WOOD BISON IN LATE HOLOCENE ALASKA AND ADJACENT CANADA: PALEONTOLOGICAL, ARCHAEOLOGICAL AND HISTORICAL RECORDS

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INTRODUCTION

Bison originated in Eurasia, dispersing to North America by the Bering Isthmus several hundred thousand years ago, possibly during a transition from Irvingtonian to Rancholebrean fauna (Harington 1984). Large-horned forms similar to steppe bison (*Bison* priscus McDonald 1981, Guthrie 1990; Bison *bison priscus;* van Zyll de Jong 1986) prevailed until near the end of the Pleistocene when a number of large Pleistocene mammals became extinct or shifted their ranges southward. Large-horned bison in Siberia, Alaska and northwestern Canada evolved into modern, small-horned bison during the late Pleistocene and early Holocene, culminating in the wood bison (*B. b. athabascae*). Bison were abundant on the Alaskan landscape during most of the last 100,000 years (Guthrie 1968; 1990), and wood bison were the last subspecies to occupy Alaska and adjacent regions (Skinner and Kaisen 1947; Harington 1977; van Zyll de Jong 1986).

Bison have long been thought to have been a major food resource for humans in Beringia and elsewhere. Evidence from archaeological sites in Alaska and a large body of archaeological evidence demonstrates late Pleistocene and early Holocene associations of hunting implements with bison remains (cf. Guthrie 1980; Powers et al. 1983; Frison 1991, 1996; Yesner 1994; Loy and Dixon 1998; Brink, this volume; Kooyman, this volume). However, with few exceptions (Gordon and Savage 1973; Holmes and Bacon 1982; West 1982; Guthrie 1990; Gates et al. 1992), ethnographers, archaeologists and biologists have given little consideration to the possibility that bison played a role in the late Holocene subsistence system of Athabascan people in interior Alaska and adjacent parts of northwestern Canada. On the basis of paleontological and zooarchaeological evidence, Skinner and Kaisen (1947), Holmes and Bacon (1982), Guthrie (1990), and others have suggested that northern bison populations disappeared shortly before the arrival of EuroAmericans. Van Zyll de Jong (1986) referred to the "prehistoric" range of wood bison as extending "north and west into Alaska and the Yukon," noting that "the exact boundaries of the historical distributional range of *B.b. athabascae* cannot be determined at present on the basis of the available information." He also described the occurrence of small-horned bison similar to wood bison in eastern Siberia during the Holocene.

In this study we review new and existing paleontological and archaeological data and oral accounts from Native elders in Alaska and Canada, focusing on the late Holocene history and human use of wood bison in Alaska, Yukon and the western Northwest Territories (N.T.). These data include oral narratives provided by Athabascan elders in several interior Alaskan villages, similar accounts obtained from First Nation elders in Yukon (Lotenberg 1996) and N.T., and radiocarbon dates from bison remains collected at various locations throughout the study area (Figure 1). We also explore cultural and ecological factors that may have caused the demise of bison in part of their original range in Alaska and Canada. In the course of our discussions with Athabascan elders we were also provided with information regarding the occurrence of muskoxen (*Ovibos moschatus)* prior to their extirpation. Information pertaining to muskoxen is included where it clarifies issues pertaining to the late Holocene range of wood bison and muskoxen.

WOOD BISON ECOLOGY AND BEHAVIOR

Wood bison are adapted to boreal regions, having a highly efficient digestive system and an ability to forage on a variety of common grasses and sedges found in meadows and early successional habitats (Reynolds and Hawley 1987; Reynolds et al. 1978; Larter and Gates 1991). They are highly mobile, use a variety of open and forested habitats, and maximize seasonal foraging efficiency by selecting habitats where crude protein is most available (Larter and Gates 1991). Bison are adapted to low temperatures (Fuller 1962; Peters and Slen 1964; Christopherson et al. 1978, 1979) and snow conditions typical of northern latitudes (Larter and Gates 1991; Carbyn et al. 1993). Unlike caribou,

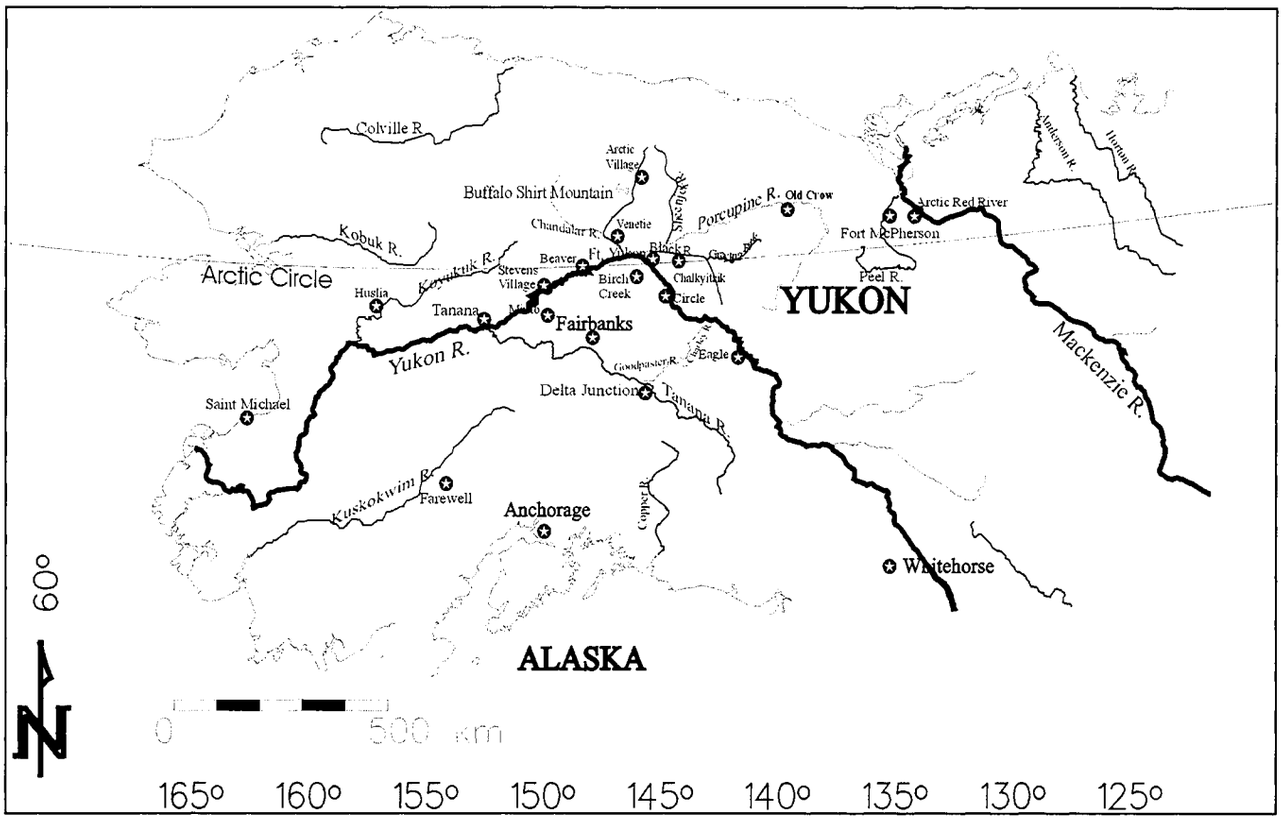

Figure 1. Map of study area showing major geographic features and locations mentioned in the text.

which crater snow with their hooves, bison expose forage by sweeping aside snow with their heads (Guthrie 1990).

The social behavior of wood bison is adapted to northern forests where forage occurs in scattered meadows separated by woodlands. Wood bison are gregarious animals that exist in several types of groups during the course of the year, although group size is generally smaller than among plains bison (*B.b. bison*) (Komers et al 1993). Cows, calves and yearlings are usually found in matriarchal groups ranging up to a few dozen animals or so. Maternity groups consisting of cows with young calves also occur. Mature bulls seldom form groups of more than a few animals, and solitary bulls are common (Komers et al 1992). Male wood bison show a linear, age-related, dominance hierarchy similar to that observed in plains bison (Komers et al 1994). Wood bison occur in small, mixed herds during the rut, apparently as an adjustment to resource availability in forested terrain (Melton et al. 1989; Komers et al 1993), but adult bulls generally remain separate during other seasons (Reynolds et al. 1978). Adult female and yearling bison occur in larger groups and have larger home ranges than do adult male bison (Larter and Gates 1994).

Soper (1941) estimates a total population of 168,000 wood bison in North America in 1800. However, the fate of wood bison was similar to that of plains bison. By the end of 19th century they had nearly vanished as a result of over-exploitation following the fur trade and westward expansion of European settlement (Gates et al. 1992). Subsequent conservation efforts improved their status in Canada (Reynolds and Gates 1991). There are currently about 2800 disease-free wood bison in six, free-ranging herds, and an additional 700 in captive herds in Canada. Prior to population declines during the 19th century, wood and plains bison occupied different habitats. During winter their movements may have overlapped in a limited area along the southern edge of wood bison range, but different migratory patterns suggest they did not share a common range during the breeding season. Differing habitat preferences and seasonal behavior maintained reproductive isolation (van Zyll de Jong 1986).

The evolutionary history of the North American bison is described in detail elsewhere (Skinner and Kaisen 1947; Harington 1977; van Zyll de Jong 1986, 1993; McDonald 1981; Guthrie 1990). These studies are in general agreement regarding the pattern of evolutionary divergence and geographic discontinuities lead to the existence of two morphologically distinct bison types during the Holocene. Modern forms evolved relatively recently, resulting in minor genetic, morphological and behavioral differences between subspecies. Studies of bison systematics show primarily clinal variation among contiguous populations, with a phenotypic discontinuity between boreal (*B. b. athabascae*) and plains (*B. b. bison*) populations supporting the

designation of only two late Holocene subspecies in North America (van Zyll de Jong 1986, 1993).

A typological approach to systematics during the late 1800s and early 1900s led to a bewildering array of species designations within the genus *Bison* (Guthrie 1980; van Zyll de Jong 1986). Subsequent recognition of the clinal variation in certain characteristics, and the relatively labile nature of social organs such as horn cores (Guthrie 1966, 1990), resulted in a trend toward synonomy in bison taxonomy (Skinner and Kaisen 1947; Guthrie 1980; van Zyll de Jong 1986).

The evolution of northern bison reflects the clinal variation and gradual reduction in body and horn size that has occurred in *Bison* over time (Guthrie 1990). Steppe bison evolved into an intermediate form, *B.b. occidentalis*, during the late Pleistocene-Holocene transition, which in turn gave rise to *B.b. athabascae* (van Zyll de Jong 1986). It is clear that wood bison are the most recent northern variant of *B. bison*, just as plains bison are the most recent southern variant. It is also known that wood bison were the last type of bison to inhabit Alaska and northwestern Canada, and were once widely distributed in this region (Skinner and Kaisen 1947; Harington 1977; Guthrie 1980; van Zyll de Jong 1986; 1993).

Wood bison are recognized as a subspecies based on morphology (Figure 2), blood characteristics and DNA. Geist (1991) suggested the subspecific status is not warranted and that observed differences are environmentally induced. However, morphological studies of plains bison and wood bison show differences in cranial and skeletal characteristics (van Zyll de Jong 1986), as well as in the anterior slope of the hump, location of the highest point on the hump, angle of the hump, cape variegation and demarcation, upper front leg hair, frontal display hair, ventral neck mane and beard, indicating that phenotypic differences are genetically controlled (van Zyll de Jong et al. 1995).

There are similarities as well as differences in mtDNA, genomic DNA (Bork et al. 1991; Strobeck et al. 1993), and erythrocyte antigens and blood proteins in plains bison and wood bison (Zamora 1983; Peden and Kraay 1979). Wilson and Strobeck (1999) investigated variability in 11 microsatellite loci of genomic DNA in 11 North American bison herds. Genetic distances between wood bison and plains bison subpopulations were usually larger than those within either subspecies, indicating that wood bison continue to function as genetic entities separate from plains bison, despite the introduction of plains bison into wood bison range in the 1920s (van Zyll de Jong et al. 1995). Strobeck et al. (1993) compared sequence divergence in a section of D-

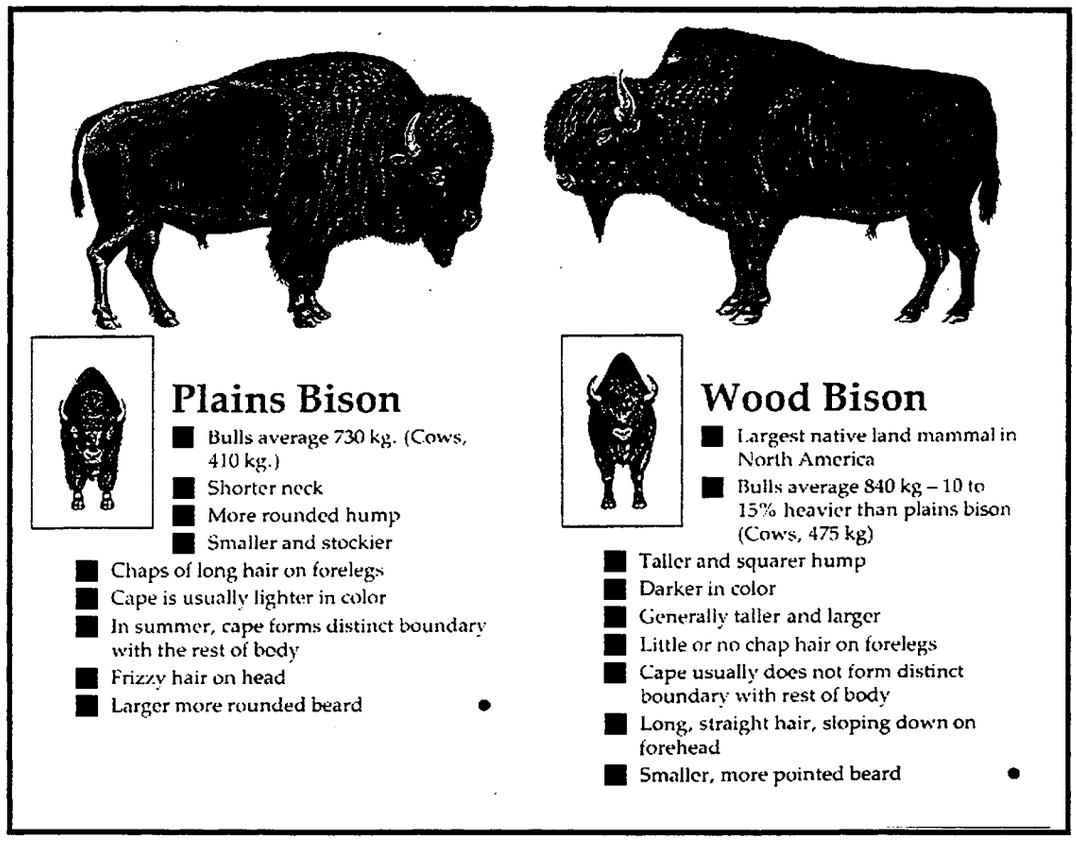

Figure 2. A comparison of the morphological characteristics of plains bison and wood bison. Reproduced with permission of Environment Canada, Elk Island National Park.

loop in the mtDNA of a small number of wood and plains bison and found that differences between the two subspecies are approximately the same or less than within plains bison. The rate of sequence divergence in mtDNA is on the order of 1% to 2% per million years (Wilson et al. 1985). These findings are consistent with the view that wood bison and plains bison existed as reproductively isolated populations during the last 5-10,000 years, a relatively short time in evolutionary terms, and probably also reflect some introgression of plains bison mtDNA into remnant wood bison populations during the 1920s (Van Zyll de Jong et al. 1995).

PROCEDURES

We first became aware of the existence of traditional knowledge about late Holocene bison in Alaska in the fall of 1991, when a resident of Fort Yukon informed the senior author that his mother had told stories describing how bison had once lived in the area around Fort Yukon. This prompted efforts to determine whether historic information might be present in the oral traditions of other Athabascan people in the region. We subsequently learned that elders in several villages in interior Alaska could recount credible and substantive stories about both the presence and the hunting of bison. We interviewed Athabascan elders in nine interior Alaska communities including Fort Yukon, Birch Creek, Beaver, Chalkyitsik, Venetie, Arctic Village, Minto, Nenana and Tanana (Figure 1) between November 1991 and July 2000. In June 1998, residents of several communities in northern Yukon and NT traveled to Alaska to attend the Sixth Biannual Gwich'in "Giikhii" Gathering at Fort Yukon, where two residents of Arctic Red River, NT contributed information regarding the occurrence of bison within recent times near that community. Individuals providing information in this study are identified in connection with their accounts, which are detailed below. Most informants ranged in age from 60 to over 90 years.

Oral accounts were summarized in writing following each interview based on notes taken during the conversation. Interviews were generally conducted in English, but in some cases in *Gwich'in* with the aid of a translator. Photographs of wood bison and muskoxen were used to help confirm the identity of the animal in question. Individuals were specifically asked to identify the animals represented and to provide, if possible, Athabascan or English names for them. Efforts were made to collect information about the abundance and spatial and temporal distribution of bison, their physical and behavioral characteristics, other details relating to their occurrence and how they were hunted and used, and if and where bison remains had been found.

Several accounts were substantiated and elaborated on through second and third discussions with elders. In subsequent discussions we reviewed and clarified details, particularly if there appeared to be confusion about the literal or interpretive meaning of an account (see Burch 1975). Information from two informants was independently reviewed and verified by researchers not directly involved in the study. William Schneider, a long time associate of Moses Cruikshank, and Curator of Oral History at the University of Alaska Fairbanks (UAF), conducted additional interviews with Mr. Cruikshank, independently confirming our results in the process. Historic accounts provided by Reverend David Salmon were compiled and reviewed by UAF anthropologist Thomas O'Brien who, in 1994, began a long-term collaborative project to record Rev. Salmon's life history (e.g. geneology, land use, historic travel narratives), and to collect narratives pertaining to a variety of other ethnographic and historic topics (O'Brien 1997). O'Brien conducted a line-by-line review with Rev. Salmon to evaluate with him the accuracy of accounts recorded previously by Stephenson.

We recognize the potential for bias in oral accounts, just as there is a bias in written and other documentary sources. We also recognize their utility for historical reconstruction and value in understanding natural history (cf. Garraghan 1940; Dundes 1965; Cruikshank 1981; Vansina 1986; Burch 1991; Beaudry 1994; Stevenson 1996; Wenzel 1999). We find no reason to discount or dismiss the following accounts pertaining to the late Holocene occurrence of bison in Alaska. While individual narratives vary in level of detail, they provide a relatively robust set of historical data with which to reevaluate the biogeography of wood bison and some aspects of late Holocene Athabascan subsistence, economy and ecology.

The emergence of oral accounts describing the presence of bison in recent times led to a more detailed examination of archaeological, paleontological and previously collected ethnohistorical data. We also obtained radiocarbon dates from bison skeletal material recovered from the Yukon Flats and other parts of Alaska and Canada, dating those remains that, based on morphology and preservation, appeared to represent Holocene specimens. In addition, we worked with other investigators to compile new and existing radiometric data for late Pleistocene and Holocene bison discoveries (Table 1). We relied on published literature and skeletal measurements to distinguish specimens of male and female bison where possible. In 1993 Gerlach and Mills conducted a 10 day archaeological survey in the vicinity of Smoke Creek, approximately 45 km southwest of Arctic Village, Alaska to search for evidence of bison hunting in the form of kill-, drive- or jump-sites. The survey occurred near "Buffalo Mountain" (Figure 1), a place name reported by T.E. Taylor in 1956 (Orth 1971). This survey was brief and logistically constrained, and no positive evidence was found (Mills 1993).

ATHABASCAN ORAL NARRATIVES ABOUT LATE HOLOCENE BISON ON THE YUKON FLATS AND IN OTHER AREAS OF INTERIOR ALASKA

Athabascan elders residing in the upper Yukon and Tanana River drainages in interior Alaska provided oral accounts referring specifically to late Holocene bison. Consistent oral narratives provided by multiple elders indicate bison were present and were hunted in parts of interior Alaska within the last few hundred years. There are a number of persistent themes in the oral narratives that provide insight into the late Holocene distribution, human use, and disappearance of wood bison in Alaska. Although the narratives are

substantive by current historical and ethnographic standards, there is little doubt that more detailed information would have been available to earlier ethnographers.

The accounts indicate that wood bison were widely distributed in the upper Yukon drainage, and apparently in the Tanana drainage as well, until late in the Holocene. Specific areas referred to as being inhabited by bison include the flats along the Yukon River from the vicinity of Beaver east to the lower Chandalar, Porcupine and Black River drainages in the vicinity of Fort Yukon, the Hodzana River drainage northwest of Beaver, the Grayling Fork area in the upper reaches of the Black River, and the flats adjacent to the Tanana River.

Discussions with several elders in Alaska also revealed an awareness of the fact that bison were still hunted in the Mackenzie River-Lake Athabasca region in Canada many years after significant populations had disappeared from the upper Yukon basin in Alaska. This knowledge is based on accounts from relatives who, on at least a few occasions, traveled to and from this region via the Porcupine River in connection with the fur trade during the late 1800s and early 1900s (McKennan 1965).

Oral narratives provided by thirteen Athabascan elders in the Yukon Flats communities of Beaver, Birch Creek, Chalkyitsik, Fort Yukon, and Venetie, and two elders from the communities of Minto and Nenana (Figure 1) indicate bison were sufficiently abundant to be a resource of some importance as recently as 200 to 300 years ago. One elder stated that a group of bison was seen near Eagle in 1916 or 1917, and two others report that small herds were sighted near Circle and Fort Yukon during the same period. Two elders describe instances in which single bison were killed in Alaska in the early 1900s. A few elders reported observations of tracks or other signs of bison in northeastern Alaska during the mid 1900s.

Details in these accounts are consistent with existing knowledge of bison ecology, morphology and behavior. Informants characterize the animals as being of unusually large size with small horns, a large hump, a large head, short legs, long hair and a long tail. These features are typical for wood bison (Figure 2), whose hump is especially prominent and whose tail is substantially longer than that of other ungulates present in Alaska during the Holocene (Guthrie 1990, van Zyll de Jong 1993). The elders further distinguish between bison and muskoxen, and include information that agrees with paleontological, archaeological and other historical evidence regarding their Holocene distribution (Lent 1998).[1]

Bison are said to provide high quality food and raw materials. Hides were tanned and used to make robes, pillows, and clothing, and sewing thread was made from bison hair. Bison were hunted with bow and arrow, spears, dogs, and with snowshoes to gain advantage in deep snow, and possibly with drives. The accounts obtained indicate that resident populations of wood bison declined or disappeared from Alaska by the early or mid 1800s, with the occurrence of small numbers in the eastern interior into the early 1900's.

Several elders were familiar with one or more *Gwich'in* terms for bison. Some informants indicated that one *Gwich'in* name for bison is *Dachantèe aak'ìi*, which they translate as "cow in the forest." Another provided the name *Dachantèe qwaak'ìi,* indicating it had a similar meaning. One informant described how the above terms were applied to either bison or muskoxen, and were always accompanied by a hand sign that identified the species being referred to.

These terms appear to be the most well known *Gwich'in* terms for bison; the first translates as "muskox among timber" and the second "the hefty one among timber" (J. Kari, pers. comm.). The *Gwich'in* term for muskoxen is *aak'ìi*, which appears to originate from the verb theme "to be hefty, meaty" and is literally "the one that is hefty" (J. Kari, pers. comm.). Another *Gwich'in* name for bison is said to be *Ch'itthay dighan*, which describes a large, humped animal or "humped game" (R. Mueller, pers. comm.), or "humped meat" (J. Kari, pers. comm.). A similar term, *Ch'atthaii daghan choo,* was provided by another elder (O'Brien pers. comm.). One elder provided the name *Nan'aak'ii choo*, indicating it meant simply, "big animal." *Nan'aak'ii choo* translates as "big hefty one on the land" (J. Kari, pers. comm.).

Gwich'in terms for bison appear to be a lexical innovation perhaps coined at a time when the animal was already scarce, and after a more ancient term had become obsolete. The term for bison is not as widely distributed in northern Athabascan languages, and is not as ancient as, for example, terms for moose or caribou, which are cognate terms. The apparently limited contemporary linguistic terminology related to bison in Alaska may reflect the fact that wood bison have been absent from the region, and culturally obsolete, for some time. (J. Kari, pers. comm.).

Different linguists transcribe and gloss *Gwich'in* Athabascan words in different ways. For example, one may transcribe bison as "*Dachantèe aak'ìi*", another as "*Dachantèe akìi*." The observed variation may reflect lexical, phonemic, dialectical, geographic, or idiosyncratic differences. We are unable to clarify all linguistic issues, but simply present them here as they have been interpreted for us.

Oral Narratives about the Upper Yukon Basin

Mrs. Annie James of Fort Yukon recognized a picture of bison and said that her mother, grandfather, and other "old-timers" told stories about bison in the Fort Yukon area, and in the upper Mackenzie River area in Canada. These elders described how bison were hunted in the upper Yukon area in Alaska during the "skin-clothes days," and were aware of the fact that bison still occurred and were hunted to the east in Canada after they had disappeared from the Fort Yukon area.

Mrs. James said she was told there were once "lots" of bison in the Fort Yukon area, that they were hunted with bows and arrows and spears, that the meat was sometimes dried, and that some "old-timers" thought the meat was tough. Mrs. James mentioned a number of other elders who should have information about the history of bison in the region, indicating that her knowledge of bison was not unusual.

Among these knowledgeable elders was her brother, the Reverend David Salmon of Chalkyitsik.

Rev. Salmon is acknowledged for his extensive and detailed knowledge of *Gwich'in* Athabascan history and traditions. He recounted bison stories that were related to him by his father, mother, maternal father-in-law, and additional stories based upon accounts provided by his paternal grandfather and other elders. Prior to their disappearance, bison were an important source of food for the *Gwich'in* on the Yukon Flats. Rev. Salmon emphasized that "they lived on it," especially before moose (*Alces alces*) became more common, adding that mosquitoes did not bother bison because of their long hair.[i] Bison were said to be a "good animal," providing valuable food and material for people. In discussing the history of bison in the region, Rev. Salmon often commented that the Yukon Flats "is their country...they belong to it."

According to stories passed on to Rev. Salmon, the bison that lived in this area had a large hump. During the 1970s his grandson found the skeleton of a bison in a cutbank along the Black River, about 20 miles west of Chalkyitsik (Figure 1). The remains were brought to Chalkyitsik where people noted the long spines on the cervical and thoracic vertebrae. Rev. Salmon pointed out that this was consistent with the large hump described in *Gwich'in* oral narratives. We obtained a radiocarbon date of 1730±60 BP for this specimen (Table 1, Map No. 37). Rev. Salmon has often found bison horns and other skeletal remains on the Yukon Flats, and observes that many of the bones have a "fresh" appearance and appear to be of recent origin. The Grayling River flats in the upper Black River drainage was one area known as bison country. Rev. Salmon mentioned that a bison skull had been found there and that his father found a frozen bison head along the Black River upstream from Chalkyitsik in 1926. It was recovered from permafrost and looked "fresh." Both horn sheaths were attached, and Rev. Salmon described it as being a small-horned bison.

According to Rev. Salmon, *Gwich'in* names for bison include *Dachantèe aak'ii* which he translated as, "cow in the forest", and *Ch'atthaii daghan choo*, which he translated as "large animal with a hump." He indicates these terms could be applied to either muskoxen or bison, emphasizing that only bison occurred on the Yukon Flats. Rev. Salmon explained that these two animals were distinguished in conversation on the basis of the distinctive shape of their horns, and clarified any ambiguity regarding the name *Dachantèe aak'ii*. He describes the characteristic downswept horns which "cover the head" of a muskoxen, contrasting them with the upwardly curving horns of bison. When referring to muskoxen the speaker would typically place an open palmed right hand above the ear, move it gently downward over the ear and then out and up in an arc, indicating the downswept curve and upturned end of the horn. When referring to wood bison a hunter would extend and slightly curve the first and second fingers, placing them against the upper temple, indicating the outward and upward curve of wood bison horns. The phrase "*Dachantèe aak'ii viji vikì' noiinjik*" means "cow in the forest with the horn that sweeps downward to protect the head." In contrast, the phrase "Dachantèe *aak'ii viji neekwaii gwanlii*" means "cow in the forest with two short horns turning upward." Rev. Salmon stated that even during the early 1900's hunters discussing bison or muskoxen would qualify the term with hand sign, adding that *Gwich'in* people in a large region extending from Fort McPherson to Fort Yukon commonly used the term *Dachantèe aak'ii*, accompanied by hand sign, to denote wood bison. It is interesting that this hand sign for bison is identical to that used in the traditional hand sign language of Plains Indians, as well as other indigenous peoples in North America (T. O'Brien, pers. comm.).[ii]

Rev. Salmon believes that Athabascan stories about bison hunting refer to a time no longer than 300-500 years ago, in part because he doubts that stories of this nature could persist for a longer period of time. Moreover, he indicates that bison were still being hunted at the time that moose first became known to the *Gwich'in*. Rev. Salmon said the first moose (*Alces alces*) was seen near Birch Creek about 400 years ago. People were initially afraid, but as moose became more common, they began to rely on them for food (Salmon, n.d.). McKennan (1965) describes a similar oral tradition among the Chandalar *Gwich'in* regarding the historic occurrence of moose in the vicinity of Arctic Village. Paleontological and archaeological evidence suggests that moose were present in Interior Alaska throughout the Holocene, but may have been locally absent or rare for extended periods in certain areas (Yesner 1989).

Rev. Salmon clearly distinguished bison from muskoxen and notes that bison bones are commonly found on the Yukon Flats, where the remains of muskoxen are unknown. He indicates that while oral tradition describes how wood bison were once common on the Yukon Flats, there is no such tradition regarding muskoxen, stating "...all they had was wood bison down this way." Rev. Salmon states that muskoxen were once an important resource for people to the northeast in the upper Porcupine-Peel river region, and describes hunting techniques used to take muskoxen with bow and arrow, and with muzzle loaders after they became available during the mid 1800s. Rev. Salmon also refers to a story originating with the *Dihaii Gwich'in* describing how muskoxen were sometimes killed by being driven over a cliff in the upper Chandalar River country. He indicates this technique may have also been used somewhere north of the Porcupine River, north and east of the Yukon Flats, in the "Old Crow country."

Athabascan people relied extensively on their highly developed archery to take bison and other animals. Rev. Salmon describes hunting strategies and archery technology that were effective in harvesting large game animals such as moose and grizzly bears (*Ursus arctos*), and believes they would have been adequate for bison hunting as well (O'Brien 1997). Hunters used finely crafted "self-bows" made from selected birch wood, along with a wide array of arrow types designed for specific purposes. Archery tackle was designed for long range shooting, with the draw weight of bows used by Athabascan men estimated to have ranged from 60 to 80 pounds (O'Brien pers. comm.). Arrows used to kill large game animals were generally tipped with one of a variety of bone or antler broadheads (O'Brien 1997).

Rev. Salmon states that archery training was extensive and thorough, and was intended to produce highly competent archers with years of experience, knowing that the survival of people from one generation to the next depended heavily on their skill. Hunting strategies were adapted to environmental conditions and to the behavior of animals, and often involved the efforts and expertise of several hunters. For example, during winter animals were driven into deep snowdrifts, where hunters using large hunting snowshoes could shoot at close range. Big game animals were often killed as they crossed rivers or lakes in spring and summer (O'Brien 1997).

Rev. Salmon describes a special arrowhead used to kill large animals which includes a detachable head that was serrated and barbed in such a way that it worked its way through tissue as the animal moved (O'Brien 1997). The hunter had only to penetrate the hide with this arrowhead in order to kill an animal. Although Rev. Salmon believes snares could have been used to take bison, just as they were used to take moose and caribou (*Rangifer tarandus*), he is unaware of specific stories describing their use, stating instead that the bow and arrow was the most effective weapon for this species.

Based on his knowledge of the skill and purpose of earlier generations of hunters, Rev. Salmon believes that hunting played a role in the disappearance of wood bison from the Yukon Flats, emphasizing the ease with which Athabascan archers killed moose, bears and other large game. Stressing the cyclic pattern of human populations increase and subsequent decline to very low levels due to shortages of big game and other resources, Rev. Salmon described how during hard times people hunted intensively, and may have "hunted out" bison (Salmon/O'Brien, taped interview, June 3, 1997; see also Campbell 1978; Mishler 1995). He points out that "mountain people" were generally "wiped out" during periods of starvation, but that a small number of people would typically survive along the Yukon River where salmon and other fish provided a more reliable supply of food. Human populations would subsequently increase and disperse from these areas. Rev. Salmon further said that the more open nature of the terrain in the past would have made bison vulnerable to hunters, and also believes that intensive hunting might have caused the last bison to leave the country and go to the "Canadian side."

Rev. Salmon recalled stories told to him by his maternal grandfather, John Chitleii (1840-1923), a noted hunter from Old Crow, Yukon (O'Brien 1997), regarding the disappearance of bison in the region. These accounts described the occurrence of bison in the country lying between Old Crow and Arctic Red River, NT, including the Peel River area, during a time when habitat was more open than at present. Bison were once hunted in this area but populations eventually declined, first in the western portion of this range and later to the east as well. Rev. Salmon said the stories told by John Chitleii indicated that bison disappeared from the region east of Old Crow after they had disappeared from the Yukon Flats.

Rev. Salmon and other elders emphasize geographical and temporal differences between oral traditions relating to bison in Canada, some of which were obtained during periodic long-distance trading forays in the mid 19th century. Rev. Salmon is aware that bison occurred in the area near Lake Athabasca in Canada during the mid 19th century, after they had largely disappeared from the Yukon Flats, based on information passed on by his father, William Salmon, reflecting the experiences of his paternal grandfather, King Salmon. During the period from approximately 1850-1868 King Salmon made several journeys into Canada via the Porcupine and Mackenzie Rivers in connection with the Hudson Bay Company. He traveled as far as Lake Athabasca and the Wabasca River, a tributary of the Peace River (Salmon n.d.).

Mr. Moses Cruikshank of Beaver said there were many *Gwich'in* stories describing how bison inhabited the Yukon Flats in the old days when, "big herds" of these animals occurred in the area. Large numbers of bison were sometimes killed in the fall when much of the meat was dried and "used all winter long." A story attributed to Chief Christian[iii] relates to "a mountain up in the Sheenjek River country" called "Buffalo Shirt Mountain." Mr. Cruikshank said "a large herd of bison came through and covered the mountain like a shirt" at this location. Bison were hunted there for several years, and were guided by fences down on the flats and driven over a cliff. Mr. Cruikshank said many bison were killed during this period. He noted that the taking of large numbers of bison by people at "Buffalo Mountain" occurred sometime before Chief Christian was born, and before firearms were generally available. Rev. Salmon estimates that Chief Christian was born about 1855 and was 93 years old when he died (T. O'Brien, pers. comm.). Campisi (1993) indicates Chief Christian was born in Arctic Village in 1866. Mr. Cruikshank said bison lingered in the area for a few years, but eventually disappeared. He remembered the "old-timers" saying there were two types of bison, one living on the flats and the other in the mountains, and that one was larger than the other. He thought the "mountain buffalo" were larger, but was not certain about this point. Mr. Cruikshank further states that a strong bow was required to kill bison, and that bison hunting was sometimes dangerous.

Mary Sam was born in 1914 and lived in the Black River area near Chalkyitsik until 1947. She presently lives in Beaver, Alaska. Mrs. Sam recalls that when she was about nine years old her grandparents, Mariah and Henry Gwats'oo, told stories originating from her great-grandfather that described how bison were once abundant in the Black River country. Mrs. Sam believes that her great-grandfather might have seen bison in that area. She was told these animals had small horns, a big hump, short legs, long hair, and were hunted with bow and arrow. They were said to have been a major source of food, were a "counterpart" (literal translation from *Gwich'in*) to moose in the diet, and were valued for their high quality meat.

With regard to the disappearance of wood bison, Mrs. Sam said that "maybe they ate it up," suggesting that hunting might have contributed to the disappearance of bison in the Black River area. She remembers her grandfather saying that moose were also likely to become scarce in the future

because there would be more people in the area. She also described how on one occasion her grandparents pointed to another young girl, saying, "...When this young girl grows up, and her children grow up, then the bison will come back." She recalled a story about a hunter who returned to a village in the area near Beaver after unexpectedly encountering a bison north of the Yukon River, describing how "his eyes were really big." Although her grandparents had told her the *Gwich'in* name for wood bison, she could not recall it. Mary Sam clearly differentiated muskoxen from bison, noting that a muskox had recently been seen near Arctic Village or Venetie. Muskoxen were reintroduced to northern Alaska in 1969-70 and have expanded their range in recent years, with some males dispersing south of the Brooks Range (Reynolds 1998).

Ms. Ann Fisher describes how her mother, the late Charlotte Adams of Beaver, often talked about the former occurrence of bison in the Hodzana River area northwest of Beaver. These accounts originated from Charlotte's father, "Old Adam" who, with his family, lived and traveled in the Hodzana drainage (Cruikshank 1986). He often talked about seeing bison in this area when he was a young man, later referring to them as "white mans moose." Old Adam hunted with bow and arrow and spears in the early days and is said to be one of the last people to have killed a bear with a spear. The inscription at his gravesite indicates he was born in 1848 and died in 1944, at the age of 96. This account indicates that resident bison populations existed in the vicinity of Beaver during or after the mid-1800s.

Mrs. Virginia Titus provided stories regarding the presence of bison in interior Alaska that were conveyed to her by her father and grandfather. Her family originally lived in the Koyukon Athabascan community of Tanana. However, her father spent most of his life in Fort Yukon and travelled extensively between the two communities. Her father heard many stories about bison and their value to people in the "skin clothes days," when animal skins were the only materials available for clothing. She was told that bison were once common and widespread in Alaska, although they were found mostly at low elevation and were scarce in the mountains. The flats in the Tanana and Yukon drainages were said to support bison in the early days. According to Mrs. Titus, bison were second only to moose as a source of food, and were an important source of material for clothing and shelter as well. Bison had a "big head," and the hides were tanned with the hair on to make warm robes and clothing. The hair was soft, and bison hides were preferred for clothing because they did not cause allergic reactions in people.[iv]

Mrs. Titus said these stories described the presence of bison in the 1700s and into the early 1800s, as well as earlier. Her grandfather said bison were hunted with bow and arrow, with spears, with the aid of snowshoes in winter, and with the aid of dogs. Mrs. Titus said the dogs used by people in the early days were larger than the sled dogs generally used today. She adds that there was more snow in the early days, noting this may have increased the vulnerability of bison to hunters. She indicated that the disappearance of bison in this region was due to hunting, stating "...they were easy to kill, that's why they are not here," Mrs. Titus recalled the name for bison as "*nan' aak'ii choo,* " which she translated as "big animal."[v] Mrs. Titus stressed that stories relating to bison were not recorded earlier because of the generally poor communication between interior Alaska Natives and early settlers, missionaries and explorers.

Mr. Elliot Johnson, age 96, of Fort Yukon, also states that bison once lived on the Yukon Flats and were hunted in the early days. He had heard other "old-timers" talk about the former occurrence and use of bison on the Yukon Flats, specifically mentioning Chief Christian and Chief Robert, two prominent leaders in the Fort Yukon area during the late 1800s and early 1900s (T. O'Brien, pers. comm.). In addition to being an important source of food, bison provided raw materials, with hides making good blankets and pillows and the hair being used to make thread for sewing. Bison hides were left outside for a time to rid them of "bugs" before using them because they harbored parasites.[vi] According to Mr. Johnson, the decline of bison populations was followed by a period of food scarcity, which continued into the 1900's when he was a young man. He indicates that people referred to this period with the phrase "no buffalo, no power." Big game was extremely scarce in the Fort Yukon area during this period, which was characterized by social instability and extensive movements in search of bison and other game. Mr. Johnson states that he saw four bison along the Porcupine River a few miles from Fort Yukon on one occasion in the early 1900s. He describes them as having black, upward curving horns, long hair, and being about five feet high at the shoulder. He did not shoot these animals because it was the first time he had seen "buffalo", and later he returned to the site with other people in an unsuccessful effort to relocate them. Mr. Johnson also recounts a story told by his father-in-law, Frank Alexander, relating to an animal that he encountered as he was travelling from Tanana to Fort Yukon. He shot the animal with his rifle, thinking it was a moose, but on approaching it found it had a long tail and was actually a bison.

The late Julia Tritt of Venetie recounted stories told by her grandfather and other elders about how "buffalo" were hunted on the Yukon Flats. She referred to bison as the "big animal," stating that elders often remarked on the animals' "big head," long tail and large size. She said hunters often found their large round tracks in the snow. They were said to be fairly easy to hunt and to kill with bow and arrow or spears, and dogs were also used to help bring them down. Bison were sometimes caught in, and often ruined, snares set for moose or caribou. These snares were often not strong enough to hold them. She said bison were "good eating" and provided high quality food for people. Sewing thread was made by plaiting together several of the longest hairs, and a single bison hair was used to suture cuts on people. Mrs. Tritt said bison hides were hard to tan compared to those of other animals, and were sometimes only partially tanned and used to cover the floor in a dwelling. She said that bison eventually disappeared or left the country. Mrs. Tritt indicated these accounts pertained to the early 1800s and earlier.

Mr. Earl Erick of Venetie recalls stories told by his grandmother, the late Myra Roberts of Venetie. As a young woman, Mrs. Roberts lived at White Eye, located about 20 miles northeast of Beaver along the Yukon River. Her grandfather, father, and mother, described how small numbers of bison still roamed the flats adjacent to the Yukon River near White Eye in the recent past, with populations extending to the east at least as far as the area around the lower Chandalar River, the Porcupine River and Fort Yukon. Mrs. Roberts said these animals had small horns. Mr. Erick said Mrs. Roberts indicated that people in her grandfather's generation knew others who had seen bison in this area, and believes the stories about bison pertain to a period ending about 200 years ago.

Other elders in the Fort Yukon area also know that bison inhabited the area in the past, but provided fewer details about them or their relationship to people. Mr. Steven Henry of Chalkyitsik knew of their former presence, and states that bison were once abundant on the Yukon Flats. Based on stories told by his father, Paul Henry, Steven Henry believes that bison disappeared about 200 years ago. Mr. Richard James of Birch Creek said his grandfather, Birch Creek Jimmy, told him that bison once lived on the Yukon Flats and were a source of food for people in the area. Birch Creek Jimmy died in 1979 at the age of 111. Prior to his death in 1997, Mr. Steven Peter of Arctic Village (then residing in Fort Yukon) stated that bison lived on the Yukon Flats and were called *Dachan aak'ii*. He was also aware that bison existed to the east in Canada in more recent times. One of their characteristics was that they were difficult for wolves (*Canis lupus*) to kill. Mr. Peter said bison were known to kill wolves by kicking them. Mr. Daniel Flitt of Fort Yukon also said bison were once abundant on the Yukon Flats.

Oral Narratives from the Tanana Drainage

Mr. Peter John of Minto recognized an illustration of bison and noted that the animal had once lived in the Minto area. He stated that long ago "we used to hunt that animal," and described a place on the Chatanika River, near Minto, where old bones are often found. The remains of Pleistocene fauna, including bison, have been recovered from the Chatanika River and are deposited in the University of Alaska Museum (Gerlach lab notes, June 19, 1997).

Mr. Howard Luke, originally from Nenana and now residing near Fairbanks (see Luke 1998), stated that as a young boy he was told that bison once occurred "on the Fort Yukon side." He describes how people traveled from the Tanana drainage up the Goodpaster River and into the Yukon drainage in the early days, probably by way of the Charley River. He said these animals were wood bison and existed well before the introduction of plains bison to Alaska (Luke 1998). Plains bison were introduced near Delta Junction, Alaska, in 1928 (Dubois and Stephenson 1998). Although he did not know exactly how long ago bison were present, he was clear about the identity of the animal and certain that they once lived in the Fort Yukon area. Mr. Luke is not aware of stories regarding the occurrence of bison in the Tanana drainage. Mrs. Catherine Attla of Huslia, Alaska was present during the discussion with Howard Luke, and states that she too is unaware of any oral tradition regarding bison in the Koyukuk River area near Huslia.

Other 20th Century Oral and Documentary Accounts from Alaska

In addition to the accounts describing the presence of wood bison 200 years ago and earlier, a few accounts suggest that a few bison occurred in the upper Yukon area in the early 1900s. Mr. Bill Goebel, a resident of Eagle, relates an account provided to him in 1992 by his aunt, the late Sarah Malcolm of Eagle, shortly before her death at the age of 87. Mrs. Malcolm was a Han Athabascan who spent her life in Eagle. She stated that several bison were seen near Eagle in 1916 or 1917, when she was 11 or 12 years old. The bison became entangled in, and broke, snares set for moose or caribou. She said people were afraid of the animals because of their large size. Mr. Goebel questioned her closely as to the identity of these animals, but Mrs. Malcolm was certain they were "buffalo," and that this was the only time they were seen near Eagle in recent times. Lotenberg (1996) notes that a Vuntut *Gwich'in* First Nation Elder said there was a place near Eagle called Buffalo Hill.

Mr. William Joseph of Chalkyitsik, originally from the village of Circle, recalls a story told by his grandfather, Zias Joseph, who spent his life in the Circle area. Zias Joseph described how he once saw a group of 5-7 bison on the hills near Circle as they traveled through the area. Zias Joseph died in the 1930's when he was about 60 years old, suggesting these bison were observed in the late 1800s or early 1900s.

Mary Sam recalled an incident that occurred in 1922, when she was 8 years old, when her grandfather was hunting moose during winter near the south end of Ohtig Lake, about 6 miles south of Chalkyitsik. He killed a moose, and after returning to their camp near Chalkyitsik, described how he had found large, round tracks of a big animal he had never seen before. He thought a bison, an animal he said previously occurred in the area, made the tracks.

Mr. Joe Herbert of Chalkyitsik describes a similar incident that occurred in January 1941, when his family was living at Shuman House, on the Porcupine River about 25 miles north of Ohtig Lake. His grandfather (also named Joe Herbert) found large, round tracks of what he thought was a bison, and droppings in large mushy piles he described as looking like "cow patties" a short distance north of Shuman House. Drag marks showed that the animal's chest touched the snow, which was no more than 20 inches deep. They returned to the area the following day but the tracks had been largely obscured by drifting snow during the night. The droppings described are characteristic of bison, which unlike muskoxen or moose, do not produce fecal pellets.

Virginia Titus recalls that her father, Robert Albert, described to her how he and his adopted father, Pretty Albert, encountered a bison near Tanana, probably in the winter of 1918. This occurred when they were on their trapline and when her father, who was born in 1904, was fourteen years old. Her father remembered being scared

when they encountered a large animal in the brush. His father shot the animal with a lever-action rifle, the first cartridge rifle they had obtained. The animal was a large bison. After butchering the animal they stored the meat in an underground cellar insulated with grass. The hide was given to their Chief, which he used in their "talking house" as a place to sit. The carcass provided food for their dogs for a long time. Mrs. Titus said this was the last known occurrence of bison in the Tanana area. Recall that Elliot Johnson reports seeing four bison near Fort Yukon, and described how his father-in-law killed a bison in the upper Yukon area, probably in the early 1900s. Mr. Arthur Adams of Beaver said that Jack VanHatten, who with his family lived in the upper Black River area above Grayling Fork during the early 1900s, recounted the story of a trapper who shot a bison in that area. However, the date of this occurrence is unknown. A number of residents of the upper Yukon basin in Alaska provided additional accounts describing tracks or other sign suggesting that a few bison may have occurred in this region as late as the mid 20th century.

The journal of James Geoghegan (James Geoghegan Collection, University of Alaska Archives), who lived near Delta Junction, Alaska in the early 1900s, includes a reference to the presence of bison near Donnelly, Alaska in 1918 or 1920. Unfortunately, it is not possible to determine whether the author is referring to plains bison introduced to this area in 1928 or to the presence of a few indigenous wood bison prior to that time.

Oral Narratives From and About Adjacent Canada

Mr. Moses Sam of Arctic Village said his uncle, Henry John, told him stories about "Indians over Old Crow way" who hunted buffalo for food, although he is not aware of their presence in the upper Chandalar River-Arctic Village area. The late Mr. Isaac Tritt, Sr. of Arctic Village knew that bison occurred in Canada, specifically mentioning the Mayo area in Yukon. However, he was not aware that they occurred in eastern Alaska. He said the *Gwich'in* name for bison was *Dachantèe qwaak'ii*, which he translated as "in the timber, cow."

Mr. Hyacinthe Andre, age 86, and his younger brother Gabe Andre, of Arctic Red River, NT provided information regarding the occurrence of bison in this area (Figure 1). They are most familiar with the lower Mackenzie River area near Arctic Red River. Hyacinthe Andre spent much of his life in the Anderson River country to the east, between the Mackenzie and Horton rivers. The Andre brothers referred to oral traditions describing the former occurrence of bison in this area. Hyacinthe Andre said he had heard "old stories" referring specifically to the Travaillant Lake area east of Arctic Red River as having once supported bison, that bison were once hunted to the north near the arctic coast, and that bison once occurred on the "barren-grounds" adjacent to the Anderson River, mentioning that bison skulls had been found there. He does not recall the *Gwich'in* name for bison, but notes they disappeared a long time ago and that it has been at least 200 hundred years since bison were hunted in the region north of Arctic Red River. Mr. Andre clearly differentiates bison from muskoxen, saying the bison were much larger than muskoxen, and that these animals "were powerful and could run through four feet of snow with no problem."[vii]

Gabe Andre adds that bison also occurred adjacent to the Mackenzie River near Arctic Red River, including the area near the Ontaratue River south of the Mackenzie. He recalls one story that describes how the bison disappeared after a bison head had been sent south to be examined. An account presented by Lotenberg (1996) indicates that bison were hunted near Fort MacPherson, about 30 miles west of Arctic Red River, in the 1820s. These accounts appear to be consistent with the presence of late Holocene bison remains along the arctic coast near Cape Bathurst, on the Old Horton River Channel, and Harowby Bay, about 250 miles northeast of Arctic Red River (Figure 3). As described below, one of these specimens is radiocarbon dated at 420±65 years BP.

PALEONTOLOGICAL, RADIOMETRIC, ARCHAEOLOGICAL AND ETHNOGRAPHIC INFORMATION

Paleontological and Radiometric Data

Paleontological discoveries often result from incidental encounters, are influenced by the vagaries of preservation, and in Alaska and Canada often represent isolated rather than mass mortality events (Lyman 1994). Radiometric data for Holocene bison are the product of the chance discovery of specimens and the selection of samples for dating by various investigators during the last few decades. The oral narratives presented above reflect the accumulated knowledge of people whose accounts are chronologically ordered, but sometimes do not contain precise temporal referents.

Table 1 presents available radiometric data for bison remains collected in Alaska and northwestern Canada that date to either late in the Pleistocene-Holocene transition (Guthrie 1995) or to the Holocene. Except for specimens dated by the sedimentary matrix within which they were found (Nos. 4, 9, 17, 18, 23, 25, 26, and 41), dates for Holocene bison are derived directly from bone. The sample of dated specimens includes some from known geological and sedimentary contexts, others found in direct association with archaeological and cultural material, and some without established associations.

The sample of Holocene bison includes 47 specimens from 44 locations, including 19 from Alaska and 28 from Canada (Table 1, Map Nos. 1-44). Conventional radiocarbon ages provided by the laboratory conducting each assay, or as reported in published literature are listed in Table 1. Males (n=15) predominate over females (n=4) in the sample of Holocene remains of known sex, probably because the remains of male bison are more robust and tend to persist longer than the remains of females. The ten earliest radiocarbon dates represent temporally late, eastern Beringian representatives of the Mammoth-Steppe Fauna, a widespread faunal community associated with steppe-tundra and found throughout Beringia (Guthrie 1982,1985, 1990; Matthews 1982; Vereschagin and Barynishnikov 1982; Burke and Cinq-Mars 1998).

MAP NO.	LOCATION	CONVENTIONAL 14CAGE	REFERENCE	LAB NO.	COMMENTS
	Old Crow, (Loe. 11-1) Y.T.	11,990±180	Harington 1978	1-7765	Bison scapula
	Fairbanks Creek, AK	11,980±135	Harington 1978	ST-1633	Bison bone
	Birch Creek, Yukon Flats, AK	11,900± 70	ADF&G, this study	Beta-67494	Female bison skull with horn sheaths
	Cleary Creek, AK	11,735±130	Pewe 1975	ST-1631	Bison bone
	Old Crow Flats, Y.T.	11,530±200	Harington 1977	QU-780	Bison humerus
	Broken Mammoth Site, Delta Junction, AK Cultural Zone IV	11,510±120 11,420±70	Holmes 1996	WSU-4262 CAMS 5358	Bison bones with processing marks; associated hearth charcoal dates
	Dry Creek, AK	10,715±225	Guthrie 1985	ST-1561	Bison bone
	Lost Chicken Creek, AK	10,370±160	Harington 1978	1-8582	Distal portion of bison tibia
	Broken Mammoth Site, Delta Junction, AK Cultural Zone lll	10,290± 70 10,270±110	Holmes 1996	CAMS-5357 WSU-4263	Bison bones with processing marks; associated hearth charcoal dates
	Bluefish Cave II (MgVo-2) Y.T.	10,230±140	Burke & Cinq-Mars 1998	RIDDLE-561	Bison metacarpal at archaeological site
	Engigstciak, Y.T.	9870±180 9770±180 9400±230	Cinq-Mars et al. 1991	RIDDL-362 RIDDL-281 RIDDL-319	Bison bone (tibia, metacarpal, and metatarsal) showing processing marks
2	Muskeg River, N.T.	9645±190	Harington, this study	1-9997	Bison cranial fragment
3	Cape Bathurst, N.T.	9560±60	Harington, this study	Beta-79861 **CAMS-18424**	Left bison scapula
4	Gerstle River Quarry Site, AK	9970±60 8280±60	Holmes 1998	Beta-98432 Beta-98434	Bracketing dates from charcoal for 6 bison bones
5	Porcupine River, AK	9000±250	UAF Museum, unpublished	Beta-18552	Bison bone
6	Victoria Island, Minto Inlet, Kuujjua River, N.T.	8080±60	Harington, this study	TO-3709	Partial male 8. *bison* skeleton with cranium and horn cores
7	Broken Mammoth Site, Delta Junction, AK. Cultural Zone II	7600±140	Holmes 1996	WSU-4264	Bison bones with processing marks; associated hearth charcoal date
	Cultural Zone IA	2260±40	D. Yesner, pers. comm.	Beta-128716	Bison naviculo-cuboid; associated charcoal date
8	Mt. Granger, Whitehorse, Y.T.	7510±90	M. Hoefs, pers. comm.	Beta-135361	Female 8. *bison* horn sheath from alpine ice patch
9	Canyon Site, Aishihik River, Y.T.	7195±100	Workman 1978 Harington 1978	SI-1117	Bison bone fragments around buried hearth; associated charcoal dates
10	Sullivan Pit, AK	6730±260	Repenning et al. 1964	W-1108	Bison bone
11	McIntyre Creek, Y.T.	ca 5840±70	Hare, this study	Beta-70100 CAMS-11243	Bison bone associated with cultural material
12	Goldstream Creek, AK	5340±110	Pewe 1975	SI-845	Bison horn sheath
13	Harrowby Bay, Beaufort Coast, N.T.	5230±110	Cinq-Mars 1991 Harington 1990	RIDDL-321	Metacarpal at archaeological
14	Fort Yukon, AK	5045±45	Guthrie, this study	AA4379 VP4157	Male 8. *bison* skull
15	Carmacks, Y.T.	4880±80	Harington, this study	Beta-25120	8. *bison* skull from terrace
16	Julian Site (JcRw-13) Fisherman Lake, N.T.	4800±160	Morlan 1999	S-0906	Bison bone at archaeological site
17	Canyon Site (JNg-1) Y.T.	4730±320	MacNeish 1964	W-1125	Bison bone; associated charcoal date
18	Kusawa Bluffs Site (JdVa-2), Y.T.	4490±130	Greer 1986	Beta-14402	Date from elk bone located below bison bones in archaeological site
19	Black River, Yukon Flats, AK	4495±60	ADF&G, this study	Beta-65662	Male 8. *bison* horn core and cranium
20	Black River, Yukon Flats, AK	4390±70	ADF&G, this study	Beta-136731	Male 8. *bison* skull with horn sheaths
21	Fort Yukon, AK	3710±70	ADF&G	Beta-74344	Female 8. *bison* horn core and part of cranium
22	Fort Yukon, AK	3520±40	Gerlach, this study	Beta-104823	Male 8. *bison* skull with both horn sheaths
23	Delta River Overlook Site (XMH-297), Delta Jct., AK	3980±150 2285±145	Holmes and Bacon 1982	GX-6752 GX-6750	Bison tibia fragment; associated charcoal dates
24	Ruby Range, Kluane District, Y.T.	3470±70	M.Hoefs, pers. comm.	Beta-136362	Bison tibia at archaeological site
25	Pelly Farms Site (KNd-2) Y.T.	3160±70	MacNeish 1964	S-193	8. *bison;* associated charcoal date
26	Pelly Farm Site (KND-2) Y.T.	2920±140	MacNeish 1964	GSC-127	8. *bison;* associated charcoal date
27	Fairbanks, AK (railroad terminal)	2900±80	Guthrie, this study	AA3320, AMNH A-501-5331	Male 8. *bison* skull
28	Montague House, Y.T.	2800±60	Hare, this study	Beta-7010	Bison ribs

MAP NO.	LOCATION	CONVENTIONAL 14C AGE	REFERENCE	LAB NO.	COMMENTS
29	¾ mile downstream from Circle, Yukon Flats, AK	2545±80	Guthrie, this study	AA3217, AMNH A-479-4783	Male *B. bison* skull
30	Lower Tanana River, AK	2460±70	Guthrie, this study	unknown	Male *B. bison* skull
31	Braeburn, Y.T.	2460±40	M.Hoefs, pers. comm.	Beta-137731	*B. bison* skeleton in dry lake bed
32	Killik River (Site KIR 275), AK	2330±50	C. Martin, T. Birkedal, pers. comm.	Beta-130571	Bison metatarsal near archaeological site
33	Kluane Lake, (Congdon Creek) Y.T.	2180±30	M.Hoefs, pers. comm.	Beta-91755	Male *B. bison* cranium
34	Takhini River, Y.T.	2150±40	M. Hoefs, pers comm.	Beta-91756	Male *B. bison* frontal
35	Finlayson River, Y.T.	2200±60	Harington, this study	Beta-79854	Young male *B. bison* cranium
36	Baillie Islands, N.T.	1890±90	Harington 1980	I-5407	Bison horn sheath
37	Black River, Yukon Flats, AK	1730±60	ADF&G, this study	Beta-62999	Male *B. bison* skeleton
38	Dawson (Loc. 16), Y.T.	1565±85	Harington, this study	I-11051	Bison tibia, apparently fractured by humans
39	Quartz Creek, Dawson, Y.T.	1430±95	Harington 1977	I-5405	*B. bison* horn core
40	Tetlin-Tanacross area, AK	1270±55	Guthrie, this study	AA3218, AMNH A-393-1013	Male *B. bison* skull
41	Frenchman Lake Site (KaTx-6), Y.T.	<1250	J. Hunston, pers. comm.		Bison bone above White River Ash
42	Cowley Lake, Y.T.	940±90	Harington, this study	Beta-69762	Female *B. bison* skull
43	Old Horton River mouth, N.T.	420±65	Harington 1990 Morrison 1997	Beta-28765	Small adult male *B. bisons* skull showing cut marks
44	Anchorage, AK	170±30	Gerlach, this study	Beta 136732	Male *B. bison* skull with horn sheath

Table 1. Location and radiocarbon dates for bison specimens representing the end of the Pleistocene-Holocene transition or the Holocene in Alaska and adjacent Canada. Map numbers for specimen dates within the last 10,000 years correspond to those in Figure 3. Most radiocarbon ages are corrected for isotopic fractionation.

Several dated and undated specimens of northern small horned bison have been taxonomically referred to *B.b. athabascae* (cf. Skinner and Kaisen 1947; Harington 1977; van Zyll de Jong 1986). Measurements from these and other Holocene specimens for which cranial and postcranial material are sufficiently intact to allow morphometric analysis (specimens designated as *B. bison* in Table 1) indicate they are appropriately regarded as *B.b. athabascae*. This conclusion is based on comparisons with morphological data published by van Zyll de Jong (1986). The temporal and geographic distribution of these remains (Table 1, Figure 3) is consistent with earlier conclusions regarding the widespread occurrence of relatively small-horned bison, representing *B.b. athabascae*, in Alaska and northern Canada during the mid and late Holocene.

Radiometric data for a large number of Pleistocene and some Holocene bison have been previously published by Guthrie (1990), Harington (1977, 1978, 1980a, 1980b, 1989, and 1990) and others. The geographic location of dated Holocene specimens, and four undated specimens of small-horned bison, is shown in Figure 3. The distribution of wood bison during the mid and late Holocene as indicated by currently available radiometric data is also shown, as is the region in Alaska and northwestern Canada where oral and/or written accounts describe the presence of bison during this period (van Zyll de Jong 1986; Gates et al. 1992; Lotenberg 1996; this study).

The temporal distribution of available radiocarbon dates representing Pleistocene and Holocene bison in Alaska and adjacent Canada, based on data compiled in this study and by Guthrie (1990), C.R. Harington (radiocarbon table in Annotated Bibliography of Quaternary Vertebrates in Northern North America) and others, is shown in Figure 4. These data are the cumulative result of a variety of paleontological and archaeological studies over many years. While this sample reflects some degree of randomness, the compilation also reflects an early emphasis on dating relatively large horned Pleistocene bison, as well as a more recent emphasis on dating small horned Holocene specimens and bison remains found in archaeological contexts. Additional late Pleistocene dates were recently obtained from bison remains found on Alaska's North Slope (Matheus et al. 1999), but are not represented in Figure 4.

Radiometric and zooarchaeological data demonstrate that bison occurred in this region during the late Pleistocene and Holocene, and that the late Holocene distribution of wood bison included much of eastern Alaska, southern Yukon, the western NT, and possibly western Alaska as well (Skinner and Kaisen 1947). Well preserved bones indicate their presence along the arctic coast of the Yukon and NT, and on Victoria Island (Figure 3); oral accounts, as well as the archaeological evidence reviewed below (Morrison 1997), indicate the distribution of wood bison overlapped to some extent with that of muskoxen and caribou in parts of this region. Radiometric evidence discussed below also indicates that bison occurred near the arctic coast of Canada and in the northern Brooks Range in Alaska during the late Holocene.

Radiocarbon data indicate that bison occurred in Alaska at least as recently as 170±30 BP, based on a skull found at Anchorage (Map No. 44).[viii] Although there are currently no historic accounts regarding the presence of bison south of the Alaska Range, this specimen indicates they were present in

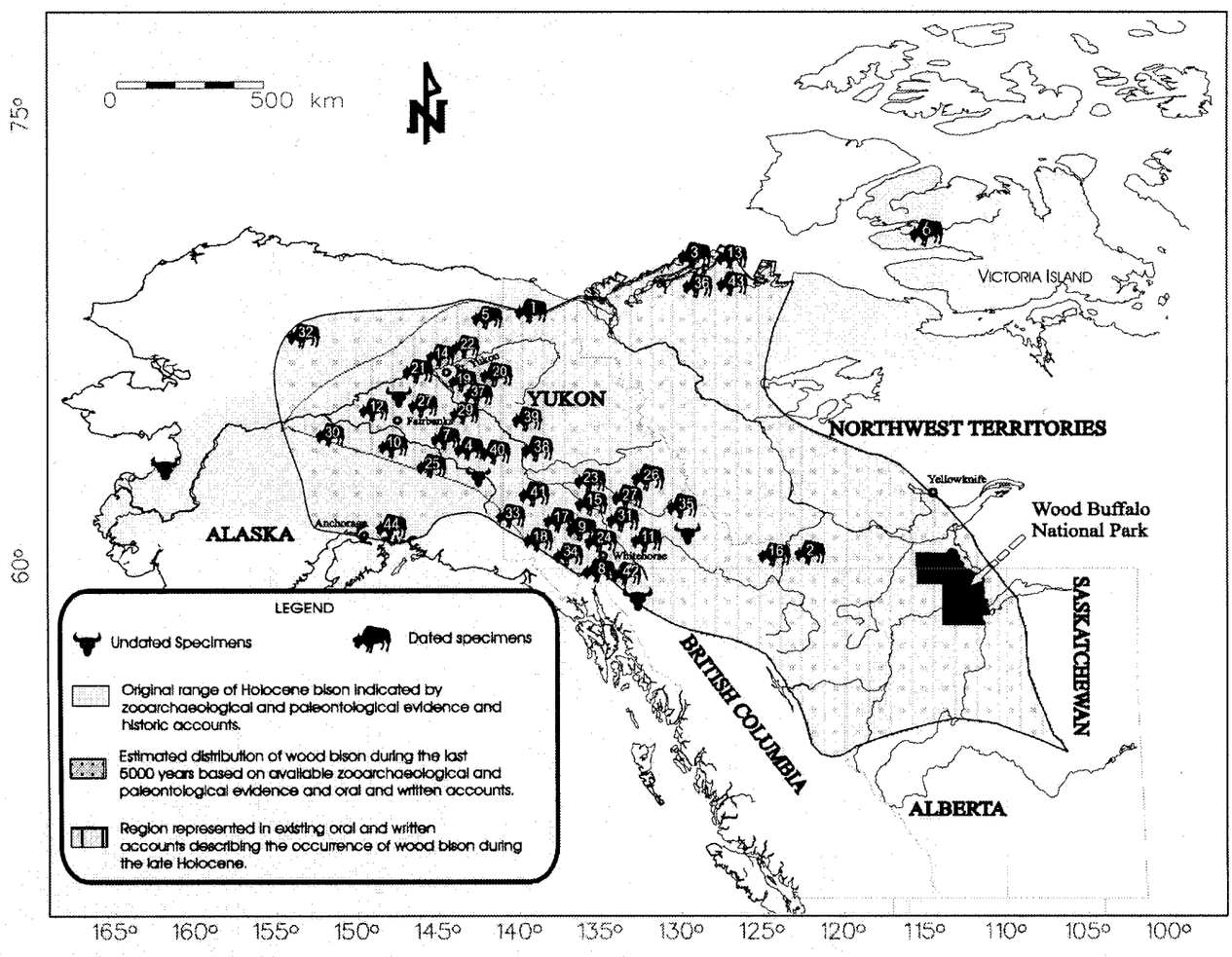

Figure 3. Approximate location of Holocene bison remains in Alaska and adjacent Canada, and estimated original and late Holocene range of wood bison in North American based on available zooarchaeological, paleontological, oral and written historical documentation (Skinner and Kaisen 1947; McClellan 1975, 1981; van Zyll de Jong 1986; Gates et al. 1992; Lotenberg 1996; this study). Location numbers correspond to map numbers in Table 1.

this area during the late Holocene. The lower Matanuska and Susitna river drainages near Anchorage contain extensive meadows that may have supported bison populations in the past. Radiocarbon dates for specimens collected in the upper Yukon and Tanana river lowlands, as well as oral accounts, indicate that bison also inhabited those areas during the late Holocene, further suggesting that low-elevation meadows were a component of wood bison habitat in Alaska.

Bison remains are distributed geographically from west to east across Alaska and into Canada (Figure 3), and temporally throughout the Holocene (Figure 4). The area represented by oral narratives encompasses the area where late Holocene bison remains appear to be most common. The available chronometric data and historic accounts suggest that wood bison were more common in eastern Alaska and the southern Yukon during the late Holocene than in areas to the north and west. However, the two specimens yielding the most recent radiometric dates occur some distance outside (Anchorage), or near the edge (arctic coast, Northwest Territories) of the area referred to in the oral accounts, indicating that wood bison persisted into the last millennia over a broader area than is indicated by currently available historical accounts. The area south of the Alaska Range in Alaska is the only extensive region where physical evidence for late Holocene bison is not presently corroborated by oral and/or written historical documentation (Figure 3).

ARCHAEOLOGY

Alaska

Archaeological investigations in interior Alaska are limited, consisting largely of site surveys (e.g., Dixon et al. 1985; Libby and Medlock 1979; Roseneau et al. 1975) with limited systematic excavation. Alaskan archaeological sites at which bison remains have been positively identified include the Dry Creek site near Healy (Powers et al. 1983), the Broken Mammoth (Holmes 1996), XMH-297 (Holmes 1979; Holmes and Bacon 1982) and Gerstle River (Holmes 1998) sites near Delta Junction, and the KIR-275 site in the north-central Brooks Range.

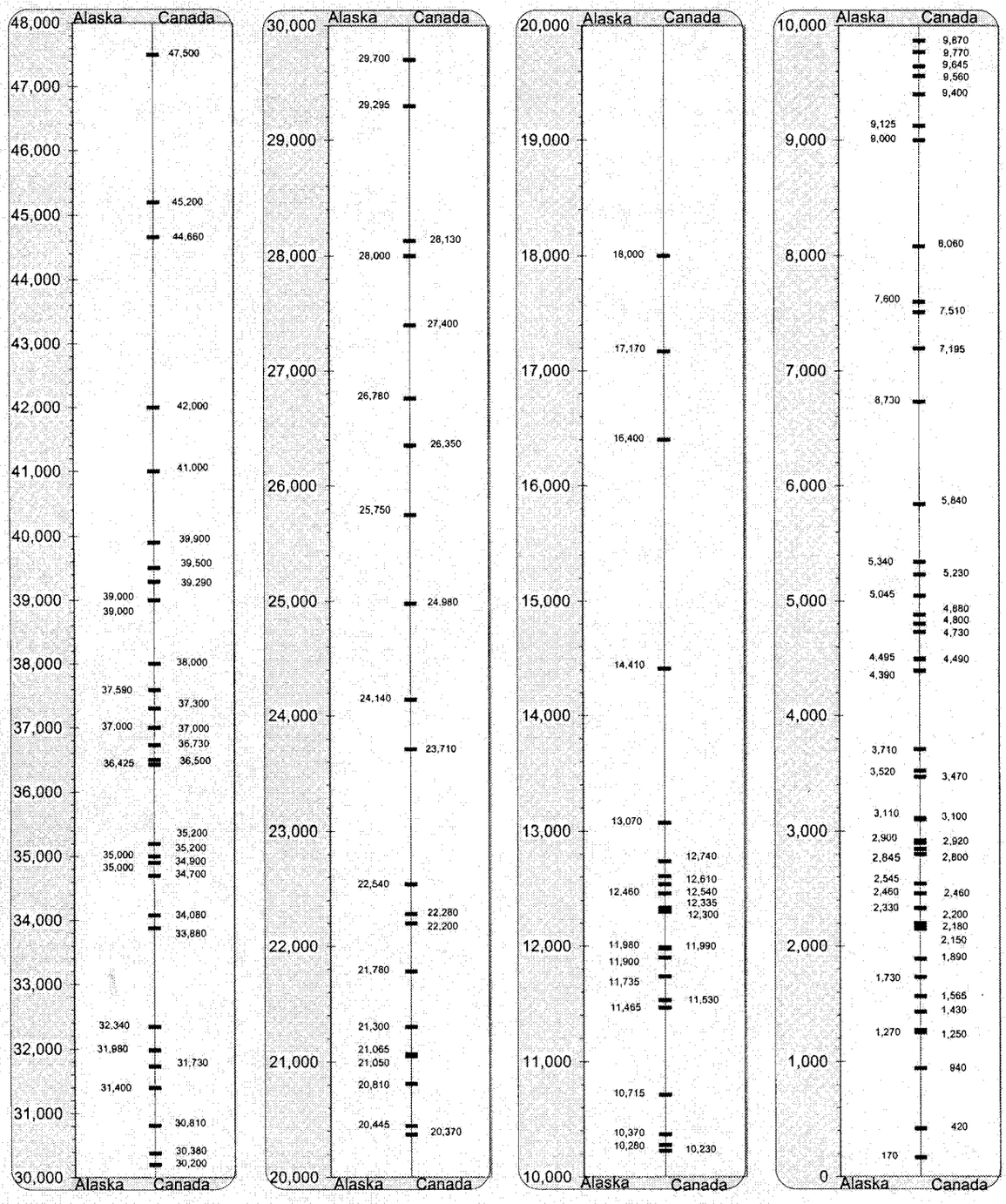

Figure 4. Temporal distribution of uncalibrated radiocarbon dates (years before present) for late Pleistocene and Holocene bison in Alaska and adjacent Canada. The median date was used in two cases where bracketing dates were available for Holocene bison. Dates later than 12,000 B.P. are detailed in Table 1. Pleistocene dates are based on published and unpublished data from Larsen (1968); McDonald (1981); Guthrie (1990); Bureau of Land Management, Fairbanks, open files; S. Dickson (pers. comm.); and the Annotated Bibliography of Quaternary Vertebrates of Northern North America, C.R. Harington, manuscript.

The Broken Mammoth site yielded a variety of bison bones in four "cultural zones." Five radiocarbon dates for bison remains range from 7600±140 to 11,420±70 BP, and a sixth bison bone was recently dated stratigraphically at 2260±40 BP (D. Yesner, pers. comm.). Part of a bison tibia found at the XMH-297 site was stratigraphically dated to between 2285±145 BP and approximately 3980±150 BP, shortly after the fall of the Jarvis Ash (Holmes and Bacon 1982). Bison remains at the Gerstle River site include a phalanx, metatarsal, naviculo-cuboid, calcaneum, and fragments of a

scapula and sacrum in strata bracketed by charcoal dates of 8280±60 to 9970±60 BP (Holmes 1998). A bison metatarsal found near the KIR-275 archaeological site in the Killik River drainage has been dated at 2330±50 BP (C. Martin and T. Birkedal, pers comm.). The late Holocene date was subsequently corroborated by dates of 2470±50 and 2500±50 BP (P. Matheus, pers comm.). Isolated bison remains have also been found in late Holocene flood-plain deposits in interior Alaskan streams, but most are not dated or are from ambiguous stratigraphic contexts (Péwé 1975a, 1975b).

Yukon and Northwest Territories

Archaeological surveys and excavations conducted in northwest Canada, primarily in Yukon, provide additional insight into the occurrence of bison during the Holocene. Radiocarbon dates for bison remains spanning much of the past 10,000 years have been obtained from a number of archaeological sites, including those in Table 1 (Map Nos. 1, 9, 11, 13, 16, 17, 18, 24, 25, 41 and 43). The Engigstciak site in northern Yukon represents the earliest known association of bison remains with cultural artifacts in this region (Cinq-Mars et al. 1991). The majority of dates in the sample of Holocene sites occur between about 3,000 and 6,000 years BP. The only archaeological site with bison remains dated to within the past 1,200 years is the Bison Skull site (OaRw-2). In 1987 a bison skull with attached horn cores was discovered at this site, located along the banks of the Old Horton River Channel (Le Blanc 1988), near the extreme northwestern arctic coast of the Northwest Territories (Map No. 43, Table 1). The specimen yields a radiocarbon date of 420±65 BP (Harington 1990). The skull was found in close association with the skulls of two muskoxen at a site that had a long history of human use, primarily for caribou hunting and butchering (Le Blanc 1991; Morrison 1997). Cut marks on the upper surface of the bison skull suggest it was used as a cutting platform.

Late Holocene sites in the Old Crow area include two extensive spring caribou hunting sites: Klo-kut MjVl-1 (Morlan 1973) and Rat Indian Creek MjVg-1 (Le Blanc 1984). Both sites contained large, well-preserved faunal assemblages with abundant caribou remains and a diverse array of other species, including moose. No bison bones were reported at these sites. Other large-scale excavations include the Old Chief site MjVk-7 (Cinq-Mars 1974; Donahue 1974), NbVk-1 (Morlan 1972a), Cadzow Lake (Morlan 1972b) and the Whirl Lake site MjTp-1 located near the MacKenzie River Delta (Gordon and Savage 1973, 1974). These sites range from mid-to-late Holocene in age and several contain extensive faunal assemblages. The late Holocene component at the Whirl Lake site (dating to uncalibrated AD 1740±90 and AD 1730±90) contained remains of caribou and moose, 15 elements from an unidentified artiodactyl and 17 unidentified large-sized mammal bones (Gordon and Savage 1974). Gordon and Savage (1973) discuss the possibility that bison are represented at this site, although the reasons for this suggestion are not explicit.

Cultural practices and/or poor preservation may obscure the significance of bison as a food resource during the last millennium, at least in southern Yukon. Bone preservation appears to be less problematic at certain sites in northern Yukon where permafrost and rapid soil deposition improve preservation. Faunal remains of large mammals such as moose and bison are well represented at various mid-Holocene sites in southern Yukon (cf. MacNeish 1964; Workman 1978), but there appears to be a paucity of identifiable large mammal bones at late Holocene sites.

Greer (*in prep*) examined faunal assemblages from late Holocene components at 38 archaeological sites in southern Yukon, representing the past 1200 years. These include more than 125,000 bone fragments, most of which could not be specifically identified. The large mammal component is determined for only 16 bones or bone fragments. Caribou occurred with the highest frequency, followed by Dall sheep (*Ovis dalli*). Moose were identified at only one site (JcUj-12), and no bison remains were identified. Greer (ibid.) indicates that several unidentified bone samples were large enough to represent moose, although the possibility exists that some may represent bison.

The intensive processing of large mammal bones during the late Holocene may also be related to changes in cooking and preparation techniques. Late Holocene archaeological sites in southern and central Yukon are characterized by an increase in the occurrence of fire-cracked rock, which Charlie and Clark (1993) indicate may be related to the increased use of stone boiling techniques (Clark and Gotthardt 1997). Intensive processing of large mammal bones to produce bone grease is well documented in the ethnographic record (cf. Leechman 1954; Binford 1978, 1981). Greer (*in prep*) suggests large mammal bones were smashed into small fragments to facilitate the extraction of bone grease, often making it difficult or impossible to determine the species represented at late Holocene sites. Other cultural practices can further complicate the interpretation of faunal remains at archaeological sites, including the practice of disposing of the bones of some species in rivers, lakes or in fires, placing remains in trees and using bones to manufacture tools (McClellan 1975; O'Brien 1997).

Paleontological, archaeological (Table 1) and ethnographic evidence (Lotenberg 1996) shows that bison occurred in Yukon and were harvested by First Nation hunters during the late Holocene, although bison are not highly visible in the archaeological record. The same appears to be true for moose, which, on the basis of Greer's sample, are nearly invisible in the late Holocene archaeological record. The relatively large size of bison and moose probably increases the probability that carcasses were processed extensively at kill sites, further reducing the likelihood that largely intact bones would accumulate at archaeological sites (Binford 1978, 1981, 1983). The fact that high-ranked resources (Smith 1983; Simms 1984; Smith and Winterholder 1992; Broughton 1997; Janetski 1997) such as moose and bison are most susceptible to overexploitation could also account for the low frequency of their remains in archaeological sites (Broughton 1997; Kay 1994a, 1994b, 1997).

ETHNOHISTORY AND ETHNOGRAPHY

There are numerous ethnohistorical studies describing *Gwich'in* Athabascan lifestyles during the early contact period (Franklin 1970, 1971; Dall 1898; Hardisty 1872; Jones 1872; Kirkby 1865; Mackenzie 1801; Murray 1910; Petitot 1970; Richardson 1851, Vol 2; Whymper 1868), but these accounts include no mention of bison. The same is true of ethnohistorical research into the *Gwich'in* fur trade era during the mid- to late-nineteenth century (Krech 1976, 1978, 1979, 1981, 1987), focused loosely as it is on historical context, economics and the response of Native societies to Euroamerican influence. Although written records place bison in southern Yukon and the western NT during and after the mid 1700s (Gates et al. 1992; Lotenberg 1996), we have yet to find written documents placing bison in Alaska at the same time. Similarly, traditional knowledge regarding the late Holocene occurrence of bison in the upper Porcupine-Peel River area is not reflected in the journals of Archdeacon Robert McDonald (Archives of the Ecclesiastical Province of Rupert's Land, Winnipeg), who traveled in the region from 1862 until the early 1900s, or in other written accounts from the region (R. Le Blanc, pers. comm.).

Formal ethnographic studies in northeastern Alaska began in the early 1930s when Osgood (1936) studied the Peel River and Crow Flats *Gwich'in*, and McKennan (1965) began systematic studies with the Chandalar *Gwich'in*. Subsequent research includes studies by Balikci (1963a, 1963b), West (1963), Leechman (1954) and Slobodin (1962, 1981). Except for one intriguing clue, these studies contain no specific references to bison procurement or use.

McKennan (1965:18) notes: "Muskoxen, now extinct in the area, were said to have frequented the Chandalar territory in former days, and a small mountain near the forks of Smoke Creek [Figure 1] is known to the natives as [*ch'itthay ik*; James Kari pers. comm.) which they translate as Muskox Shirt Mountain." However, McKennan's original field notes, and information supplied by *Gwich'in* elder Moses Cruikshank and by Thomas E. Taylor, suggest McKennan may have been provided with a name reflecting the occurrence of "buffalo," but later concluded his informants were referring to muskoxen.

McKennan's original field notes,[ix] reflecting information obtained in 1933, primarily from Chief Christian, read as follows:

Musk Ox [*ch'itthay*]
[*ch'itthay ik*] = Buffalo (sic) shirt.
Little Mt. on Smoke Creek.
Musk ox formerly driven
over cliff on top.

McKennan apparently assumed the informant's reference to "Buffalo" was incorrect (as indicated by his insertion of "sic"), whereupon he changed it to "Musk ox."[x] Moses Cruikshank indicates that a mountain known as "Buffalo Shirt Mountain" was located in the "Sheenjek River country," in the next large drainage east of the Chandalar River. This geographic discrepancy may simply reflect Mr. Cruikshank's reference to a general geographic region in the foothills of the Brooks Range. United States Geological Survey (USGS) topographic maps identify a mountain between the lower reaches of Smoke Creek and the Wind River as "Buffalo Mountain" (Figure 1), based on information provided to USGS engineer T. E. Taylor by local residents (Orth 1971).[xi] His records, as cited by Orth (1971), indicate the name "Buffalo Mountain" was provided to him by residents of Venetie when he visited that community in November 1956. Taylor reviewed local place names with Venetie elders, using aerial photographs and 1:250,000 quadrangles to identify topographic features and inquire as to their names. Mr. Taylor recorded phonetic spellings of *Gwich'in* place names in notes and on maps. Many *Gwich'in* also spoke English and provided English equivalents for place names, as shown on current USGS topographic maps.

Venetie elders informed Taylor that the English name for the mountain was "Buffalo Shirt," and that the name arose from stories indicating that "buffalo" were formerly hunted there. Oral tradition described how buffalo were driven over an escarpment at this site. Taylor's informants stated this animal no longer occurred in the region and that they themselves had not seen or hunted buffalo. They did not speculate regarding the reasons for their disappearance, but were resigned to the fact that the buffalo were gone. Taylor said his informants stated "emphatically" that these animals were "buffalo," and were aware of the difference between bison and muskoxen. He indicates further that he did not question these statements, in part because there seemed to be no doubt as to their meaning, and because he was aware of the existence of wood bison in Canada.

The fact that a few muskoxen apparently persisted in the eastern Brooks Range until the late 1800s makes it difficult to clarify the ambiguity reflected in McKennan's field notes. Lent (1998) reviews historical data regarding the presence of tundra muskoxen in Alaska, and notes there is no subfossil evidence of Holocene muskoxen in the eastern Brooks Range. Oral and written accounts cited by Lent show that small numbers were present in this area in the late 1800s, and that several muskoxen were killed in the upper reaches of the Sheenjek and Chandalar drainages on at least two occasions in the 1890s. However, knowledge of group sizes characteristic of muskoxen and wood bison (Tener 1965; Komers et al 1993), as well as the apparent scarcity of muskoxen in the area, suggest that a herd of the size implied in oral accounts about "Buffalo Shirt Mountain" would be more typical of bison.

DISCUSSION

Zooarchaeological, paleontological, oral and written historical data demonstrate that wood bison populations persisted in a large part of their original range in Alaska and Canada during the late Holocene, and were a component in the economies of Athabascan people in central and eastern Alaska during this period. Their corresponding significance in adjacent parts of Yukon and NT is also indicated. The zooarchaeological record and oral accounts from a wide

geographic area indicate that wood bison occurred on more than a sporadic basis in the late Holocene, and were sufficiently abundant to persist for a period of several thousand years. Oral narratives from Athabascan elders in Alaska and Yukon indicate bison were procured on more than an occasional or intermittent basis, with some historic accounts emphasizing the importance of bison as a resource. Although multiple oral accounts indicate that bison were indeed a source of food and materials, the precise nature of their seasonal, annual, and long term significance relative to other plant and animal resources is unspecified.

Extensive paleontological and limited archaeological data, in combination with oral accounts, indicate that wood bison were hunted by humans until their disappearance from Alaska during the last few hundred years. Wood bison had apparently become scarce shortly before early Euroamerican explorers, naturalists, and entrepreneurs entered Alaska from the east, and before firearms became widely available (Jennings 1968, Holmes and Bacon 1982, Guthrie 1990). In terms of historical context this decline coincided with the period during which bison were largely extirpated from the woodlands east of the Mississippi River (Dary 1989; Belue 1996), the period between the landing of the Mayflower in 1620 and the Lewis and Clark Expedition in 1804-1806, and with the Russian exploration of Alaska's western coast (Bancroft 1886). Wood bison disappeared from substantial portions of their original range in Alaska and Canada by the early 19th century.

Lotenberg (1996) reevaluated the history of wood bison in Yukon primarily on basis of traditional knowledge obtained through interviews with Native elders representing six First Nations in Yukon and northern British Columbia, as well as from previously published records. These accounts indicate wood bison were relatively abundant in a large portion of this region approximately 400 years ago, and continued to inhabit parts of southern Yukon during most of the last 400 years. Based on reports from Native elders, McClellan (1975) concluded that bison populations were declining in parts of Yukon during the eighteenth century, and that Inland Tlingit shot bison with arrows, although their importance in the subsistence economy was not addressed (McClellan 1981). Other traditional stories from southern Yukon also mention the former presence of bison (Sidney et al. 1977). The occurrence of bison in Yukon during the 1800s and early 1900s is corroborated by a limited number of documentary records (Clarke 1945; Jeckell 1933; Gates et al. 1992). The reported occurrence of bison near the Canadian border at Eagle, near Circle, and near Fort Yukon, Alaska, and two reports of bison being killed in interior Alaska during the early 1900s (this study), further suggest that wood bison persisted into the 1900s in Yukon, and that small numbers of bison also occurred, at least on a transient basis, in eastern Alaska adjacent to the Canadian border during this period.

Oral accounts detailed above indicate substantial bison populations were present in Alaska as recently as 200 years ago. Radiometric data corroborate their presence during the late Holocene, with one radiocarbon date indicating bison were still present in Alaska during the early 19th century, although in an area where there are no known historic accounts. The likelihood of finding and dating remains of the most recent wood bison is influenced by many factors, including the rate and duration of population decline prior to the disappearance of the species. Considering the improbability of finding or obtaining samples from the last wood bison in Alaska, the temporal gap between oral accounts and radiometric data in interior Alaska and southern Yukon is not unexpected.

The ability of humans to observe environmental phenomena, and to record and transmit historical knowledge, provides more comprehensive insight into the recent past than can be obtained from zooarchaeological data alone. This is especially true for phenomena that are difficult or impossible to reconstruct through paleontological or other proxies.

A substantial but not exhaustive search for written documents has been completed. The apparent absence of written documents referring to bison in Alaska may indicate that bison had become scarce by the early 1800s, before there was a significant Euroamerican presence in eastern Alaska. Although small numbers apparently persisted until the early 1900s, the handful of early travelers who produced journals or other written records may have remained unaware of, or failed to record, their presence. That early 20th century ethnographers failed to collect information about bison hunting in the north may reflect the limitations of a restrictive working paradigm that focused largely on the contemporary landscape, as well as a sometimes limited sample of informants (Osgood 1936; McKennan 1965; Burch and Mishler 1995). Knowledge of Alaska's faunal history was comparatively limited when the early ethnographic studies were undertaken, with little or no published information indicating that bison might have persisted into the late Holocene. Information about an animal that was no longer present may not have been elicited nor, in the absence of a direct question, offered. Alternatively, as often occurs with other early records, pertinent information may have been available but was simply not included in written accounts (Lyman 1998).

There are similarities in the oral narratives provided by Yukon (Lotenberg 1996) and Alaska Native elders, as well as some elements that are found only in one or the other oral tradition. The diverse content of these accounts is typical of the varying nature of detail encountered in oral narratives passed from one generation to another, representing events and observations occurring from one to several generations earlier. Similarities include: (1) descriptions of the presence of substantial bison populations at one time; (2) indications that bison were hunted extensively, were a major source of food, and provided raw material for clothing and other uses prior to their decline and disappearance during the last few hundred years; (3) indications that late Holocene bison populations were found primarily in low elevation habitats; (4) reports that bison skulls and other remains continue to be found in areas historically known as bison range; (5) observations that moose were absent or scarce at the time bison were abundant; (6) consistent narratives indicating that bison were hunted with bow and arrow; (7) indications that trees and shrubs expanded during and after the period when

bison declined and disappeared, and moose populations expanded; and (8) that several elders from different areas remembered traditional names for bison.

Information found only in Yukon accounts includes descriptions of the use of snares to take bison, and the use of bison horn to make spoons. One account describes the yellow fat that is peculiar to bison, and a few elders indicated that their parents or grandparents hunted bison (Lotenberg 1996). Information peculiar to the Alaskan accounts includes: 1) observations that meat was dried for winter use; 2) that there may have been two types of bison; 3) that hides were used for blankets and pillows and hair was used as thread; 4) that the animal had a long tail and a large hump and head; 5) a reference to the non-allergenic nature of bison hides; 6) indications that bison and moose contributed jointly to the Athabascan subsistence economy at one time; and 7) that dogs were used to hunt bison. There are also indications that drives were used to kill bison in the mountains north of the Yukon Flats in Alaska. However, other accounts mention that drives may have been used to take muskoxen in the upper Chandalar drainage and in the upper Porcupine River region in Canada. The degree to which drives were used to procure bison and/or muskoxen remains unclear.

Accounts from both Alaska and Yukon include a few observations of bison or their sign indicating that small numbers of bison occurred, at least on a transient basis, after the decline of larger and geographically more widespread populations. Both sets of accounts include a few possible reasons for the decline or disappearance of bison populations. Yukon elders mention the expansion of forests, deep or crusted snow, cold winters and volcanic ash. Narratives from Alaska suggest that hunting by humans acted in combination with other environmental factors to cause the disappearance of wood bison, and that the less forested nature of the terrain during the late Holocene made bison especially vulnerable to hunters.

The hunting technology and strategies described in Athabascan oral accounts are consistent with existing knowledge of big game hunting techniques used by early Athabascan hunters. However, the reported use of dogs as an aid in hunting bison warrants discussion. Dogs were widely used by the *Gwich'in* to hunt moose and caribou, assisting hunters on snowshoes, especially in late winter when snow was crusted, and to pursue wounded animals (Osgood 1936; McKennan 1965; Nelson 1973).

Behavioral studies of interactions between wolves (*Canis lupus*) and wood bison indicate that dogs may have been effective in holding bison in a given area, and diverting their attention while hunters approached. Carbyn et al. (1993:178-210) describe hunting strategies of wolves in Wood Buffalo National Park, Canada, noting that bison herds often remain stationary for extended periods in the presence of wolves, relying on joint defensive behavior rather than flight. Wolves may spend hours or days in proximity to bison herds before causing a stampede and attempting a kill, or isolating a vulnerable individual. Bison often travel considerable distances after being stampeded by wolves. These researchers also found that a careful and patient approach allowed human observers to follow and observe wood bison at close range, with little disturbance to the animals. The behavioral response of bison to domestic dogs may be much the same as their response to wolves.

Radiocarbon dates for relatively recent bison specimens from Alaska, Yukon and NT range from 170 to 11,900 years before present (Table 1). A few additional specimens from this region have been taxonomically referred to *B.b. athabascae*, but are not yet dated. In combination with archaeological and paleontological data, the oral narratives suggest that bison also occurred along the western arctic coast of Canada during the Holocene, where they likely coexisted with caribou and muskoxen (McGhee 1996:85-93). Archaeological evidence representing early (Cinq-Mars 1991) and late (Harington 1990; Morrison 1997) Holocene sites, as well as oral accounts, indicate humans in this region hunted bison. The distribution of wood bison remains and other historic information suggest that Holocene bison populations were most prevalent in interior Alaska and in northwestern Canada (Figure 3). If the late Holocene climate was similar to the present, the distribution of late Holocene bison remains may reflect relatively low snow accumulation, and less icing and wind-packed snow in this region than in areas to the west (National Oceanic and Atmospheric Administration 1986).

The distribution of late Pleistocene fauna was strongly affected by changes in the Cordilleran and Laurentide ice sheets, which covered much of western Canada and southern Alaska during this period (cf. Matthews 1982; Pielou 1991). Radiocarbon dates for late Pleistocene bison in western Canada (Figure 4) were obtained from localities in west central Yukon which, along with interior Alaska, remained largely ice-free during this period. The apparent hiatus in radiocarbon dates between about 20,000 and 13,000 BP for bison in northwestern Canada may reflect glacial advances and associated changes in environmental conditions which occurred between about 24,000 and 17,000 BP (Hollin and Schilling 1981; Dyke and Prest 1987). The subsequent glacial recession and concomitant expansion of bison populations eastward is reflected in the increased number and wider distribution of dated bison remains between about 13,000 BP and the late Holocene (Figures 3 and 4, Table 1). Bison also colonized south central Alaska after the last major glacial recession, although there is currently only one specimen recorded in this region. The available data suggest that bison colonized new habitat as glaciers retreated, reaching areas as far east as Victoria Island and southern NT during the early Holocene (Figure 3). In contrast, paleontological and zooarchaeological data indicate that bison inhabited the ice-free refugia in interior Alaska continuously during the 48,000-year period represented in Figure 4.

A number of authors have already suggested that bison persisted in Alaska into the late Holocene, and were an important resource for humans during this period (Skinner and Kaisen 1947; Jennings 1968; Harington 1977; Holmes and Bacon 1982; Peek et al. 1987; Guthrie, 1990:286). Holmes and Bacon (1982), and West (1982) suggest that increasingly limited habitat and deep snow, combined with

hunting by "Beringian hunters" likely caused the extirpation of bison. The reasons for the late Holocene disappearance of wood bison in Alaska, Yukon, and parts of Northwest Territories and British Columbia will likely never be understood in the detail that would accompany a similar event in contemporary times. However, published literature and historic accounts suggest a combination of factors that must be considered in explaining the decline and disappearance of wood bison, including predation by wolves and bears, hunting by humans, environmental factors that altered the amount and distribution of suitable habitat, and meteorological or climatic factors.

Predation

Studies of extant northern bison herds suggest it is unlikely that predation by wolves or bears, alone or in combination, would have led to the extirpation of healthy wood bison herds. Introduced or reintroduced herds at several locations in Alaska and northern Canada have achieved, and maintain, viable population levels without significant predator control. Mortality from predation is rare in most herds, even where wolves, black bears (*Ursus americanus*) and grizzly bears are common. Several northern bison herds are limited primarily by regulated hunting, with predation being only a secondary cause of mortality (Gates and Larter 1990; DuBois and Stephenson 1998; Whitman and Stephenson 1998; B. Hayes, pers. comm.). However, other bison populations recently infected with cattle diseases (bovine tuberculosis and brucellosis) may be more susceptible to the demographically limiting effects of predation (Joly et al. 1998).

Several studies have applied metapopulation modeling and knowledge of island biogeography, habitat fragmentation, and population ecology to the question of large mammal extinction (Armbruster and Lande 1993; Beck 1996; Ward 1997). These studies show that even modest levels of exploitation by predators, including humans, have substantial effects on the survival of isolated large mammal populations. Various studies show that isolated populations of birds and mammals are more vulnerable to extinction than larger, contiguous populations (MacArthur and Wilson 1967; Brown 1978; 1986: Grayson 1991). Lande (1988) emphasized the importance of stochastic demographic factors and habitat distribution in determining extinction threshholds for wildlife populations.

It has been suggested that hunting by humans affected the distribution and abundance of a number of large mammal species in North America during the late Pleistocene and Holocene (cf. Martin and Klein 1984; Martin and Wright 1989; McGhee 1996:85: Ward 1997; Whitney-Smith 1998; Martin and Szuter 1999). In this model the high return per unit effort in hunting large mammals resulted in their being preferred prey for early humans (Winterhalder 1981a, 1981b; Feit 1987; Smith 1983; Stephens and Krebs 1986), while the ability of humans to rely on alternative resources such as fish, small game and plants mitigated the adverse consequences of overexploitation of large ungulates (Kay 1997; 1998). The effectiveness of aboriginal hunting techniques allowed hunters to kill prime-age animals in addition to more vulnerable individuals, and to select for female ungulates under certain conditions (Kay 1994a, 1995, 1997, 1998; Stiner 1990).

There is some evidence that aboriginal hunting in Alaska resulted in declines or local extirpation of some species including Dall sheep, muskox, moose and brown bears during the late Holocene (Campbell 1978; Lent 1998; LeResche et al. 1974; Coady 1980; Birkedal 1993). Similarly, unregulated hunting by aboriginal people appears to have been an important factor in the decline or disappearance of muskoxen in parts of Canada (Stefansson 1921; Hone 1934; Harington 1961; Tener 1965; Gunn et al. 1984; Will 1984). Lent (1998) suggests that hunting could have led to the disappearance of muskoxen in Alaska even though they were not a staple resource for most indigenous people. Three Athabascan elders who contributed to our study suggest that hunting played a role in the disappearance of wood bison in Alaska, citing the relative ease with which bison were hunted and killed, periodically high human populations, and the need to hunt intensively during periods when food was scarce. Other historical accounts from northeastern Alaska and the Yukon Flats also suggest that human populations sometimes affected the abundance of big game in the region. The *Gwich'in* stories of Johnny and Sarah Frank of Venetie (Mishler, 1995: 11-13) describe how in the early days "...there were hardly any big game animals because there were too many people." These accounts refer to fluctuations in human populations in this region, and describe how "...when big game animals were scarce, lots of people froze to death." References to famines are common in the legendary history of the Chandalar and Tranjik *Gwich'in* (McKennan 1965; Nelson 1973).

The value of bison as a resource and their vulnerability to the hunting implements and techniques of early humans (West 1982) may have resulted in hunting being an additive mortality factor which, in combination with predation and other sources of mortality, affected the population dynamics of bison. The apparent scarcity of moose in much of Alaska during the late Holocene (Yesner 1989; LeResche et al. 1974; Coady 1980) may have accentuated the importance of bison as a big game resource, as would the seasonal or annual scarcity of caribou in many areas (Burch 1972). The behavioral characteristics of female and juvenile bison, which occur almost exclusively in herds (Komers et al. 1993), would increase their vulnerability (Lande 1988) and the likelihood that more than one animal would be taken in an encounter with human hunters (Fisher and Roll 1997). The possibility that changes in hunting technology improved the effectiveness of hunters should also be considered. The development of archery or other improvements in technology during the late Holocene (Blitz 1988) may have altered the relationship between hunter effort and return.

Habitat Availability

Guthrie (1982:314) indicates that in contrast to some other species represented in Pleistocene megafauna such as horses (*Equus sp.*) or proboscideans, bison are able to cope with relatively deep snow. Some earlier studies suggest that windswept areas adjacent to mountainous terrain were the

most important habitat for Holocene bison in Alaska, based on the premise that bison are not well adapted to substantial snow accumulation (cf. Ager 1974; Holmes and Bacon 1982). However, the distribution of wood bison remains (Figure 3) and geographic referents in oral accounts indicate the presence of late Holocene bison in low elevation habitat. Current evidence suggests that such areas were an important habitat for wood bison in Alaska and Yukon. Despite indications that meadow habitat declined during the late Holocene, recent studies show that the Yukon Flats and other parts of interior Alaska continue to offer suitable habitat for bison herds at or above the level currently estimated to represent a minimum viable population (Newmark 1987; Berger et al. 1995; Dubois and Stephenson 1998; Whitman and Stephenson 1998; ADF&G unpublished data; Wood Bison Recovery Team 1998). The quantity and quality of potential bison habitat in Alaska is substantially greater than in Yukon (Reynolds et al. 1982b; M. Hoefs, pers. comm.), and rivals or exceeds that found in wood bison range in other parts of Canada (Berger et al. 1995; Gates 1992, H. Reynolds, pers. comm.).

Extant wood bison populations occur primarily in low elevation habitat where sub-hygric meadow systems are intermixed with boreal forest (Larter and Gates 1991), further suggesting that Holocene bison were not restricted to windswept habitats. Bison are adapted to temperatures of -48 F or lower (Fuller 1962; Peters and Slen 1964; Christopherson et al. 1978), and prosper in areas where snow depths average 24-30 inches or more (Larter and Gates 1991; Carbyn et al. 1993). Meagher (1973, 1976) concluded that bison can tolerate deeper snow than other northern ungulates, based on the fact that plains bison have prospered in Yellowstone National Park despite a harsh winter climate, foraging in snow depths exceeding 50 inches. However, snow depth and hardness influence bison foraging behavior, as demonstrated by Meagher (1976), who found that snow depth had a major influence on habitat selection in Yellowstone Park. Wind-packed or ice crusted snow also presents difficulties for bison, and snow density was the principle factor influencing the selection of feeding sites by wood bison in the Slave River lowlands (Reynolds and Peden 1987).

There are a number of references to historic changes in vegetation in interior Alaska and other northern regions, with a trend toward expansion of shrubs and forests during the last few centuries (Vanstone 1974; McKennan 1965); a variety of biotic and abiotic factors appear to be involved (cf. Jacoby, and D'Arrigo. 1989; Campbell et al. 1994; Zimov et al. 1995; Chowns et al. 1998; Overpeck et al. 1997). Several elders from communities on the Yukon Flats also referred to oral traditions indicating the area was formerly more open, with fewer trees and shrubs and more extensive meadow systems (O'Brien 1997:37).

At present the Yukon Flats is characterized by a diverse mosaic of mixed spruce-poplar and spruce hardwood forests, spruce muskeg, and successional and climax stands of willow and alder. Both wet and dry meadows are common, comprising approximately 12 percent of the total area. Despite the apparent reduction in the amount of available meadow habitat, the Yukon Flats and parts of the Tanana Valley continue to offer suitable habitat for viable bison populations (Berger et al. 1995; ADF&G unpublished data).

Bison are eclectic, with an ability to exist in a variety of climatic and habitat regimes ranging from subarctic boreal and eastern deciduous forest, to relatively arid conditions in the southwestern United States (van Zyll de Jong 1986, Dary 1989). In recent decades wood bison have been reintroduced in the southern Yukon, and plains bison have been introduced in the Delta, Farewell, Copper River and Chitina River areas in Alaska. Except for the Copper and Chitina River herds, which settled in poor quality habitat (Miquelle 1985), these herds increased at high rates and continue to show high productivity (DuBois and Stephenson 1998; Whitman and Stephenson 1998).

It is clear that suitable bison habitat is still available in parts of the range once inhabited by wood bison, a fact that opposes the idea that changes in habitat caused their decline and disappearance. Further, the nature of recent environmental changes that are reported to have occurred in interior Alaska indicate that wood bison declined and disappeared at a time when the extent of meadow habitat was greater than at present. Lent (1998) observed that the successful reintroduction of muskoxen to northern Alaska demonstrates that suitable habitat for this once extirpated species continues to exist. However, changes in the distribution of suitable habitat, in combination with hunting and other mortality factors, probably contributed indirectly to the disappearance of wood bison in Alaska.

Rather than being more widely distributed over the landscape, as was the case during the Pleistocene, Holocene bison habitat became more limited through time (Guthrie 1990), although it was not eliminated as has sometimes been suggested (Guthrie 1982). The transition from relatively treeless steppe to increasingly forested terrain during the late Pleistocene and Holocene would have gradually created a mosaic in which bison habitat was largely confined to low-lying areas with upland or riparian meadow habitat. This would have included the Yukon and Tanana lowlands in Alaska, and/or windswept habitats adjacent to large mountain valleys (Holmes and Bacon 1982; Guthrie 1990). This is the general pattern of distribution suggested by the occurrence of skeletal remains of Holocene bison (Table 1; Fig. 3). However, more widespread sedimentation and greater human activity at low elevations would probably increase bone preservation and enhance the likelihood of discovery, making it difficult to assess the degree to which uplands might have been used by late Holocene bison.

Habitat for late Holocene bison populations most likely occurred in discrete patches that, while capable of supporting viable populations, were nonetheless separated geographically. Once a subpopulation was extirpated, geographical constraints and stochastic events affecting founding populations would limit the likelihood of recolonization. This is consistent with the behavior of existing northern bison populations, with distribution being substantially limited by geographic barriers such as mountains or extensive stands of unbroken forest (Gates and

Larter 1990; Larter and Gates 1991). The seasonal and annual movements of extant northern bison populations are largely constrained by the distribution of habitat (Larter and Gates 1990). The distribution of late Holocene bison was probably limited in comparison to moose, caribou and sheep, which persist through the present.

Lent (1998) concludes that small numbers of muskoxen persisted in the eastern Brooks Range, after their extirpation in northwestern Alaska in the mid 1800s, in part because of the relatively low human population density in the mountainous terrain in the area. Historic accounts, including those presented here, indicate that resource availability and other attributes caused areas adjacent to large rivers to be a year-round focus of human habitation during the late Holocene (cf. Schneider 1986; Luke 1998). This pattern of late Holocene human land use would have placed wood bison populations in juxtaposition with human populations, making them accessible to human hunters on a year-round basis, and limiting the occurrence of refugia (Taylor 1984) where bison were not subject to human exploitation. This situation contrasts with that on the Great Plains, where migration reduced the vulnerability of plains bison to predation (Kay 1994a; 1996).

Influence of Climate

Limitations in the current understanding of the late Holocene climatic regime make it difficult to draw precise inferences regarding the influence of climate on the geographic distribution of wood bison in the northwestern part of their original range. Nevertheless, it is difficult to account for the disappearance of wood bison from Alaska and northwestern Canada on the basis of environmental or climatic changes alone, unless there were catastrophic weather events on a regional scale, or broad, uniform and sustained changes that led to the elimination of suitable habitat. There is currently no evidence for either of these phenomena.

The boreal forest is the product of frequent and often pronounced climatic fluctuations since its establishment following the most recent glacial period (Juday et al. 1998). During the last glacial period the arid climate in lowland central Alaska, central Yukon and eastern Russia precluded the formation of ice sheets, and cool and arid conditions prevented the expansion of forests. Following the end of full glacial conditions and a warming trend beginning about 14,000 years ago, forests expanded northward (Pielou 1991). In addition to climatic and vegetational changes that have occurred on a scale of millennia, decadal and century long climatic changes altered plant species abundance and distribution (Bartlein 1988).

Based on studies of Greenland ice cores, tree-rings and other paleoecological proxies, Holocene climate was characterized by significant diversity, with environmental change occurring on an increasingly regional basis. Continuous paleoclimatic records from the GISP2 ice core show variability on an annual to millennial scale, indicating that Holocene climate was significantly more complex than glacial ice age climate (Greenland Ice Core Project 1993; O'Brien et al. 1995; Overpeck et al. 1997; Ice Core Working Group 1998). The Holocene climate was also comparatively stable over variable periods of time (Guthrie 1990). Some oral accounts (see above) mention periods of deeper snow or extreme cold in the past (see also Fleener 1998), although these are difficult to reconcile with Little Ice Age (LIA) models at this point.

There is general agreement that glaciers and arctic sea ice expanded globally at various times during the Little Ice Age (LIA), which is generally viewed as occurring from the 13th through the 19th centuries (Grove 1988). Overpeck et al. (1997) review evidence for climatic and environmental change in the Arctic during the last four centuries, based on a variety of paleoenvironmental indicators. Their study reveals large-scale variability over the past 400 years, but suggests that declines in summer insolation and other factors led to successively cooler summers, culminating in the Little Ice Age. The onset of the LIA occurred about A.D. 1400 following several centuries of warming during the so-called Medieval Warm Period (MWP). Cold, dry conditions and increased atmospheric circulation generally characterized the LIA. Similar conditions appear to have prevailed at various times during the Holocene (Kreutz et al. 1997). Although patterns related to the LIA were global in nature, the period is not defined by uniform cooling on a regional scale. There is no unambiguous and uniform LIA signal recorded in tree-rings (Jacoby and D'Arrigo 1989; D'Arrigo and Jacoby 1992). Instead, the period includes both warm and cold anomalies that varied geographically and may have persisted into the 20th century.

Increases in the severity of winter storms and extent of sea ice during the LIA were accompanied by changes in agricultural production which contrasted with milder conditions during the Medieval Warm Period (Lamb 1995). The GISP2 paleo-atmospheric record indicates the LIA had the most abrupt onset of any of the rapid Holocene climate change events (O'Brien et al. 1995), and involved the most dramatic change in atmospheric circulation and surface conditions in the last 4000 years, with similar timing and magnitude in both polar hemispheres. Summer temperatures from A.D. 1597 to 1730 in both hemispheres were the lowest in the last 500 years (Kreutz et al. 1997). However, the LIA was one of the shortest cold intervals during the last 110,000 years, and was substantially shorter than other major climatic changes during the Holocene. No single factor appears to be responsible for bipolar changes during the LIA. Moreover, there is no indication of a general increase in volcanic activity during the last 600 years (Kreutz et al. 1997), although a steady warming trend from 1840 to the mid 1940s may have been precipitated, in part, by frequent, sulfur-producing volcanic eruptions (Overpeck et al. 1997).

Studies of past climates based on tree-rings reveal a pattern of temperature variation in interior and northern Alaska from the 1500s to the present. This record is in general agreement with overall trends at high latitudes in the Northern Hemisphere. Temperatures in interior Alaska were distinctly cooler during the LIA than during the 20th century, and reconstruction from tree-rings shows the effects were most pronounced in the early part of the record (from at least the 1500s to 1700). This was followed by a partial warming in

the early 1700s, an abrupt return to colder conditions from about 1800 to 1840, and a steady warming from 1840 to the mid 1940s (Jacoby and D'Arrigo 1989; D'Arrigo and Jacoby 1992; Overpeck et al. 1997). This pattern is apparent in tree-ring data obtained at several sites in northern Alaska and northwestern Canada (Overpeck et al. 1997).

Warmer winters may have been correlated with heavier snowfall, rendering bison more vulnerable to human hunters and other predators, or with windy or icing conditions that redistribute and harden snow and thus interfere with the foraging ability of bison. Russell (1898) reports that exceptionally deep or ice-crusted snow during a single winter (apparently the winter of 1870) decimated wood bison populations in the Slave River area. Similarly, Harington and Cinq-Mars (1995) suggest that sudden winter thaws may have affected the survival of saiga antelope (*Saiga tatarica*) and other megafauna during the late Pleistocene in northwestern North America.

Murray (1910) notes that moose were fairly common in the Fort Yukon area in 1847-48, while oral narratives (McKennan 1965; this study) indicate they were scarce in earlier times. Murray's observations pertain to a period immediately following the most extended period of increased weather severity in the LIA, and suggest moose had increased in numbers and distribution following the period of absence or extreme scarcity described in historical accounts. It is unlikely that bison populations would have been decimated at the same time that moose populations expanded, considering that bison are relatively well adapted to deep snow and cold (Peters and Slen 1964; Christopherson et al. 1978, 1979; Larter and Gates 1991; Carbyn et al. 1993; Meagher 1973, 1976). Similarly, Lent (1998) concludes there is no clear evidence that climatic change during the late Holocene caused the extinction of Alaskan muskoxen, noting that larger fluctuations in climate had occurred previously (Haworth 1989). Kay (1997: 145-146) concludes that the LIA or other climatic or weather events do not account for the general scarcity of moose prior to the very late Holocene in much of North America.

Bison persisted in Alaska and northwestern Canada for at least several hundred thousand years despite climatic fluctuations that were frequent, dramatic and abrupt in comparison to the relatively benign climatic regime during the Holocene (Guthrie 1990). This suggests that the temporally limited and modest climatic changes during the LIA are an unlikely cause for the demise of wood bison. The LIA did not result in the extirpation of other large ungulates in the region including moose, caribou or Dall sheep. These species can be strongly affected by severe winter weather and snow conditions (Fancy and White 1985, 1987; Heimer et al. 1994; Adams and Dale 1998), with snow depth being particularly important in affecting the population dynamics of moose (Kelsall 1969; Peterson and Allen 1974; Gasaway et al. 1992).

Wood Bison Biogeography during the Late Holocene

The results of our study support earlier indications that bison persisted during much of the Holocene in Alaska (Holmes and Bacon 1982; Guthrie 1990), and that substantial populations persisted in some areas longer than was previously thought. The available skeletal remains of wood bison, associated radiocarbon dates, and oral and written narratives establish that: 1) bison were widely distributed on the late Holocene landscape, and that wood bison populations persisted in northern and eastern Alaska and adjacent Canada until their extirpation during the last few hundred years; 2) bison were a resource of some importance for Athabascan and other Native peoples during the late Holocene; 3) bison populations were high enough to persist over a period of several thousand years and to support significant human use; and 4) low elevation meadow systems, windswept areas at higher elevation, and some areas that are presently arctic tundra supported late Holocene bison populations.

Based on written accounts by Europeans who traveled in northwestern Canada during the late 18th and early 19th centuries (Gates et al. 1992), as well as oral accounts and skeletal remains, van Zyll de Jong (1986) indicated that the so-called "historic" range for wood bison included northern Alberta, the southwestern NT, and parts of northern British Columbia and Saskatchewan (Figure 3). Skinner and Kaisen (1947) had earlier suggested that wood bison were found in the eastern Rocky Mountains as far south as New Mexico. However, subsequent craniometric analyses indicate the southern limit of wood bison distribution was some distance north of the US-Canada border, and that specimens from areas west of the Great Plains in the United States represent *B.b. bison* (van Zyll de Jong 1986).

The recent distribution of bison in southern Canada, where wood and plains bison populations might have overlapped, was particularly germane to van Zyll de Jong's study of the taxonomic status of recent bison. Based on data from three subfossils in Alaska and four from Yukon and northern British Columbia, van Zyll de Jong (1986) further suggested that the "prehistoric" range of wood bison extended "...north and west into the Yukon and Alaska." In consultation with van Zyll de Jong, Canada's National Recovery Team for Wood Bison subsequently revised the boundaries for the original range of wood bison to include additional parts of northern Alaska and Canada (C.C. Gates, pers comm. 1998), based on additional subfossil evidence (Harington 1990). This region included interior, arctic and western Alaska and part of northwestern arctic Canada, encompassing parts of the north that were also classified as original range by Skinner and Kaisen (1947).

Based on existing historical documentation, we describe three general categories relative to Holocene bison distribution in northern North America (Figure 3). The region that appears to have been inhabited by small horned *B. bison* (*sensu* Wilson 1978; 1996) at some time during the Holocene is shown. This region includes areas previously referred to as "prehistoric" and "historic" range for wood bison (van Zyll de Jong 1986), as well as an additional part of the arctic coastal region in Canada where recent paleontological data reveals their presence during the early Holocene. The known distribution of wood bison during the late Holocene (i.e. the last 5000 years) is also shown. This

region is based on information obtained from skeletal remains as well as oral and written historic documentation. It reflects knowledge of distribution in the southern portion of the late Holocene range of wood bison, based on previous analyses of paleontological, oral and written information (van Zyll de Jong 1986; Gates et al. 1992), as well as similar information now available regarding areas further north. Finally, Figure 3 shows the region where oral and written accounts describe the presence of wood bison within the last few hundred years. The occurrence of additional dated and undated specimens east and west of the area where there is currently abundant evidence for the recent occurrence of wood bison suggests that future studies may reveal a wider late Holocene distribution than is presently known. Small-horned bison similar to wood bison also occurred in northern Eurasia during the Holocene (Flerov 1979; van Zyll de Jong 1986, 1993; Lazarev et al. 1998).

Zooarcheological, oral and written historical documentation demonstrate that much of Alaska and adjacent Canada is part of the original range of wood bison (Figure 3), and that this area is part of the "historic" range for the subspecies. However, we caution that in the absence of objective and biologically meaningful criteria, the implied dichotomy between "history" and "prehistory" obscures the continuum of time, introducing an ethnocentric bias (Lyman 1996) and confusing the study of the past (Tudge 1997:17). For example, if written records were selected as the sole criteria for "historic" status, the potential depth of "history" would range from thousands of years in parts of the Old World to less than 200 years in interior Alaska. The oral history of indigenous people as well as zooarchaeological and paleontological data would be excluded from the "historic" record. Oral, written, zooarchaeological and paleontological documentation are complimentary and supplementary sources of historical information and should be used in combination (Lyman 1996; 1998).

The available information supports the conclusion that geographical isolation and hunting are factors that acted in combination and led to the extirpation of wood bison. The discontinuous nature of late Holocene habitat probably played an important, albeit indirect, role while hunting is the most likely proximate factor that reduced numbers and prevented the recovery of subpopulations or recolonization of suitable habitat. Bison have recently prospered in suitable habitat in Yukon and other parts of northwestern Canada, and in Alaska, and we now know that additional suitable habitat exists in Alaska. The recent expansion of wood bison populations demonstrates that earlier declines, and the extirpation of bison in various regions, were not caused solely by changes in habitat.

There appear to be similarities in the timing and causes for the extirpation of wood bison and muskoxen in Alaska. Lent (1998) concludes that muskoxen were rare, and nearly extinct, in northern Alaska prior to the arrival of Europeans and the availability of firearms. A similar pattern characterizes the extirpation of wood bison in the northwestern portion of their original range. Some of the last records of isolated groups or individuals of both wood bison and muskoxen in Alaska, and wood bison in Yukon, involve the taking of groups or individuals with firearms in the late 1800s or early 1900s. Hunting by humans appears to have been an important factor in the disappearance of both species (Lent 1998). Although populations of both animals had declined or, in some areas, disappeared before firearms were widely available, continued hunting of remnant populations with firearms is an additional factor that may have ultimately precluded repopulation of their original habitats.

A combination of factors has had various effects on the status of bison in North America and parts of the Old World. Over millennia the "Great Bison Belt" that extended across Eurasia into Beringia and southward across North America, diminished in size (Guthrie 1980, 1990: 51). However, the genus *Bison* was still widely distributed on North America's Great Plains, in eastern woodlands, and in northwestern Canada and Alaska during the late Holocene (Soper 1941; Dary 1989). It appears that bison herds numbering in the millions were unique to the Holocene Great Plains, with its huge expanse of contiguous grasslands (Guthrie 1980, 1982, 1990). Populations in other habitats did not fare as well as bison on the Great Plains. However, even on the plains and prairies, bison abundance and distribution were affected by human populations, particularly after the availability of horses altered patterns of mobility and changed procurement strategies, and horses became sufficiently abundant and widespread to compete with bison for forage (Flores 1996; Fisher and Roll 1997). A number of studies describe the significant role of predation by humans in the dynamics of late Holocene plains bison populations (Roe 1951; Guthrie 1980; Speth 1983; Flores, 1991, 1996; Belue 1996; Dobak 1996; Fisher and Roll 1997; Haynes 1997; Morgan 1997; Martin and Szuter 1999; Isenberg 2000).

The relationships between bison, human populations and other environmental factors have been diverse, with no single defining pattern. Nevertheless, it is clear that during the last millennia bison populations were dramatically reduced in Eurasia and much of North America in areas where the amount and distribution of suitable late Holocene habitat were more limited than on the Great Plains. The ecological history of bison suggests that bison and humans coexisted in Alaska and adjacent regions for a period exceeding 10,500 years, although the nature and extent of local and/or regional fluctuations in bison numbers are unknown. Wood bison were not extirpated in part of their original range in northern Canada, although they rapidly approached extinction following over-hunting during the 19th century. European bison also declined during the Holocene, with habitat reduction and overhunting being key factors causing their near extinction in the early 1900s, when a remnant population of less than 100 wisent (*B.b. bonasus*) persisted only in the forests of eastern Europe (Gstalter and Lazier 1996). Bison persisted in northern Eurasia into the middle or late Holocene but apparently disappeared earlier than in Alaska or parts of adjacent Canada (van Zyll de Jong 1993; Rusanov 1975; Flerov 1979; Archipov 1989; Lazarev et al. 1998). Plains bison persisted in a large region in North America despite being hunted extensively before the introduction of firearms. The status of contemporary wood bison, plains bison and wisent has improved as a result of conservation efforts including reintroductions into suitable

habitat, elimination of livestock diseases, and regulation of hunting (Dary 1989; Gates et al. 1992; Gstalter and Lazier 1996).

Notes

[1] The *Gwich'in* are familiar with muskoxen (McKennan 1965) based on their historic presence some distance north and northeast of the Yukon Flats. Lent (1998) notes an absence of physical evidence for the occurrence of Holocene muskoxen in northeast Alaska, and cites oral accounts indicating that muskoxen were scarce in the eastern Brooks Range during the late 1800s, and absent farther south. In contrast, the remains of bison are common in interior Alaska, including in those areas specifically referred to in oral accounts as formerly inhabited by bison. Lent cites a report by Reed (1946) that describes an account by Henry Rapelle of Fairbanks who, in 1895, observed the head and skin of a young bull muskox that had recently been killed by an Indian on the Kandik River. While this appears to be the only record of a muskox occurring in low elevation habitat south of the Brooks Range during the period in question, archaeological data demonstrate the presence and intermittent human use of Holocene muskoxen in northwest Alaska and adjacent Canada (Gerlach and Hall 1988; Lent 1998).

[2] Studies of contemporary bison show the density of primary hair at the skin surface is the highest among bovids, and is substantially greater than in artiodactyls such as moose, elk (*Cervus canadensis*) or deer (*Odocoileus sp.*), contributing to the scarcity of ticks on bison (Peters and Slen 1964; Mooring and Samuel 1998) and making them a relatively poor host for other ectoparasites (B. Samuel, pers. comm.). However, there have been no studies of the effect of mosquitoes on bison.

[3] These *Gwich'in* terms and phrases were transcribed by Kathy Sikorski, Alaska Native Language Center, University of Alaska Fairbanks, from an audio recording of Rev. Salmon provided by T. O'Brien.

[4] Chief Christian was a prominent leader in the Venetie area during the early 1900s and provided substantial information to early ethnographers (see McKennan 1965). He was William Salmon's cousin (T. O'Brien, pers. comm.).

[5] Anecdotal information from commercial bison ranchers also indicates that bison hides are non-allergenic for humans, possibly because the hair is not oily, and the high density of hair discourages insects (Mike Fogel, pers. comm.).

[6] Ms. Titus' said her grandfather, Charlie Johnson, recounted stories from his father, which held that the disappearance of bison from Alaska was related to a decision by Native elders. Shamans decided that when a certain group of Native people left Alaska for the south, they would take the "big animal" (bison) with them to live separately from the "small animals," including moose and caribou, which remained in Alaska. She later explained they had taken bison with them in a spiritual sense by taking a small amount of bison hide, hair, and meat with them in a basket. The decision that some people would move south was prompted by the fact that there were too many people, extremely cold winters, and the desire to find a warmer place. She was told that people would one day say the buffalo died out, but that actually they followed Athabascan people out of Alaska and would one day return.

[7] Recent studies show that North American bison sometimes harbor a limited number of ectoparasites, including lice and mites (Reynolds et al. 1982a). The ectoparasites found specifically on wood bison are not well known, although a species of chewing louse (*Damalinia* sp.) probably occurs. This species would probably not be apparent to, or affect, humans (W. Samuel, pers. comm.).

[8] As noted in our discussion, bison travel and forage in snow exceeding 50 inches in depth.

[9] A date of 470±90 BP was previously reported for this specimen, based on an assay conducted soon after the specimen was found in 1969 (McDonald 1981). The more recent date is based on current AMS techniques. The skull was also radiometrically dated to 170±70 BP (D. Hood, Beta Analytic, Inc., pers. commun.) The suggestion that this specimen might represent a domestic cow (Dixon 1993: 33) is incorrect. The largely intact skull with horn sheaths has been identified by Guthrie, and by McDonald (1981) as representing *Bison*.

[10] Alaska Polar Regions Dept., Elmer E. Rasmussen Library, Robert A. McKennan Collection, Series 2, Box 3, Folder 16.

[11] These linguistic issues were discussed with linguists Richard Mueller of Fairbanks and James Kari and Lillian Garnett, Alaska Native Language Center, University of Alaska Fairbanks *(pers.* comm.). Mueller translates *ch'itthay* to mean "it's flesh" or "it's meat," while *ik* refers to "shirt." Kari translates *ch'itthay* as a nondescript term referring to a game animal and the phrase *ch'itthay ik* as "game coat." Mueller suggests that perhaps the informant was referring to *ch'itthay dighan* which he translates as "humped game." As described above, Rev. Salmon applied a similar term to bison.

[12] We reviewed this information with T.E. Taylor in January 1999. He obtained many of the local place names in northern Alaska, as reflected on USGS topographic maps, through discussions with local residents in the Yukon, Tanana and Kuskokwim drainages during the 1950s. His notes are on file at USGS, National Mapping Division, Anchorage, AK.

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THE NORTH POINT WET SITE AND THE SUBSISTENCE IMPORTANCE OF PACIFIC COD ON THE NORTHERN NORTHWEST COAST

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INTRODUCTION

Although the role of salmon continues to attract considerable attention among archaeologists studying the prehistory of the southern coastal regions of Alaska and especially the Northwest Coast (see Cannon, this volume), the role of Pacific cod has received comparatively little notice. The seasonal importance of Pacific cod in the subsistence of prehistoric residents of southeast Alaska was proposed in the analysis of the Hidden Falls faunal assemblage (Moss 1989a), and cod are abundant in other Alaskan and Northwest Coast assemblages (Ackerman *et al.* 1985; Croes 1995; Souders 1997). Cod may have been heavily exploited at times when other resources, especially salmon, were limited in abundance due to seasonal shortfalls, difficulties with storage, or periods of climatically-induced deterioration of key salmon spawning and migration areas. Cod may also have been chosen simply because of a desire for fresh food as opposed to stored food, or because of personal preferences. The current southern limit of this species suggests that Pacific cod was not a significant subsistence factor south of the Columbia River, although this species is adapted to a fairly narrow sea temperature range. The distribution and use of cod by people has no doubt changed over the course of prehistory.

In this paper, we describe the North Point site (49-SUM-25), and provide an analysis of the faunal assemblage. The assemblage is unique in its depositional setting within the intertidal zone, and in its clear association with both late Holocene microblade and ground slate industries on the northern Northwest Coast. The North Point archeofauna is dominated by Pacific cod. This is not unique, however, and the significance of this species, especially as a pivotal resource during late winter-early spring and possibly as a key resource during periods of Neoglacial cooling, has yet to be adequately evaluated across the North Pacific region.

SITE BACKGROUND

In 1994-95, survey and excavations were carried out in the vicinity of Port Houghton and Cape Fanshaw, southeast Alaska (Figure 1). A more detailed review of the environmental setting and survey in the Port Houghton area is provided in Bowers *et al.* (1995a, 1995b, 1996), and in the Environmental Impact Statement for the proposed Port Houghton/Cape Fanshaw timber sale (Parametrix 1998)[1].

As a result of this research, Component I of the North Point site was discovered and test excavated. This intertidal/wet site (Figure 2) was discovered in 1994 as part of a survey of a proposed log transfer facility located about 400 meters to the south of a previously-known historic site (Sealaska 1975; Stanford and Lightfoot 1981). Component II of the North Point Site consists of a historic moss-covered cabin ruin in the uplands, historic artifacts in the intertidal zone and in upland test pits, a stone-lined cache pit, and culturally modified trees, all dating to the late 19th or early 20th centuries (Bowers *et al.* 1996). The historic component is not discussed further in this paper.

During two seasons of fieldwork, twenty-five 50 x 50 cm test pits were excavated: six in the vegetated uplands, and nineteen in the intertidal zone (Figure 2). Seven 1 x 1 m test pits were placed in the mid-to-lower intertidal zone, and one in the uplands. Dozens of soil probes were also placed in the intertidal zone and uplands. The total area of the site tested is 14.25 m^2, representing less than 1% of the estimated 50 x 80 m site area comprising Component I.

The North Point site is about 35 km northeast of the north end of Kupreanof Island, 25 km east of Admiralty Island, and about 64 km north of Petersburg, Alaska. The study area lies on the Alaskan mainland, at the juncture of Stephens Passage and Frederick Sound (Figure 1). 49-SUM-25 is located within a small cove on the south shore of Port Houghton at the tip of a broad peninsula forming the narrow entrance into the North Arm of Port Houghton (Figures 1 and 2). Offshore, a discontinuous line of partly submerged bedrock lies at a right angle to the narrow beach, offering a natural breakwater and partial protection to the small beach from winds and tides (Figures 1 and 2). Less than 50 m inland, the land rises steeply and becomes more densely vegetated. Other than a minor ephemeral drainage flowing out of the forest from the south, there is no stream or other freshwater source in the site vicinity today. The area surrounding the North Point site is comprised of saltwater shorelines, islands, forested mountains, river valleys, a salt chuck, and estuaries. Elevations range from sea level to summits reaching over 1,524 m in the eastern portion of the study area.

A variety of maritime and terrestrial natural resources exist in the area today. Five species of salmon are seasonally abundant, as are other anadromous fish and Pacific herring, halibut, flounder, sablefish, Pacific cod and other bottom fish. Sea mammals such as harbor seals and Steller sea lion exist in the area, as well as occasional humpback whales. Marine invertebrates are found in Sandborn Canal, and at Steamboat Bay near the entrance to Port Houghton. Seasonal use of the Port Houghton Salt Chuck, Sandborn Canal, and the North Arm of Farragut Bay by waterfowl for nesting and molting areas could have provided important waterfowl hunting and egg gathering opportunities for subsistence users