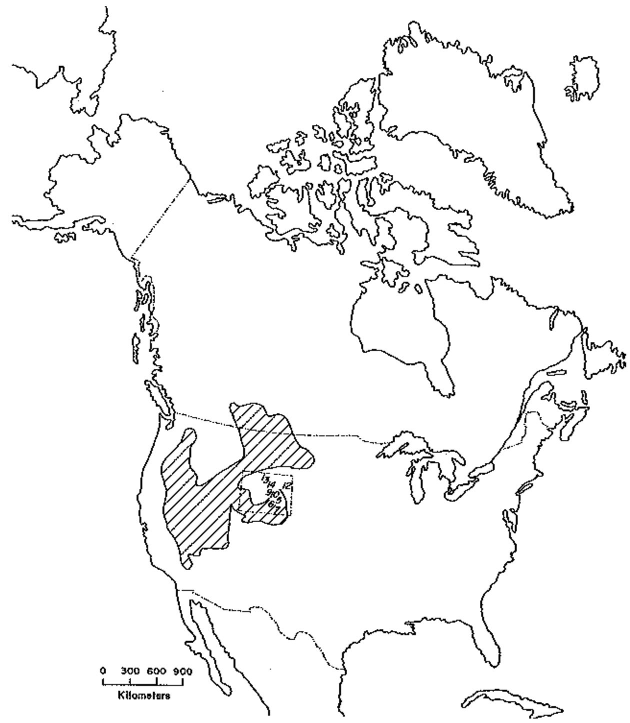

Figure 11b. Modern North American distribution (shaded area) and late Pleistocene/early Holocene *Lagurus curtatus* (sagebrush vole) localities in Wyoming. See Table 2 for locality numbers and names.

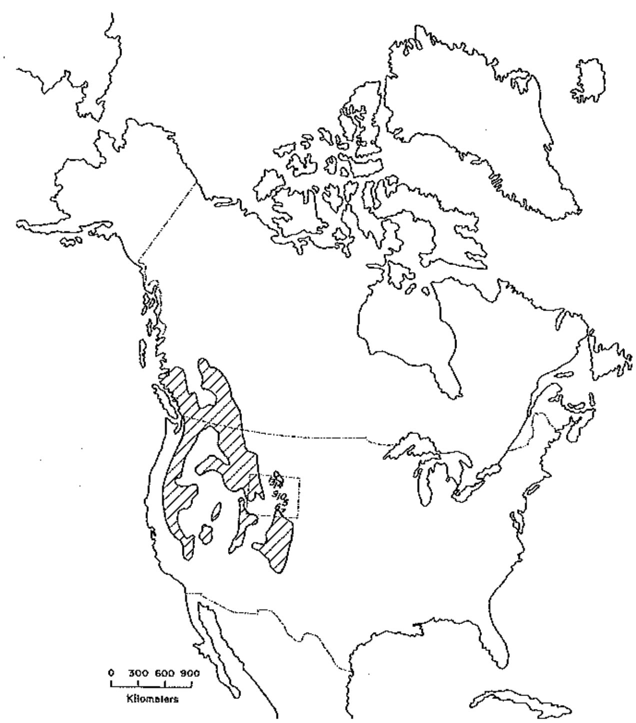

Figure 11c. Modern North American distribution (shaded area) and late Pleistocene *Ochotona princeps* (pika) localities in Wyoming. See Table 2 for locality numbers and names.

Figure 11d. Modern North American distribution (shaded area) and late Pleistocene *Brachylagus idahoensis* (pygmy rabbit) locality in Wyoming. See Table 2 for locality number and name.

Rangifer tarandus (caribou)

Two specimens of caribou have recently been recovered from Wyoming (Fig. 12a). The first specimen, a partial antler, was found in gravels of the Tongue River during removal of overburden from a north-central Wyoming coal mine. *Equus* sp. and *Bison* sp. were preserved in the same deposits. The second record, a basal antler fragment, is from the Sheridan Elks Club Cemetery in the Bighorn Mountains. These two localities, less than 20 km (12.5 mi) apart, suggest either widely distributed or migrating populations of caribou in northern Wyoming basins during the late Pleistocene. These records of caribou add another tundra inhabitant to the late Pleistocene of Wyoming.

Antilocapra americana (pronghorn)

The pronghorn was more widely distributed but less abundant than at present during the late Pleistocene. It has been identified from ten localities (Fig. 12b), some of which are outside of the pronghorn's modern range. This is one of a few species that apparently exhibits no significant size reduction between late Pleistocene and modern individuals. This monospecific antelope is highly cursorial and adapted to open prairies (O'Gara 1978). There is no evidence, as yet, for other antilocaprids (e.g., *Capromeryx*, *Stockoceros*) in Wyoming during the late Pleistocene.

Oreamnos americanus (mountain goat)

Fossil remains of mountain goats have been found at three localities within the Laramie Range, southeastern Wyoming (Fig. 12c) (Anderson 1968, Guilday *et al.* 1967, Zeimens and Walker 1974). *Oreamnos* is not a natural part of the modern fauna of Wyoming, existing populations invaded the state from stock introduced in Montana around 1942 (Long 1965). The three fossil records from Wyoming and the relict populations in the Black Hills indicate that the species had a wider distribution during the late Pleistocene.

Ovibos moschatus (barren-ground muskox)

This obligate arctic tundra species has been recovered from the Pleistocene of Wyoming (Walker 1982b) (Fig. 12d). *Ovibos* occurs today in scattered regions of the Arctic, browsing on willows and grazing on grasses (Banfield 1974). However, Harington (1970) considered *Ovibos* to have been more of a steppe species in the late Pleistocene. Its late Pleistocene distribution south of the continental ice was sporadic and it has never been found in large numbers in any Pleistocene local faunas (Harington 1978). *Symbos* apparently had a wider geographic distribution than *Ovibos*.

The specimen of *Ovibos* from near Douglas, Wyoming (Walker 1982b), is considered to be Wisconsinan in age. Reheis *et al.* (1984) reported another specimen from the Bighorn River terraces in north-central Wyoming that is regarded as late Illinoian.

LATE PLEISTOCENE/HOLOCENE MAMMALIAN LOCAL FAUNAS

There are 20 known paleontological and archeological localities (Table 2, Fig. 5) in the Wyoming Basin (12 late Pleistocene and eight Holocene) that contain faunas (Tables 4-8) with sufficient numbers of mammalian species to adequately discuss zoogeography and paleoenvironments. A brief discussion of each of these sites, which have been grouped geographically, is presented below.

Northern Bighorn Mountains and Absaroka Mountains

One cave and three rockshelters in the Little Mountain area (Taucher 1953, Willis 1953) of the northern Bighorn Mountains have provided the most data on Full and Late Glacial mammal communities of Wyoming. Today, Little Mountain is semi-arid with less than 19.3 cm (7.6 in.) mean annual rainfall (Alyea and Pochap 1976). The vegetation is predominantly composed of *Juniperus communis* (common juniper), *Artemesia tridentata* (big sagebrush), *Cercocarpus parvifolus* (mountain mahogany), and numerous short grasses. Isolated stands of *Pinus flexilis* (limber pine), *Picea englemannii* (Englemann spruce) and *Pseudotsuga mensiesii* (Douglas fir), are found along stream bottoms or protected canyon walls. The modern mammalian fauna is not extensive, and most larger species are migratory (Chomko 1979a).

Full glacial faunas are known from Natural Trap Cave and Prospects Shelter (Fig. 5, Table 4). In addition, Natural Trap Cave may contain a

Figure 12a. Modern North American distribution (shaded area) and late Pleistocene *Rangifer tarandus* (caribou) localities in Wyoming. See Table 3 for locality numbers and names.

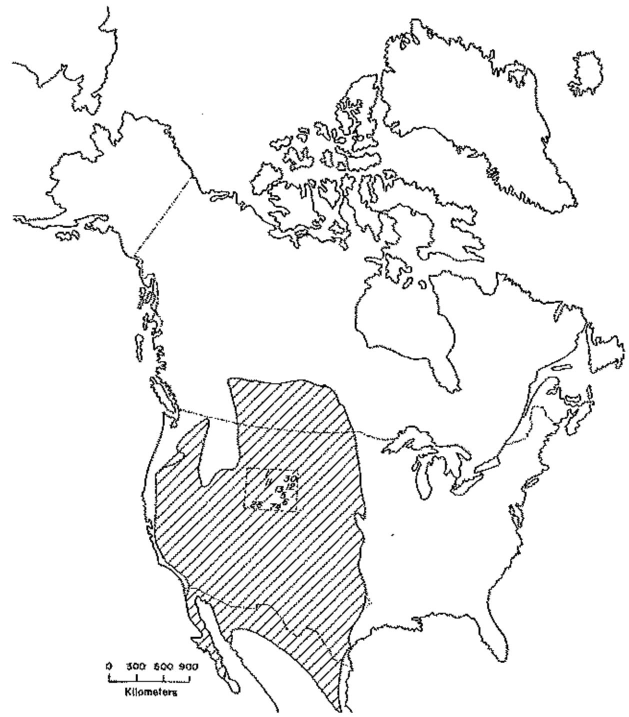

Figure 12b. Modern North American distribution (shaded area) and late Pleistocene/Holocene *Antilocapra americana* (pronghorn) localities in Wyoming. See Tables 2 and 3 for locality numbers and names.

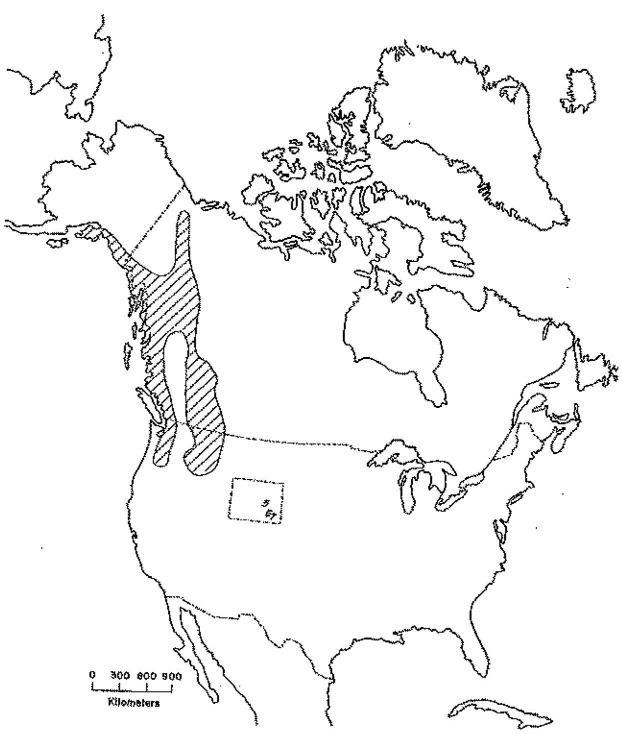

Figure 12c. Modern North American distribution (shaded area) and late Pleistocene *Oreamnos americanus* (mountain goat) localities in Wyoming. See Table 2 for locality numbers and names.

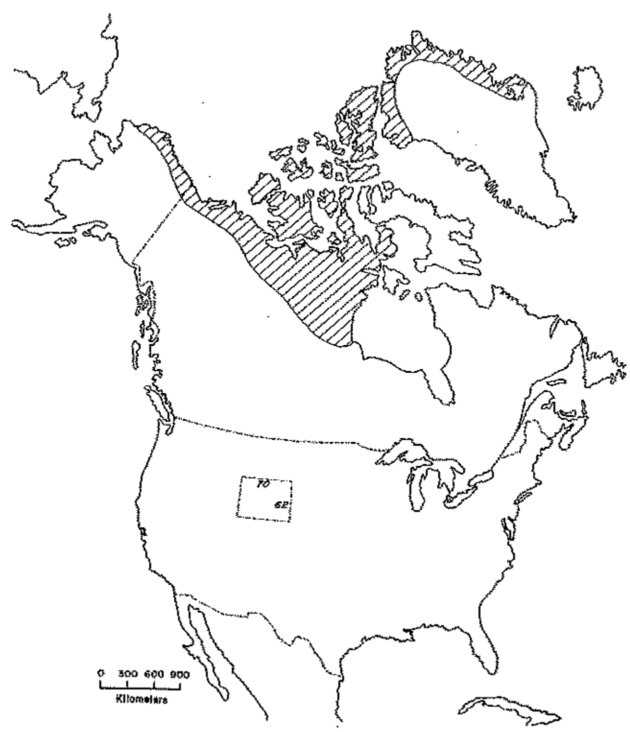

Figure 12d. Modern North American distribution (shaded area) and late Pleistocene *Ovibos moschatus* (muskox) localities in Wyoming. See Table 3 for locality numbers and names.

stratified record of early Wisconsinan and Sangamonian faunas. The Full Glacial faunas from Little Mountain suggest either a steppe tundra similar to that in the Alaskan refugium (Guthrie 1968a, 1968b) or a community like the modern high alpine tundra in the Bighorn Mountains (Chomko 1979a, 1979b; Chomko and Gilbert this volume; Gilbert *et al.* 1978). The environment became more grasslandlike between 14,000 and 11,000 years B.P. as tundra species became rare in the fauna. After 11,000 years B.P., the environment approached modern conditions, and the 7500 year old faunule from Eagle Shelter is identical to the modern fauna (Chomko 1982).

The Dead Indian Creek site (Fig. 5, Table 8) is found in the high altitude Sunlight Basin in the Absaroka Mountains of northwestern Wyoming (Frison and Walker 1984). It lies along the present stream channel of Dead Indian Creek, just above that creek's junction with Sunlight Creek. The modern environment is riverine, with boreal forests immediately adjacent to the stream. The fauna, which dates between 4180 and 4430 years B.P., is dominated by *Odocoileus hemionus* (mule deer) and *Ovis canadensis* (mountain sheep). Other species in the fauna reflect an environment similar to the modern one (Scott and Wilson 1984).

Southern Bighorn Mountains and Bighorn Basin

Two rockshelters, Little Canyon Creek Cave and Bush Shelter, in the southern Bighorn Mountains have recently been tested, and both contain small, but significant Late Glacial faunas. Extensive Holocene (mainly Archaic period) faunas are also present. The modern environment around Little Canyon Creek Cave (Fig. 5, Table 6) (Shaw 1980) is semi-arid. Although the cave is found on the edge of a riverine community that is dominated by *Populus* sp. (cottonwood), *Salix* sp. (willow), and *Acer negundo* (boxelder), juniper stands and big sagebrush dominate the uplands.

The late Pleistocene fauna, similar to those of Natural Trap Cave and Prospects Shelter, is associated with a possible Pre-Clovis cultural component (Shaw and Frison 1979). This Late Glacial fauna was below a stratigraphic unconformity, with a date of 10,170±250 years B.P. on the cultural level above the unconformity. Archaic period deposits were preserved in another section of the site (Shaw 1980). The fauna from the Archaic deposits has not been fully analyzed but it should present a good mid-Holocene mammalian record for the Bighorn Mountains.

Bush Shelter, tested during the summers of 1980 and 1984, is located 10 km (6.25 mi) north of Little Canyon Creek Cave (Fig. 5) in the southern Bighorn Mountains (Walker, Frison, and Miller 1985). The modern environment is similar to that at Little Canyon Creek Cave. The total depth of the deposits is unknown, but more extensive Pleistocene deposits are preserved (Fig. 13) than at Little Canyon Creek Cave. Excavations in 1980 resulted in recovery of large amounts of small mammal material directly below a 9000±270 years B.P. level, with several species no longer locally extant. In 1984, excavations concentrated on clarifying stratigraphic relationships and obtaining a Holocene sequence of small mammal remains from overlying deposits. Preliminary analyses (Tables 6 and 7) demonstrate distinct changes in species composition of the Bush Shelter l.f. through time. One meter below the 9000 years B.P. level, *Dicrostonyx* occurs in larger numbers than either *Ochotona*, *Phenacomys*, *Clethrionomys*, or other microtines. Thirty-five centimeters below the 9000 years B.P. level, *Phenacomys* and *Clethrionomys* increase in abundance and *Dicrostonyx* has almost disappeared. At the 9000 years B.P. level, *Phenacomys* becomes rare and *Dicrostonyx* disappears. Composition of modern microtine guilds is beginning to form.

The pika persists in the fauna until just below the Early Plains Archaic cultural levels. This record is much later than any previously documented in the southern Bighorn Mountains. The Bush Shelter faunal sequence illustrates the individualistic response of species to environmental change.

The Big Goose Creek site (Fig. 5, Table 8) is situated along the eastern slope of the Bighorn Mountains in north-central Wyoming (Frison, Wilson, and Walker 1978). Willow and cottonwood dominate the vicinity and the uplands support well-developed grasslands. The Big Goose Creek l.f. dates between 450 and 530 years B.P. (Frison, Wilson, and Walker 1978). Few environmentally sensitive species were recovered during excavations, but those identified represent habitats similar to those in the area today.

The Colby site (Fig. 5, Table 5) (Frison 1976) is a Clovis mammoth kill site in the southern

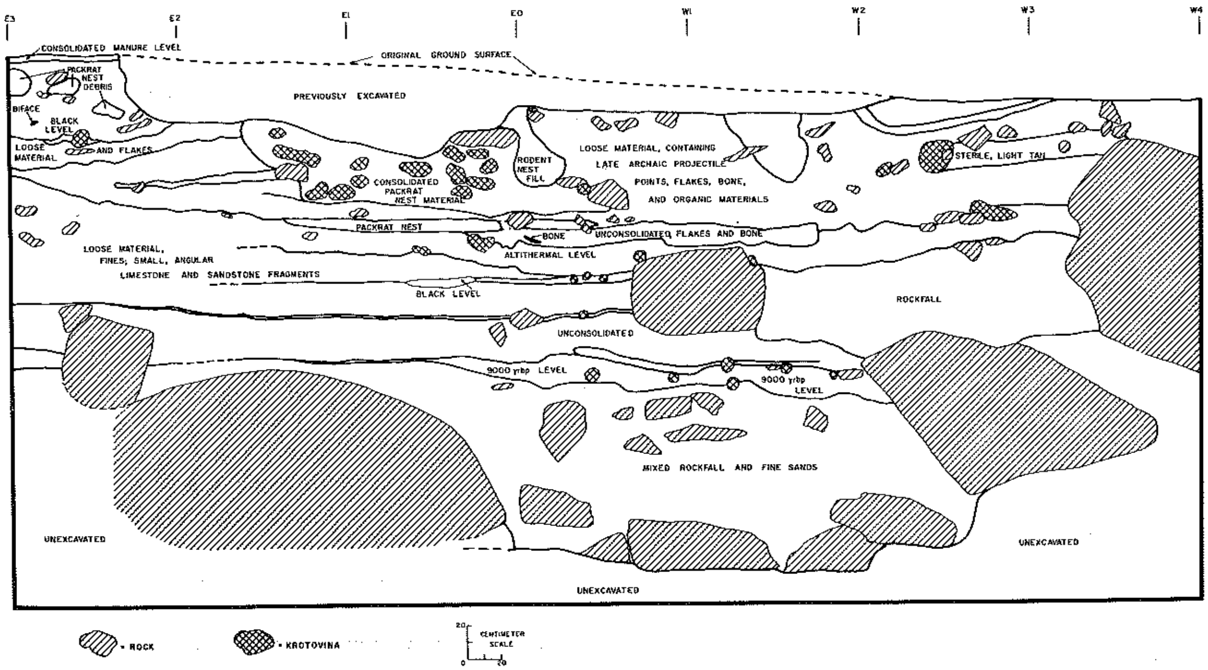

Figure 13. Stratigraphic profile along south 5.2 meters at Bush Shelter, Washakie County, Wyoming.

Bighorn Basin. Modern vegetation around the site is primarily *Atriplex* spp. (saltbush) and sagebrush, with only a sparse short-grass covering below the shrubs. The megafauna from the site is similar to others of the 11,000-12,000 years B.P. time period in the Bighorn Basin and Bighorn Mountains region. No microfauna except for an occasional *Lepus* bone was recovered (Walker and Frison 1980). Based on the prevalence of grazing mammals (*Mammuthus*, *Camelops*, *Equus*) and on phytoliths (MacDonald 1974), it can be concluded that the late Pleistocene environment was predominantly tall grasses.

The Medicine Lodge Creek site (Fig. 5, Table 7) is a deeply stratified occupation on the western slope of the Bighorn Mountains. The site lies at the base of a large sandstone overhang less than 200 m (660 ft) from Medicine Lodge Creek. The uplands are covered by a sagebrush/juniper community, with extensive *Pinus contorta* (lodgepole pine) forests less than three km (1.86 mi) east.

One cultural level (9590±180 years B.P.) near the bottom of the excavated deposits (Frison 1978, Walker 1975a) contained an extensive small mammal faunule in a midden apparently resulting from subsistence debris (Walker 1975a). The presence of *Ochotona*, *Clethrionomys*, and *Phenacomys* in the level suggests that boreal forests may have extended down Medicine Lodge Creek valley to at least 1463 m (4828 ft) during the Pre-Boreal. The faunule may also result from human foraging activities at higher elevations, and therefore, may not reflect environmental change (Walker 1975a). While still culturally derived, these species reflect regional environments apparent at other sites. Small mammals were present throughout the remainder of the sequence at Medicine Lodge Creek, but samples were insufficient for paleo-environmental interpretations.

The abundance of *Lagurus* in large numbers in the midden (MNI = 180) is noteworthy. This species is not known from the Bighorn Basin today (Long 1965) although the modern environment appears favorable for sagebrush voles. Presumably its absence is the result of environmental change. The apparent abundance of *Lagurus* throughout the Holocene deposits at Medicine Lodge Creek may be the consequence of feeding by owls. Owl pellets may produce extensive bone accumulations of species that appear to be rare in the natural environment. *Notiosorex* (gray shrew), which like *Lagurus* is difficult to trap, was found in high concentrations in an owl pellet accumulation in Texas (Raun 1960).

Laramie Range

The first late Pleistocene Wyoming local fauna studied in detail was the Little Box Elder Cave l.f. (Fig. 5, Table 5) (Anderson 1967, 1968, 1970; Kurtén 1975; Kurtén and Anderson 1974; Long 1971). Today, this site is situated in a mountain mahogany community at the eastern base of the Laramie Range. Isolated stands of limber pine occur within 2 km (1.24 mi) of the cave, willow, boxelder, and *Populus sargentii* (cottonwood) exist along Little Box Elder Creek less than 1.5 km (0.93 mi) from the cave. An open short-grass prairie, typical of eastern Wyoming, is found within 1 km (0.62 mi) to the north.

At least 60 mammalian (Anderson 1968) and 70 avian (Emslie 1983, 1985) species have been identified from Pleistocene and Holocene deposits in Little Box Elder Cave (Table 5). The Late Glacial faunule, which has not been accurately dated radiometrically, contains an exceptional record of both large and small mammals (Anderson 1968). Due to the depths, irregular stratigraphic contacts, and mixture of the deposits, a series of radiometric dates is needed to adequately document the range of time represented by the stratigraphic sequence. Absence of charcoal necessitates the use of bone collagen or apatite dates for the lower deposits. Radiocarbon dates on these substances are frequently plagued with contamination problems (Land *et al.* 1980, Stafford *et al.* 1982).

Recent excavations (Indeck and Walker 1983) have shown that over 1.5 m (4.9 ft) of Holocene deposits are preserved in the rear of the cave. A radiometric date on organic remains from a *Neotoma* (woodrat) deposit, located just above the Pleistocene/Holocene disconformity, provides a minimal date of 9250±230 years B.P. This marks the beginning of the Holocene sedimentation. A second date of 2720±120 years B.P. is from a small cultural feature less than 0.5 m (1.6 ft) below the surface that did not contain any diagnostic artifacts.

Anderson (1968) postulated both a cooler and wetter climate as well as a possible lowering of life zones in the area of Little Box Elder Cave during the late Pleistocene. As the climate warmed during the Boreal and Atlantic periods, several of the boreal taxa were replaced by species adapted to more xeric environments found south and east of the cave today.

Bell Cave (Fig. 5, Table 5) lies about 109 km (68 mi) south of Little Box Elder Cave along a canyon in the Laramie Range. This canyon is one of few that provides easy access to the top of the Laramie Range from the floor of the Laramie Basin. The present environment, similar to that at Little Box Elder Cave, is dominated by mountain mahogany, big sagebrush, and grasses. A small stand of pine is found about 2 km (1.24 mi) to the east of the cave.

Only preliminary investigations have been conducted on the Bell Cave l.f. (Walker 1974, Zeimens and Walker 1974), but to date, 44 mammalian and 10 avian species have been identified. This local fauna, while smaller in total numbers of specimens, is similar in species composition to that of Little Box Elder Cave; therefore, these two local faunas accumulated under similar environments. Recently, a bone collagen date of 12,240±330 years B.P. was obtained for this fauna.

Horned Owl Cave (Fig. 5, Table 6) is in the opposite canyon wall just south of Bell Cave. Because of the mixed nature of the deposits and limited controlled excavations, the Horned Owl Cave l.f. is small in both total numbers of species and specimens. This local fauna has not been dated radiometrically. However, like the Bell Cave l.f. and the Little Box Elder Cave l.f., species composition of the Horned Owl Cave l.f. suggests that the late Pleistocene climates were cooler and moister (Guilday *et al.* 1967).

Tina-Ann's Cave (Fig. 5, Table 6) is about 9.92 km (6.2 mi) north of Bell and Horned Owl caves. Stands of pine are not present near Tina-Ann's Cave today, probably because of intensive use by Euro-american settlers and gold miners in the region (Tom Moore pers. comm.) and not due to climatic change. Only limited test excavations have been conducted at Tina-Ann's Cave and these indicate that the fossiliferous deposits exceed one meter in thickness. Eleven species of mammals have been recovered (Table 6). All, except *S. elegans*, occur in the Little Box Elder Cave l.f. Analysis of Tina-Ann's Cave l.f. is continuing and additional excavations are planned.

The Casper site (Fig. 5, Table 7) (Frison 1974), another bison kill, has produced a limited local fauna. The site is located in an extensive but stabilized sand dune field that was active during the early Holocene (Albanese 1974). Four species (*Lepus townsendii* [white-tailed jackrabbit], *Spermophilus tridecemlineatus* [thirteen-lined ground squirrel], *Thomomys talpoides* [northern pocket gopher], and *A. americana*) recovered from the site still inhabit the area today (Wilson 1974). *Camelops* sp. was later identified (Frison, Walker, Webb, and Zeimens 1978) but this does not alter the environmental interpretation proposed by Wilson (1974).

Laramie and North Platte Rivers and Black Hills Regions

Gravel deposits along the Laramie and North Platte rivers, southeastern Wyoming, have consistently yielded isolated bones of Pleistocene mammals. The majority of these have been recovered from Monolith Quarry and C & M Gravel Pit along the Laramie River (Fig. 5); the C & M Gravel Pit has been especially productive.

These gravel deposits have not been dated but the faunal remains suggest a late Pleistocene age. The current arid environment limits the uplands to sagebrush but permits willow to grow along the river edge. Neither of these local faunas have been fully described. However, the presence of *Mammuthus*, *Equus*, *Camelops*, and *Bison* suggests an "open" environment.

The Agate Basin site (Fig. 5, Tables 5 and 7) in northeastern Wyoming has yielded an extensive microfauna from each of the four cultural components (Clovis, Folsom, Agate Basin, and Hell Gap). This sequence allows for analyses of faunal changes through brief intervals of time during the late Pleistocene and early Holocene (Walker 1982a). The area today is surrounded by a short-grass prairie, with large sagebrush clusters covering overgrazed or otherwise disturbed land during the last 50 years. An occasional *Populus tremuloides* (aspen) can be found along Moss Agate Arroyo and the Cheyenne River to the north and east of the site. The modern fauna is dominated by *M. ochrogaster*, *S. tridecemlineatus*, and *Peromyscus maniculatus* (deer mouse). The two former species do not occur in the late Pleistocene/early Holocene faunules.

The microfauna from the Clovis faunule at the Agate Basin site (Table 5) is limited, but appears to be similar to that of the Folsom faunule with boreal species like *P. intermedius*, *C. gapperi*, *M. pennsylvanicus*, and *Microtus longicaudus* (longtail vole). The Agate Basin faunule is sparse, but the overlying Hell Gap faunule also contains a boreal component similar to the Folsom faunule (Table 7). *Perognathus fasciatus* (Wyoming pocket mouse) first appears in the Hell Gap faunule and may indicate a change to more steppe-like conditions. *Lagurus curtatus*, also a steppe-like indicator, is present throughout the sequence.

The Vore Bison Jump (Fig. 5, Table 8) lies in the western portion of the Black Hills of northeastern Wyoming where bison were driven to jump into a karstlike sinkhole formed in the Triassic Spearfish Formation. Reher and Frison (1980) estimated that the remains of 15,000 to 20,000 *Bison* occur in the sinkhole. The area around the site is presently a short-grass prairie with few shrub species. The fauna recovered from the site suggests a similar environmental situation 200 years ago (Walker 1975b, 1980).

The River Bend site, an early Historic Native American campsite (Fig. 5, Table 8), is along a large abandoned meander of the North Platte River near Casper, Wyoming. Before a commercial housing development began, the area was dominated by a sagebrush/grassland habitat. The River Bend l.f. sample is large but it has not been completely analyzed (Buff 1983, McKee 1985, n.d.). The list of species in Table 8 is preliminary.

The River Bend fauna does have some microtine species (*Microtus montanus* [montane vole] and *Microtus ochrogaster* [prairie vole]) that may not be found in the immediate site area today. Only general data on modern mammalian distributions in the Casper, Wyoming, area are available (Long 1965). However, the occurrence of these microtine species in the local fauna, unless due to the foraging activities of the site inhabitants, suggest an expansion of the boreal forest that presently covers Casper Mountain today. A complete analysis will clarify this and may reveal a response by the microtines and other rodents to the Little Ice Age climates.

The historic fauna from the Rock Ranch Trading Post (Fig. 5, Table 8) near Torrington, Wyoming (G. Zeimens pers. comm.), contains a large faunal sample, mostly representing food items (some domestic) utilized by the inhabitants of the trading post. The native mammalian fauna recovered from the site suggests that environmental conditions were similar during the site occupation to those in the area today. However, the presence of *Stizostedion canadense* (sauger) suggests an increased streamflow regime in the North Platte River during Historic times (G. Baxter pers. comm.).

PALEOENVIRONMENTAL SYNTHESIS

Evidence for the Quaternary history of the Wyoming Basin indicates that there have been climatic and environmental fluctuations for the last 20,000 years. During the late Wisconsinan, mean annual precipitation may have been no greater than that of today (Porter *et al.* 1983, Walker 1982a); however, cooler temperatures increased effective moisture and permitted expansion of glaciers. Mean annual temperatures may have been lowered by 12°C (21.6°F) (Mears 1981, Porter *et al.* 1983). These changes in Wyoming's environment are documented by (1) alpine glacial features (e.g., cirques, moraines, till deposits), (2) periglacial relicts and paleosols on the basin floors, and (3) shifts in the distributions of species of plants (palynological, phytological, and mycofloral evidence) and animals, especially mammals.

During the Full Glacial, tundralike conditions existed in Wyoming. This is documented by periglacial features (Mears 1981) and the affinities of the Wyoming mycoflora with the modern tundra (Christensen and Beiswenger 1982). In addition, mammalian species like *Dicrostonyx*, *Ovibos*, and *Rangifer*, present in the Wyoming fossil record, are characteristic of tundra environments.

Full Glacial environments of Wyoming may have been more similar to alpine tundra communities than to arctic tundra. However, like Full Glacial faunas throughout most of North America, those of Wyoming contain species that do not occur together today. These disharmonious faunas indicate that there are no modern analogues for the late Pleistocene climates or environments (Graham and Lundelius 1984, Lundelius *et al.* 1983). Overall, the presence of these disharmonious faunas suggest a more equable climate during the late Pleistocene. At the same time, evidence is also present that suggests there was a seasonal nature to resource availability (see Walker 1986).

The late Pleistocene tundralike environments had a higher percentage of grasses and grassland vertebrate species than modern arctic tundra. This is readily apparent in the phytolith record of Natural Trap Cave, which is dominated by grass (panicoid, festucoid, and chloridoid) phytoliths. Also, the diverse grazing mega-ungulates (i.e., *Mammuthus*, *Camelops*, *Equus*, *Bison*) of Natural Trap Cave would have required both a firm substrate unlike the muskeg of the modern tundra and a nutritious vegetational resource, such as grasses, for subsistence (Graham and Lundelius 1984, Guthrie 1984).

Boreal forest environments were also more widespread during the Full Glacial as well as the Late Glacial. Forests extended from mountain ranges down stream valleys onto the basin floors (Walker 1982a). The tree line may have been lowered by as much as 1200 m (4000 ft) (Baker 1983), but these forests did not encroach on the entire basin as suggested by Long (1965) and Wells (1970). Instead, the basins probably contained extensive riparian forests in a boreal grassland as described by Rhodes (1984) for other parts of the northern plains.

Climatic conditions changed during the Late Glacial: tundra species like *Dicrostonyx* decreased and grassland species increased in the mammalian communities. The pollen sequence at Cub Creek Pond indicates that a mosaic forest of spruce/fir/whitebark pine replaced the alpine tundra/spruce parkland at higher elevations (Waddington and Wright 1974). Late Glacial paleosols on the basin floors, especially those associated with the Clovis interval (11,000 to 12,000 years B.P.), also appear to have formed under cool and moist climates (Reider 1980). These basin environments still supported riparian forests.

As throughout most of North America, the late Pleistocene extinction event in Wyoming is correlative with the Clovis interval. However, the definitive occurrence of *Camelops* in a Hell Gap bison kill (ca. 10,000 years B.P.) at Casper (Frison *et al.* 1978) and *Platygonus* in a Folsom occupation (ca. 10,780 years B.P.) at Agate Basin (Walker 1982a) suggest that the extinction process may have extended into the Holocene. As in other areas of North America, the extinction event in Wyoming was accompanied by major reorganizations in the floral and faunal communities.

One method by which paleoenvironments can be visualized is by examination of the "area of sympatry" for all or part of the paleocommunities (Stephens 1960). An area of sympatry for a fossil fauna is the area where all the modern ranges of the constituent species overlap. The modern environment that supports this area of overlap or sympatry is thus assumed to be similar to the paleoenvironment that supported the fossil assemblage. However, there are four basic assumptions that must have been met before paleoenvironmental interpretations can be proposed (1) all species in the fauna must have been correctly identified, (2) habitat requirements and tolerance limits of the species must not have changed significantly, (3) the modern ranges of the species must be known accurately, and (4) disjunct ranges must not be incorporated into the area of sympatry.

Sympatries from the stratified sequence of faunules at Agate Basin (Walker 1982a) document the environmental changes during the critical interval at the end of the Pleistocene (Fig. 14). Species from the Folsom faunule co-exist today in the coniferous forest region of northwestern Wyoming. Based on such an area of sympatry modern climatic data suggest that January mean temperatures may have been 5°C (9°F) colder and July mean temperatures 13°C (23°F) colder at the Agate Basin site during the Folsom interval (~10,500 years B.P.). The sympatry also suggests an increase of 30.2 cm (12 in.) of precipitation and 90 less frost-free days (Walker 1982a).

The Hell Gap sympatry (Fig. 14) suggests a shift in the climate similar to that to the south and east of the Folsom sympatry. This sympatry reflects the addition of the steppe species *P. fasciatus* and the loss of the boreal species *C. gapperi*. The area of sympatry in northwestern Colorado and south-central Wyoming contains major coniferous forest stands but also includes a large portion of the sagebrush/grassland region of the Wyoming Basin. Climatic data indicate that January mean temperatures may have been 2.8°C (5°F) colder and July mean temperatures 7°C (12.6°F) colder at Agate Basin during the Hell Gap interval (~10,000 years B.P.). There may also have been a 22.9 cm (~9 in.) increase in annual precipitation and there were 50 less frost-free days than today.

These climatic reconstructions are based on extrapolations from micromammal areas of sympatry and they should not be considered as absolute for either occupation period. However, it is apparent that climates associated with each sympatry are not identical and environmental changes can be proposed during cultural occupation at

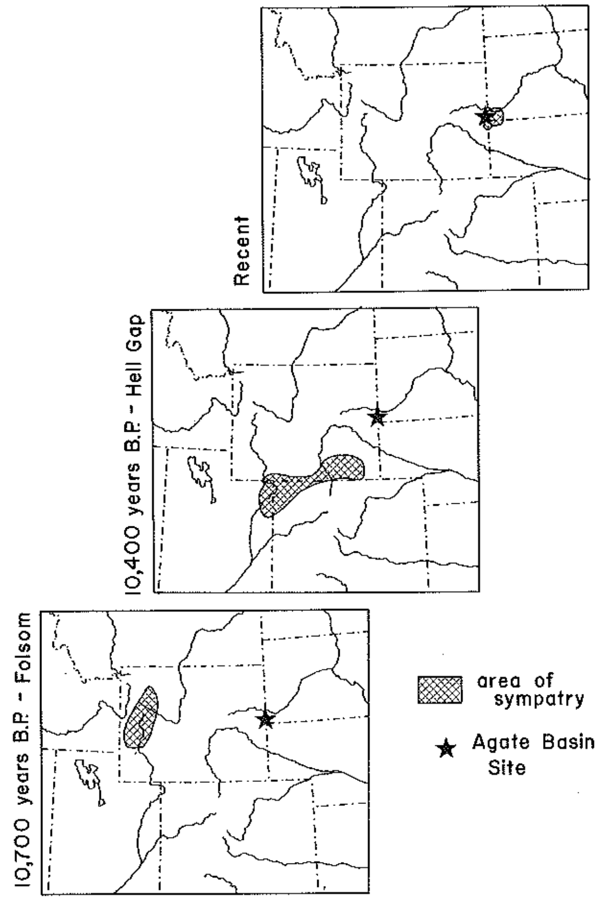

Figure 14. Small mammal sympatry areas for the small mammal fauna from the Agate Basin site (from Walker 1982a).

Agate Basin. The yearly temperatures were warmer during the Hell Gap occupation (~10,000 years B.P.) than during the Folsom (~10,500 years B.P.), and the Hell Gap occupation was associated with a longer frost-free period than the Folsom.

The primary difference between the two areas of sympatry is the 7.3 cm (29 in.) decrease in annual precipitation by the time of Hell Gap occupation. With the cooler Folsom temperatures, the effective moisture was also probably greater. Overall, during the Late Glacial/Pre-Boreal period in northwestern Wyoming, year-round temperatures were cooler, associated with a greater effective moisture and a major reduction in the number of frost-free days.

During the Pre-Boreal period (10,030-9300 years B.P.) some boreal mammal species were still present in the basin areas, but a mixture of steppe forms were starting to be found in association with these boreal types. Data are still lacking on when the boreal species were restricted to the mountain tops. By the Sub-Boreal period (5060-2760 years B.P.), as shown by the Dead Indian Creek and Little Canyon Creek Cave faunas, modern mammalian distributions were probably reached. This is consistent with the environmental interpretations of the palynological record of the Powder River Basin (Markgraf and Lennon 1986) and the pedological sequences of the basins (Reider 1982b).

There are five local faunas from Wyoming postdating the Altithermal. Because these sites were excavated before the introduction of the water-screening techniques to archeology, the small mammal remains from most of these sites are minimal. However, enough specimens are present to suggest that a modern extant fauna was present at all of these sites. While environmental conditions during the Little Ice Age had a major effect on the *Bison* populations (Reher and Frison 1980), the response of the small mammal populations is still not known. These populations had to have been affected but available data from critical sites awaits analyses.

Author's Note

After the final preparation of this manuscript, J. Indeck (1987) completed his study of the fauna from Little Box Elder Cave (Fig. 5, Table 5). Four taxa either discussed in this paper or listed on Table 5 were not, or could not, be confirmed within the collection: *S. tridecemlineatus*, *S. variegatus*, *N. fricki*, and *O. americana*. Originally, Anderson (1968) did not differentiate the species of *Spermophilis* but listed the possibility of three species, *S. tridecemlineatus/S. variegatus/S. lateralis*. Indeck has determined that only *S. lateralis* is present in the fauna. The specimens assigned to *Oreamnos* by Anderson have been referred to *Ovis* by Indeck (1987). Finally, Kurtén (1975) did not list the specimens that he referred to *N. fricki* and Indeck (1987) could not find any specimens in the Colorado collections that he would place in that taxon. Seven taxa were added to the fauna: *Antrozous pallidus* (Pallid bat), *Lepus* sp., *S. richardsonii* (=*elegans*), *Cynomys leucurus* (white-tailed prairie dog), *Cynomys ludovicianus* (black-tailed prairie dog), *Geomys bursarius* (plains pocket gopher), and *Ondatra zibethicus* (muskrat).

The elimination of *N. fricki* from the fauna removes that taxon from the late Pleistocene fauna of Wyoming. The removal of *S. variegatus* solves one dilemma discussed in this paper, that is, the northward immigration of a southern species, supposedly during the Altithermal (Long 1972). Since this was the only taxon apparently demonstrating such a response to mid-Holocene climatic change, I had always questioned why other southern species had also not responded. It now makes more sense to suggest that while such mid-Holocene climatic changes might have occurred, they were not of sufficient intensity to be reflected in mammalian range changes. However, it should also be noted that there is a low number of dated faunas from the mid-Holocene in Wyoming. Additional mid-Holocene faunas, especially from basin areas, may show such changes. Until these faunas are recorded, I feel it is best to remain parsimonious.

Environmental interpretations of the Little Box Elder Cave fauna will not change with the additions of the seven taxa. Only two of these are not found in the immediate vicinity of the cave today. *Antrozous pallidus* is found throughout northern Colorado to the south (Armstrong 1972) and *G. bursarius*, is found within 48 km (30 mi) east (Long 1965). Indeck (1987) feels the *A. pallidus* record may be similar to *M. thysanodes* in that it reflects a previously wide-ranging species now with a more restricted range.

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Table 2. Chronology of mammalian local faunas from the Wyoming Basin.

Site No. and Name (County and State)	Cultural Association and Site Function	Geologic Category	Absolute Dates RCYBP	Dating Method, Material and Lab Number	Geologic Unit	Major References	Comments
1. Natural Trap Cave (Bighorn, WY)	None	Pit Cave	21,370±275	C-14, Bone Collagen Dicarb-1687	----	Martin and Gilbert 1978a Chomko and Gilbert this volume	Stratified cave deposit through the late Wisconsin. Record ends at the Holocene boundary.
	None	Pit Cave	20,250+830 -920	C-14, Bone Collagen Dicarb-1689	----	*Ibid.*	
	None	Pit Cave	17,870±230	C-14, Bone Collagen Dicarb-1686	----	*Ibid.*	
	None	Pit Cave	17,620+1490 -1820	C-14, Bone Collagen Dicarb-690	----	*Ibid.*	
	None	Pit Cave	14,670+670 -730	C-14, Bone Collagen Dicarb-689	----	*Ibid.*	
	None	Pit Cave	12,777±900	C-14, Bone Collagen ----	----	*Ibid.*	
	None	Pit Cave	10,930±300	C-14, Bone Collagen ----	----	*Ibid.*	
2. River Gravel Beds (Albany, Converse, Sheriden, WY)	None	Fluvial	>10,000	Geological/ Biostratigraphy	----	Anderson 1974 Walker 1982b	Sand and gravel quarries with large mammals but no known microfauna.
3. Prospects Shelter (Bighorn, WY)	None	Cave	27,000± 5.0%	Thermoluminescence	Lower Stratum IV	Chomko 1978, 1979a, 1979b	Less than 10 cm of Holocene deposits. Excellent late Pleistocene small mammal sequence.
	None	Cave	17,500± 4.5%	Thermoluminescence	Middle Stratum IV	*Ibid.*	

Table 2. (continued)

	None	Cave	16,272± 8.5%	Thermo-luminescence	Middle Stratum IV	*Ibid.*	
	None	Cave	13,500± 4.8%	Thermo-luminescence	Upper Stratum IV	*Ibid.*	
	None	Cave	10,005± 14.5%	Thermo-luminescence	Upper Stratum III	*Ibid.*	
4. **Shutdown Shelter** (Bighorn, WY)	None	Cave	>10,000	Biostrati-graphy	----	Chomko and Gilbert this volume	Faunal sequence duplicates Natural Trap Cave and Prospects Shelter.
5. **Little Box Elder Cave** (Converse, WY)	None	Cave	9250±230	C-14, *Neotoma* Scat RL-1878	----	Anderson 1968, 1974 Indeck and Walker 1983 Emslie 1983, 1985	Stratified cave deposit through 2 m plus of Pleistocene sedi-ments overlain by 1.8 m of Holocene sediments.
6. **Bell Cave** (Albany, WY)	None	Cave	12,240±330	C-14, Bone Collagen RL-1331	----	Walker 1974 Zeimens and Walker 1974	Preliminary investigations.
7. **Horned Owl Cave** (Albany, WY)	None	Cave	>10,000	Geological/ Biostrati-graphy	----	Guilday *et al.* 1967	Small sample of vertebrates. Water screening unsuccessful.
8. **Tina-Ann's Cave** (Albany, WY)	None	Cave	>10,000	Geological/ Biostrati-graphy	----	Unpublished	Preliminary investigations.
	Plains Archaic	Cave	2000-6000	Cultural	----	Unpublished	Preliminary investigations.
9. **Little Canyon Creek Cave** (Washakie, WY)	Pre-Clovis Camp	Cave	>12,000	Biostrati-graphy	----	Shaw and Frison 1979	Preliminary investigations. Most faunal material recovered from Archaic levels.
	Paleoindian Camp	Cave	10,170±250	C-14, Charcoal RL-641	----	*Ibid.*	
	Paleoindian Camp	Cave	8790±210	C-14, Charcoal RL-640	----	*Ibid.*	
	Archaic Camp	Cave	6270±170	C-14, Charcoal RL-1084	----	*Ibid.*	

Table 2. (continued)

Site No. and Name (County and State)	Cultural Association and Site Function	Geologic Category	Absolute Dates RCYBP	Dating Method, Material and Lab Number	Geologic Unit	Major References	Comments
	Archaic Camp	Cave	5300±170	C-14, Charcoal RL-1083	----	*Ibid.*	
10. Bush Shelter (Washakie, WY)	None	Rock Overhang	>12,000	Biostratigraphy	----	Unpublished	Preliminary investigations. Large numbers of small mammals.
	Paleoindian Camp	Rock Overhang	9000±240	C-14, Charcoal RL-1407	----	*Ibid.*	
11. Colby (Washakie, WY)	Clovis Mammoth kill/ Processing	Arroyo	11,200±220	C-14, Bone Collagen RL-392	----	Frison 1976 Walker and Frison 1980	Small mammals almost non-existent.
	Clovis Mammoth kill/ Processing	Arroyo	*10,548±141	C-14, Bone Collagen SMU-254	----	*Ibid.*	Date appears to be too young.
12. Agate Basin (Niobrara, WY)	Clovis?	Arroyo	11,840±130	C-14, Charcoal I-10899	----	Frison and Stanford 1982 Walker 1982a	Excellent stratified sample of small mammals throughout a short period of time.
	Clovis?	Arroyo	11,700±95	C-14, Charcoal SI-3731	----	*Ibid.*	
	Clovis?	Arroyo	11,450±110	C-14, Charcoal SI-3734	----	*Ibid.*	
	Folsom Bison kill	Arroyo	10,780±120	C-14, Charcoal SI-3733	----	*Ibid.*	Late record of *Platygonus*.
	Folsom Bison kill	Arroyo	10,665±85	C-14, Charcoal SI-3732	----	*Ibid.*	
	Folsom/ Hell Gap Bison kill	Arroyo	10,575±90	C-14, Charcoal SI-3730	----	*Ibid.*	
	Hell Gap Bison kill	Arroyo	10,445±110	C-14, Charcoal SI-4430	----	*Ibid.*	

Table 2. (continued)

	Agate Basin Bison kill	Arroyo	10,430±570	C-14, Charcoal RL-557	----	*Ibid.*	
	Agate Basin Bison kill	Arroyo	10,200±2,000	C-14, Charcoal RL-738	----	*Ibid.*	
	Unknown	Arroyo	9750±130	C-14, Charcoal SI-4431	----	*Ibid.*	Combined charcoal from 3 cultural levels. No diagnostic artifacts.
13. Casper (Natrona, WY)	Hell Gap Bison kill/ Processing	Sand dune	10,060±170	C-14, Bone Collagen RL-208	----	Frison 1974 Wilson 1974 Frison, Walker, Webb, and Zeimens 1978 Wilson and Rea 1977	Late record of *Camelops.*
	Hell Gap Bison kill/ Processing	Sand Dune	*9830±350	C-14, Charcoal RL-125	----	*Ibid.*	Date appears to be too young.
14. Medicine Lodge Creek (Bighorn, WY)	Paleoindian Camp	Rock Overhang	9590±180	C-14, Bone Collagen RL-393	----	Walker 1975a	Best small mammal sample in the site from one cultural level.
15. Eagle Shelter (Bighorn, WY)	Paleoindian	Rock Overhang	8500	Cultural	----	Chomko 1982	Excellent mid-Holocene small mammal sequence.
16. Dead Indian Creek (Park, WY)	Middle Plains Archaic Camp	Stream Terrace	4430±250	C-14, Charcoal W-2599	----	Smith 1970 Frison 1978 Frison and Walker 1984	Few small mammals recovered (no water screening). Large sample of *Odocoileus hemionus* and *Ovis canadensis.*
	Middle Plains Archaic Camp	Stream Terrace	4180±250	C-14, Charcoal W-2597	----	*Ibid.*	
	Middle Plains Archaic Camp	Stream Terrace	3800±110	C-14, Charcoal RL-321	----	*Ibid.*	
17. Big Goose Creek (Sheridan, WY)	Late Prehistoric Bison kill/ Processing	Stream Terrace	530±110	C-14, Charcoal M-1860	----	Frison, Wilson, and Walker 1978	Single component.

Table 2. (continued)

Site No. and Name (County and State)	Cultural Association and Site Function	Geologic Category	Absolute Dates RCYBP	Dating Method, Material and Lab Number	Geologic Unit	Major References	Comments
	Late Prehistoric Bison kill/ Processing	Stream Terrace	450±110	C-14, Charcoal M-1859	----	*Ibid.*	
18. Vore (Crook, WY)	Late Prehistoric Bison kill/ Processing	Sinkhole	370±140	C-14, Charcoal RL-349	----	Reher and Frison 1980 Walker 1975b, 1980	Total number of *Bison* is 15,000-20,000.
	Late Prehistoric Bison kill/ Processing	Sinkhole	>230	C-14, Charcoal RL-172	----	*Ibid.*	
	Late Prehistoric Bison kill/ Processing	Sinkhole	200±90	C-14, Charcoal RL-173	----	*Ibid.*	
19. River Bend (Natrona, WY)	Early Historic Camp	River Terrace	----	Cultural	----	Buff 1983 McKee 1985	Series of excavated lodges with middens of rodent bones outside each lodge.
20. Rock Ranch Trading Post (Goshen, WY)	Early Historic	River Terrace	----	Cultural	----	Zeimens and Housch (in preparation)	Trash middens.

(* denotes date rejected by original author).

Table 3. Identification of late Pleistocene/Holocene localities in the Wyoming Basin with less than ten mammalian species.

Location Number	Site Name	County	Major References
21.	Carter/Kerr-McGee Bison Kill	Campbell	Frison 1984 Frison, Walker, Webb, and Zeimens 1978
22.	Hunter Ranch Mammoth Locality	Laramie	Walker *et al.* 1984
23.	Union Pacific Mammoth Kill	Carbon	McGrew 1961 Irwin *et al.* 1962
24.	Finley Bison Kill	Sweetwater	Schultz and Frankforter 1951
25.	Horner Bison Kill	Park	Jepson 1953, Todd 1983 Todd and Hofman 1978 Walker 1987
26.	Pine Springs Site	Sweetwater	Sharrock 1966
27.	Hanson Folsom Site	Bighorn	Frison and Bradley 1980
28.	James Allen Bison Kill	Albany	Mulloy 1959
29.	Shirley Basin Site	Carbon	Fletcher 1970
30.	Sheaman Site	Niobrara	Walker 1982a
31.	Sister's Hill Site	Johnson	Agogino and Galloway 1965
32.	Hell Gap Site	Goshen	Irwin-Williams *et al.* 1973, Roberts 1970
33.	Worland Gravel Pit	Washakie	Walker and Frison 1980
34.	Fort Laramie *Mammuthus* Locality	Platte	McGrew 1963
35.	Rawlins *Camelops* Locality	Carbon	Anderson 1974
36.	Greybull Bentonite Pit	Bighorn	Anderson 1974
37.	Stauffer Chemical Company	Sweetwater	Anderson 1974
38.	Sheridan *Equus* Locality	Sheridan	Anderson 1974
39.	Cheyenne *Equus* Locality	Laramie	Anderson 1974

Table 3. (continued)

Location Number	Site Name	County	Major References
40.	Fort Bridger *Equus* Locality	Uinta	Hay 1924
41.	Good Place *Ovis* Locality	Washakie	Unpublished
42.	Careyhurst *Mammuthus* Locality	Converse	Hay 1924
43.	Buffalo *Mammuthus* Locality	Johnson	Hay 1924
44.	Powder River *Mammuthus* Locality	Johnson	Hay 1924
45.	Rawhide Butte *Mammuthus* Locality	Goshen or Niobrara	Hay 1924
46.	Casper *Mammuthus* Locality	Natrona	Hay 1924
47.	Dover *Mammuthus* Locality	Albany	Hay 1924 Knight 1903
48.	Lingle *Mammuthus* Locality	Goshen	Hay 1927
49.	Bosler Gravel Pit *Mammuthus* Locality	Albany	Anderson 1974
50.	Fort Steele Gravel Pit *Mammuthus* Locality	Carbon	Anderson 1974
51.	North Sheridan *Mammuthus* Locality	Sheridan	Anonymous 1960
52.	West Sheridan *Mammuthus* Locality	Sheridan	Anonymous 1960
53.	Mahogony Butte *Mammuthus* Locality	Washakie	Anderson 1974
54.	Independence Rock *Mammuthus* Locality	Natrona	Anderson 1974
55.	Hell Gap Loess *Mammuthus* Locality	Platte	Greene 1967
56.	Northeast Rawhide Butte *Mammuthus* Locality	Niobrara	Damon *et al.* 1964
57.	Bentzen-Kaufmann Cave	Sheridan	Grey 1962

Table 3. (continued)

Location Number	Site Name	County	Major References
58.	Casper City Dump *Camelops* Locality	Natrona	Albanese and Wilson 1974
59.	Laramie Airport *Equus* Locality	Albany	Unpublished
60.	Hot Springs *Ovis* Locality	Hot Springs	Rohrer 1966
61.	Bear Creek *Mammuthus* Locality	Niobrara	Unpublished
62.	Douglas *Ovibos* Locality	Converse	Walker 1982b
63.	Dave Johnstone *Mammuthus* Locality	Converse	Unpublished
64.	Lance Creek *Mammuthus* Locality	Converse	Walker 1982b
65.	West Laramie *Mammuthus* Locality	Albany	Unpublished
66.	Shawnee Creek *Mammuthus* Locality	Niobrara	Unpublished
67.	Cheyenne Airport *Mammuthus* Locality	Laramie	Unpublished
68.	Sheridan Elks Club Cemetary Site	Sheridan	Unpublished
69.	Big Horn Coal Mine Caribou Locality	Sheridan	Unpublished
70.	Big Horn River Muskox Locality	Big Horn	Reheis *et al.* 1984
71.	Horse Thief Cave	Big Horn	Unpublished
72.	Hawken Bison Kill	Crook	Frison *et al.* 1976
73.	Monolith Gravel Quarry	Albany	Unpublished
74.	C & M Gravel Quarry	Albany	Unpublished

Table 4. Species composition of full glacial (20,000-13,000 years B.P.) mammalian local faunas and faunules from the Wyoming Basin.

Taxon	Natural Trap Cave 14,670-20,250	Prospects Shelter 16,272-27,000
Insectivora		
Sorex merriami	●	●
Chiroptera		
Myotis sp.	o	●
Lagomorpha		
Ochotona princeps	●	●
Lepus arcticus	●	o
Lepus sp.	o	●
Brachylagus idahoensis	●	o
Sylvilagus sp.	●	●
Rodentia		
Tamias minimus	●	●
Tamias sp.	o	●
Marmota flaviventris	●	●
Marmota caligata	o	●
Spermophilus elegans	o	●
Spermophilus sp.	●	●
Cynomys sp.	o	●
Thomomys sp.	●	●
Perognathus sp.	●	●
Peromyscus sp.	●	●
Neotoma cinerea	●	●
Phenacomys intermedius	o	●
Microtus pennsylvanicus	o	●
Microtus montanus	●	●
Microtus xanthognathus	o	●
Microtus ochrogaster	●	●
Microtus richardsoni	o	●
Microtus sp.	●	●
Lagurus curtatus	●	●
Synaptomys borealis	o	●
Dicrostonyx torquatus	●	●
Carnivora		
Canis lupus	●	●
Canis dirus	●	o
Vulpes vulpes	●	o
Vulpes sp.	o	●
Arctodus simus	●	●
Martes sp.	●	o
Mustela sp.	●	●
Gulo gulo	●	o
Taxidea taxus	o	●
Miracinonyx trumanii	●	o
Felis atrox	●	o
Proboscidea		
Mammuthus sp.	●	o
Artiodactyla		
Bison bison ssp.	●	●
Ovis canadensis catclawensis	●	●
Antilocapra americana	●	●
Camelops sp.	●	●
Symbos sp.	●	●
Perissodactyla		
Equus conversidens	●	o
Equus sp.	●	●

Table 5. Species composition of late glacial (13,500-10,000 years B.P.) mammalian local faunas and faunules from the Wyoming Basin.

Taxon	Natural Trap Cave 10,930-12,777	Prospects Shelter 10,000-13,500	Little Box Elder Cave >10,000	Bell Cave 12,240	Colby Mammoth Kill 11,200	Agate Basin (Clovis Faunule) 11,450-11,840	Agate Basin (Folsom Faunule) 10,575-10,780
Insectivora							
Sorex cinereus	o	o	o	●	o	o	o
Sorex palustris	o	o	●	●	o	o	o
Sorex merriami	●	●	o	o	o	o	o
Sorex hoyi	o	o	●	o	o	o	o
Cryptotis sp.	o	o	●	o	o	o	o
Chiroptera							
Myotis lucifugus	o	o	o	●	o	o	o
Myotis evotis	o	o	●	o	o	o	o
Myotis thysanodes	o	o	●	o	o	o	o
Myotis volans	o	o	●	o	o	o	o
Myotis sp.	●	●	o	o	o	o	o
Lasionycteris noctivagans	o	o	●	●	o	o	o
Eptesicus fuscus	o	o	●	●	o	o	o
Lagomorpha							
Ochotona princeps	o	o	●	●	o	o	o
Lepus americanus	o	o	●	o	o	o	o
Lepus arcticus	●	o	o	o	o	o	o
Lepus sp.	o	o	o	●	●	o	●
Sylvilagus sp.	o	o	●	●	o	●	●
Rodentia							
Tamias minimus	o	o	●	o	o	o	o
Tamias sp.	o	●	o	o	o	o	o
Marmota flaviventris	o	o	●	●	o	o	o
Spermophilus elegans	o	o	o	●	o	o	o
Spermophilus tridecemlineatus	o	o	●	●	o	o	●
Spermophilus variegatus	o	o	●	o	o	o	o
Spermophilus lateralis	o	o	●	●	o	o	o
Spermophilus sp.	o	●	o	o	o	o	o
Cynomys sp.	o	o	●	●	o	o	o
Thomomys talpoides	o	o	o	●	o	o	●
Thomomys sp.	●	●	●	o	o	o	o
Perognathus sp.	●	●	●	o	o	o	o
Castor canadensis	o	o	●	o	o	o	o
Peromyscus maniculatus	o	o	o	●	o	●	●
Peromyscus sp.	●	●	●	o	o	o	o
Neotoma cinerea	●	●	●	●	o	o	o
Clethrionomys gapperi	o	o	●	o	o	o	●
Phenacomys intermedius	o	●	●	●	o	o	o
Microtus pennsylvanicus	o	o	●	o	o	●	●
Microtus montanus	●	●	●	●	o	o	o

Table 5. (continued)

Taxon	Natural Trap Cave 10,930-12,777	Prospects Shelter 10,000-13,500	Little Box Elder Cave >10,000	Bell Cave 12,240	Colby Mammoth Kill 11,200	Agate Basin (Clovis Faunule) 11,450-11,840	Agate Basin (Folsom Faunule) 10,575-10,780
Microtus longicaudus	o	o	●	o	o	●	●
Microtus xanthognathus	o	●	o	o	o	o	o
Microtus ochrogaster	●	●	●	●	o	o	o
Lagurus curtatus	●	●	●	●	o	o	●
Ondatra zibethicus	o	o	o	●	o	o	o
Synaptomys borealis	o	●	o	o	o	o	o
Dicrostonyx torquatus	o	●	●	●	o	o	o
Erethizon dorsatum	o	o	●	●	o	o	o
Carnivora							
Canis latrans	●	o	●	●	o	o	●
Canis lupus	●	●	●	●	o	o	●
Canis dirus	●	o	o	o	o	o	o
Vulpes vulpes	o	o	●	●	o	o	●
Vulpes velox	o	o	o	●	o	o	o
Ursus arctos	o	o	●	o	o	o	o
Arctodus simus	o	o	●	o	o	o	o
Martes americana	o	o	o	●	o	o	o
Martes nobilis	o	o	●	●	o	o	o
Mustela frenata	o	o	●	●	o	o	o
Mustela nigripes	o	o	●	o	o	o	o
Mustela vison	o	o	o	●	o	o	o
Mustela sp.	o	●	o	o	o	o	o
Gulo gulo	o	o	●	o	o	o	o
Taxidea taxus	o	●	●	●	o	o	o
Spilogale putorius	o	o	●	o	o	o	o
Mephitis mephitis	o	o	●	●	o	o	●
Felis concolor	o	o	●	o	o	o	o
Felis rufus	o	o	●	●	o	o	o
Felis atrox	o	o	●	o	o	o	o
Proboscidea							
Mammuthus columbi	o	o	o	o	●	o	o
Mammuthus sp.	o	o	o	o	o	●	o
Artiodactyla							
Platygonus compressus	o	o	o	o	o	o	●
Cervus elaphus	o	o	●	●	o	o	●
Odocoileus hemionus	o	●	●	●	o	o	o
Alces alces	o	o	?	o	o	o	o
Navahoceros fricki	o	o	●	o	o	o	o
Bison antiquus	o	o	o	o	o	●	●
Bison bison ssp.	o	●	●	●	●	o	o
Ovibovine indet.	o	o	?	o	o	o	o
Oreamnos americanus	o	o	o	●	o	o	o
Oreamnos sp.	o	o	●	o	o	o	o

Table 5. (continued)

Taxon	Natural Trap Cave 10,930-12,777	Prospects Shelter 10,000-13,500	Little Box Elder Cave >10,000	Bell Cave 12,240	Colby Mammoth Kill 11,200	Agate Basin (Clovis Faunule) 11,450-11,840	Agate Basin (Folsom Faunule) 10,575-10,780
Ovis canadensis catclawensis	●	●	●	●	o	o	o
Ovis canadensis ssp.	o	o	●	●	o	o	o
Antilocapra americana	o	o	●	●	●	●	●
Camelops sp.	o	o	●	●	●	●	o
Hemiauchenia sp.	o	o	?	o	o	o	o
Perissodactyla							
Equus conversidens	o	●	●	●	●	o	o
Equus sp.	●	●	●	●	o	o	o

Table 6. Species composition of undated late Pleistocene mammalian local faunas and faunules from the Wyoming Basin.

Taxon	River Gravel Beds	Horned Owl Cave	Tina-Ann's Cave	Little Canyon Creek Cave	Bush Shelter
Insectivora					
Sorex palustris	o	o	o	●	o
Lagomorpha					
Ochotona princeps	o	●	o	●	●
Lepus sp.	o	o	●	o	●
Sylvilagus sp.	o	●	●	o	o
Rodentia					
Tamias sp.	o	●	o	o	o
Marmota flaviventris	o	●	●	●	o
Spermophilus elegans	●	o	●	o	o
Spermophilus lateralis	o	●	o	o	o
Cynomys leucurus	o	●	o	o	o
Thomomys talpoides	o	o	●	●	o
Castor canadensis	o	o	o	●	o
Peromyscus sp.	o	●	o	●	o
Neotoma cinerea	o	●	o	o	o
Clethrionomys gapperi	o	o	●	o	●
Phenacomys intermedius	o	●	o	●	●
Microtus pennsylvanicus	o	o	o	●	●
Microtus montanus	o	o	o	●	o
Lagurus curtatus	o	●	o	●	●
Dicrostonyx torquatus	o	o	o	●	●
Erethizon dorsatum	o	o	o	●	o
Carnivora					
Vulpes vulpes	o	●	o	o	o
Mustela frenata	o	●	o	o	o
Mustela vison	o	●	o	o	o
Mustela nigripes	o	o	o	●	o
Taxidea taxus	o	●	o	●	o
Miracinonyx trumanii	o	o	o	●	o
Felis atrox	●	o	o	o	o
Proboscidea					
Mammuthus columbi	●	o	o	o	o
Mammuthus imperator	●	o	o	o	o
Mammuthus sp.	●	o	o	o	o
Artiodactyla					
Odocoileus hemionus	o	●	o	?	o
Rangifer tarandus	●	o	o	o	o
Bison antiquus	●	o	o	o	o
Bison bison bison	●	o	o	o	o
Bison bison ssp.	●	o	●	o	●
Ovibos moschatus	●	o	o	o	o
Oreamnos americanus	o	●	o	o	o
Ovis canadensis catclawensis	o	o	o	●	o
Ovis canadensis ssp.	o	●	●	o	●
Antilocapra americana	o	●	o	o	o
Camelops sp.	o	o	●	o	o
Symbos sp.	o	o	o	●	o
Perissodactyla					
Equus conversidens	●	o	o	o	o
Equus sp.	●	●	o	o	o

Table 7. Species composition of Pre-Boreal (9140-10,500 years B.P.), Boreal (8450-9140 years B.P.), and Atlantic (4680-8450 years B.P.) mammalian local faunas and faunules from the Wyoming Basin.

Taxon	Agate Basin (Hell Gap Faunule) 10,445-10,575	Agate Basin (Agate Basin Faunule) 10,200-10,430	Casper 10,060	Medicine Lodge Creek 9590	Little Box Elder Cave 9590	Bush Shelter 9000	Eagle Shelter 8500	Little Canyon Creek Cave 5300-6270
Insectivora								
Sorex cinereus	o	o	o	●	o	o	o	o
Sorex palustris	o	o	o	o	●	o	o	●
Sorex sp.	●	o	o	●	o	o	o	o
Chiroptera								
Myotis evotis	o	o	o	o	●	o	o	o
Myotis volans	o	o	o	o	●	o	o	o
Lasionycteris noctivagans	o	o	o	o	●	o	o	o
Eptesicus fuscus	o	o	o	o	●	o	o	o
Lagomorpha								
Ochotona princeps	o	o	o	●	●	●	●	●
Lepus americanus	o	o	o	o	●	o	o	o
Lepus townsendi	o	o	●	●	o	o	o	o
Lepus sp.	o	o	o	o	o	●	o	o
Sylvilagus sp.	o	●	o	●	●	o	o	o
Rodentia								
Tamias minimus	o	o	o	o	●	o	o	o
Marmota flaviventris	o	o	o	●	●	o	●	●
Spermophilus tridecemlineatus	o	o	●	o	●	o	o	o
Spermophilus variegatus	o	o	o	o	●	o	o	o
Spermophilus lateralis	o	o	o	o	●	o	o	o
Cynomys sp.	o	o	o	o	●	o	o	o
Tamiasciurus hudsonicus	o	o	o	●	o	o	o	o
Thomomys talpoides	●	●	●	●	o	o	o	●
Thomomys sp.	o	o	o	o	●	o	o	o
Perognathus fasciatus	o	●	o	o	o	o	o	o
Perognathus sp.	o	o	o	o	●	o	o	o
Castor canadensis	o	o	o	o	●	o	o	●
Peromyscus maniculatus	●	●	o	●	o	o	o	o
Peromyscus sp.	o	o	o	o	●	o	o	●
Neotoma cinerea	o	o	o	●	●	o	o	o
Clethrionomys gapperi	o	o	o	●	●	●	●	o
Phenacomys intermedius	o	o	o	●	●	●	o	●
Microtus pennsylvanicus	●	o	o	●	●	●	o	●
Microtus montanus	o	o	o	●	●	o	o	●
Microtus longicaudus	●	●	o	o	●	o	o	o
Microtus ochrogaster	o	o	o	o	●	o	o	o
Microtus richardsoni	o	o	o	●	o	o	●	o
Lagurus curtatus	●	●	o	●	●	●	o	●
Ondatra zibethicus	o	o	o	●	o	o	o	o
Erethizon dorsatum	o	o	o	●	●	o	o	●

Table 7. (continued)

Taxon	Agate Basin (Hell Gap Faunule) 10,445-10,575	Agate Basin (Agate Basin Faunule) 10,200-10,430	Casper 10,060	Medicine Lodge Creek 9590	Little Box Elder Cave 9590	Bush Shelter 9000	Eagle Shelter 8500	Little Canyon Creek Cave 5300-6270
Carnivora								
Canis latrans	o	o	●	o	●	o	o	o
Canis lupus	●	o	o	o	●	o	●	o
Vulpes vulpes	o	o	o	o	●	o	o	o
Mustela erminea	o	o	o	●	o	o	o	o
Mustela frenata	o	o	o	●	●	o	o	o
Mustela nigripes	o	o	o	o	●	o	o	●
Gulo gulo	o	o	o	o	●	o	o	o
Taxidea taxus	o	o	o	o	●	o	o	●
Spilogale putorius	o	o	o	o	●	o	o	o
Mephitis mephitis	o	o	o	o	●	o	o	o
Felis concolor	o	o	o	o	●	o	o	o
Felis rufus	●	o	o	o	●	o	o	o
Artiodactyla								
Cervus elaphus	o	o	o	●	●	o	●	o
Odocoileus hemionus	o	o	o	●	●	o	o	o
Odocoileus sp.	o	o	o	o	o	o	●	o
Bison antiquus	●	●	●	●	o	o	o	o
Bison bison ssp.	o	o	o	o	●	●	●	o
Ovis canadensis ssp.	o	o	o	●	●	●	●	o
Antilocapra americana	●	●	●	o	●	o	●	o

Table 8. Species composition of Sub-Boreal (2690-4680 years B.P.), Pacific (410-760 years B.P.), Neo-Boreal (115-410 years B.P.), Historic, and modern local faunas and faunules from the Wyoming Basin.

Taxon	Tina-Ann's Cave 2000-6000	Dead Indian Creek 3800-4430	Big Goose Creek 450-530	Vore Bison Kill 230-370	River Bend Early Historic	Rock Ranch Trading Post Early Historic	Modern Fauna
Marsupialia							
Didelphis virginiana	o	o	o	o	o	o	●
Insectivora							
Sorex cinereus	o	o	o	o	●	o	●
Sorex vagrans	o	o	o	o	●	o	●
Sorex nanus	o	o	o	o	o	o	●
Sorex palustris	o	o	o	o	●	o	●
Sorex merriami	o	o	o	o	o	o	●
Sorex hoyi	o	o	o	o	o	o	●
Scalopus aquaticus	o	o	o	o	o	o	●
Chiroptera							
Myotis lucifugus	o	o	o	o	o	o	●
Myotis keenii	o	o	o	o	o	o	●
Myotis evotis	o	o	o	o	o	o	●
Myotis thysanodes	o	o	o	o	o	o	●
Myotis volans	o	o	o	o	o	o	●
Lasionycteris noctivagans	o	o	o	o	o	o	●
Eptesicus fuscus	o	o	o	o	o	o	●
Lasiurus borealis	o	o	o	o	o	o	●
Lasiurus cinereus	o	o	o	o	o	o	●
Euderma maculatum	o	o	o	o	o	o	●
Plecotus townsendii	o	o	o	o	o	o	●
Lagomorpha							
Ochotona princeps	o	o	o	o	o	o	●
Lepus americanus	o	●	●	o	o	o	●
Lepus townsendi	o	o	o	o	●	o	●
Lepus californicus	o	o	o	o	o	o	●
Lepus sp.	●	o	o	o	●	●	o
Brachylagus idahoensis	o	o	o	o	o	o	●
Sylvilagus floridanus	o	o	o	o	o	o	●
Sylvilagus nuttallii	o	o	●	o	o	●	●
Sylvilagus audubonii	o	o	o	●	●	o	●
Sylvilagus sp.	●	●	o	o	●	o	o
Rodentia							
Tamias minimus	o	o	o	o	o	o	●
Tamias amoenus	o	o	o	o	o	o	●
Tamias dorsalis	o	o	o	o	o	o	●
Marmota flaviventris	●	●	●	o	●	o	●
Spermophilus elegans	●	o	o	o	●	o	●

Table 8. (continued)

Taxon	Tina-Ann's Cave 2000-6000	Dead Indian Creek 3800-4430	Big Goose Creek 450-530	Vore Bison Kill 230-370	River Bend Early Historic	Rock Ranch Trading Post Early Historic	Modern Fauna
Spermophilus armatus	o	●	●	o	o	o	●
Spermophilus tridecemlineatus	o	o	o	●	●	o	●
Spermophilus spilosoma	o	o	o	o	o	o	●
Spermophilus lateralis	●	o	o	o	o	o	●
Spermophilus sp.	o	o	o	o	●	o	●
Cynomys ludovicianus	o	o	●	o	o	o	●
Cynomys leucurus	o	o	o	o	o	o	●
Sciurus aberti	o	o	o	o	o	o	●
Sciurus niger	o	o	o	o	o	o	●
Tamiasciurus hudsonicus	o	●	o	o	o	o	●
Glaucomys sabrinus	o	o	o	o	o	o	●
Thomomys talpoides	●	●	●	o	●	o	●
Geomys bursarius	o	o	o	o	o	o	●
Perognathus fasciatus	o	o	o	o	●	o	●
Perognathus flavescens	o	o	o	o	o	o	●
Perognathus flavus	o	o	o	o	o	o	●
Perognathus parvus	o	o	o	o	o	o	●
Perognathus hispidus	o	o	o	o	o	o	●
Dipodomys ordii	o	o	o	o	●	o	●
Castor canadensis	o	o	●	o	●	●	●
Reithrodontomys montanus	o	o	o	o	o	o	●
Reithrodontomys megalotis	o	o	o	o	●	o	●
Peromyscus maniculatus	o	o	o	o	●	o	●
Peromyscus leucopus	o	o	o	o	o	o	●
Peromyscus crinitus	o	o	o	o	o	o	●
Peromyscus truei	o	o	o	o	o	o	●
Onychomys leucogaster	o	o	o	o	●	o	●
Neotoma cinerea	o	●	●	o	●	o	●
Clethrionomys gapperi	●	o	o	o	o	o	●
Phenacomys intermedius	o	o	o	o	o	o	●
Microtus pennsylvanicus	o	o	o	o	●	o	●
Microtus montanus	o	o	o	o	●	o	●
Microtus longicaudus	o	o	o	o	●	o	●
Microtus ochrogaster	o	o	o	o	●	o	●
Microtus richardsoni	o	o	o	o	o	o	●
Microtus sp.	o	●	o	o	o	o	o
Lagurus curtatus	o	o	o	o	●	o	●
Ondatra zibethicus	o	●	o	o	o	o	●
Rattus norvegicus	o	o	o	o	o	o	●
Mus musculus	o	o	o	o	o	o	●
Zapus hudsonius	o	o	o	o	o	o	●
Zapus princeps	o	o	o	o	o	o	●
Erethizon dorsatum	o	o	●	o	o	o	●

Table 8. (continued)

Taxon	Tina-Ann's Cave 2000-6000	Dead Indian Creek 3800-4430	Big Goose Creek 450-530	Vore Bison Kill 230-370	River Bend Early Historic	Rock Ranch Trading Post Early Historic	Modern Fauna
Carnivora							
Canis latrans	●	●	●	●	○	○	●
Canis lupus	○	○	●	●	○	○	●
Canis sp.	○	●	○	○	●	○	○
Vulpes vulpes	○	○	○	○	○	○	●
Vulpes velox	○	○	○	○	●	○	●
Urocyon cinereoargenteus	○	○	○	○	○	○	●
Ursus americanus	○	●	○	○	○	○	●
Ursus arctos	○	○	●	●	○	○	●
Bassariscus astutus	○	○	○	○	○	○	●
Procyon lotor	○	○	○	○	○	○	●
Martes americana	○	○	○	○	○	○	●
Martes pennanti	○	○	○	○	○	○	●
Mustela erminea	○	○	○	○	○	○	●
Mustela nivalis	○	○	○	○	○	○	●
Mustela frenata	○	○	○	○	●	○	●
Mustela nigripes	○	○	○	○	○	○	●
Mustela vison	○	○	○	○	○	○	●
Gulo gulo	○	○	○	○	○	○	●
Taxidea taxus	○	○	○	○	●	●	●
Spilogale putorius	○	○	○	○	○	○	●
Mephitis mephitis	○	○	●	○	●	●	●
Lutra canadensis	○	○	○	○	○	○	●
Felis concolor	○	○	○	○	○	○	●
Felis lynx	○	○	○	○	○	○	●
Felis rufus	○	○	○	○	○	○	●
Artiodactyla							
Cervus elaphus	○	●	●	○	●	○	●
Odocoileus hemionus	●	●	○	●	●	●	●
Odocoileus virginianus	○	○	●	○	○	○	●
Alces alces	○	○	○	○	○	○	●
Bison bison bison	●	●	●	●	●	●	●
Oreamnos americanus	○	○	○	○	○	○	●
Ovis canadensis ssp.	●	●	●	○	●	○	●
Antilocapra americana	●	●	○	●	●	●	●

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Russell W. Graham
Holmes A. Semken, Jr.
Mary Ann Graham
Editors

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