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Pleistocene vertebrates of the Yukon Territory

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ABSTRACT

Unglaciated parts of the Yukon constitute one of the most important areas in North America for yielding Pleistocene vertebrate fossils. Nearly 30 vertebrate faunal localities are reviewed spanning a period of about 1.6 Ma (million years ago) to the close of the Pleistocene some 10 000 BP (radiocarbon years before present, taken as 1950). The vertebrate fossils represent at least 8 species of fishes, 1 amphibian, 41 species of birds and 83 species of mammals. Dominant among the large mammals are: steppe bison (*Bison priscus*), horse (*Equus* sp.), woolly mammoth (*Mammuthus primigenius*), and caribou (*Rangifer tarandus*) – signature species of the Mammoth Steppe fauna (Fig. 1), which was widespread from the British Isles, through northern Europe, and Siberia to Alaska, Yukon and adjacent Northwest Territories. The Yukon faunas extend from Herschel Island in the north to Revenue Creek in the south and from the Alaskan border in the west to Ketza River in the east. The Yukon holds evidence of the earliest-known people in North America. Artifacts made from bison, mammoth and caribou bones from Bluefish Caves, Old Crow Basin and Dawson City areas show that people had a substantial knowledge of making and using bone tools at least by 25 000 BP, and possibly as early as 40 000 BP. A suggested chronological sequence of Yukon Pleistocene vertebrates (Table 1) facilitates comparison of selected faunas and indicates the known duration of various taxa.

1. Introduction

Before considering salient characteristics of Yukon Pleistocene vertebrate faunas and the purpose of this paper, I wish to pay tribute to my late friend and colleague Andrei Sher. I am particularly grateful for his early interest in the Old Crow fauna and for arranging my invitation to spend October 1973 discussing matters of common paleontological interest with him while examining collections of ice age mammal fossils at museums in Moscow, Leningrad (now Saint Petersburg) and Kiev, as a guest of N.N. Kramerenko, Director of the Paleontological Institute of the Soviet Academy of Sciences. I will never forget Andrei's surprise and delight when I first showed him some of the large Pleistocene horse bones from Old Crow Basin. We could not tell them apart from his Kolyma River specimens in size, shape or staining! Andrei also arranged for my second visit to the Soviet Union as a member of a Soviet – American field expedition to the Kolyma Lowland of northeastern Siberia (July–September, 1990). It was such a pleasure to work with Andrei in the field as well as being the fulfillment of a career-long dream.

Yukon Pleistocene vertebrate faunas (Fig. 2) include at least 133 species and range in age from about 1.6 Ma to 10 000 BP (Fig. 3, Table 1), by which time most of the large Pleistocene mammals had become extinct in the Yukon Territory. Further, mammoth, caribou and bison bone artifacts show that people had a substantial knowledge of making and using bone tools between about 40 000 and 25 000 BP (Morlan, 1980, 2003a, 2003b; Morlan et al., 1990; Harington and Morlan, 1992, 2002; Cinq-Mars and Morlan, 1999).

The purpose of this paper, developed from a shorter popular paper (Harington, 2008a), is to review from north to south the most important Yukon Pleistocene vertebrate faunas, focusing on species reported and their geological ages based on radiocarbon and tephrochronological evidence. Occasionally, individual specimens are mentioned where their degree of completeness is remarkable (e.g. partial skeletons or carcasses), as well as paleoenvironmental implications, and evidence for the presence of people. Table 1 provides a suggested chronological sequence of Yukon Pleistocene vertebrates, facilitating comparisons of selected faunas and indicating the known duration of various taxa.

2. Regional setting

Unglaciated parts of Alaska, Yukon and adjacent Northwest Territories (Eastern Beringia) formed an important refugium for

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Fig. 1. The Mammoth Steppe fauna (e.g. woolly mammoth, Yukon horse, tundra muskox and steppe bison) on the dry grasslands near present day Dawson City about 20 000 BP (George Teichmann).

vertebrates as well as other animals and plants during the Pleistocene (Hultén, 1937; Hopkins (ed.), 1967; Hopkins et al. (eds.), 1982; Guthrie, 1990; Harington, 2005). The interior of Yukon and Alaska is characterized by a strongly continental climate because it lies in the rainshadow of the Coast and St. Elias Mountains of western Canada and the Alaska Range and Wrangell Mountains of southern Alaska. Another factor contributing to this dryness was the presence of a broad Bering Isthmus in place of a Bering Strait during glacials, thus virtually removing a major upstream source of moisture. This aridity was probably established by the Pliocene (White et al., 1997; Froese et al., 2000) so that during Plio-Pleistocene glacials the Yukon interior was cold enough to support ice sheets, but too dry for extensive glaciation (Froese et al., 2009). This dryness allowed development of cool steppe-like grasslands – excellent range for the Mammoth Steppe fauna.

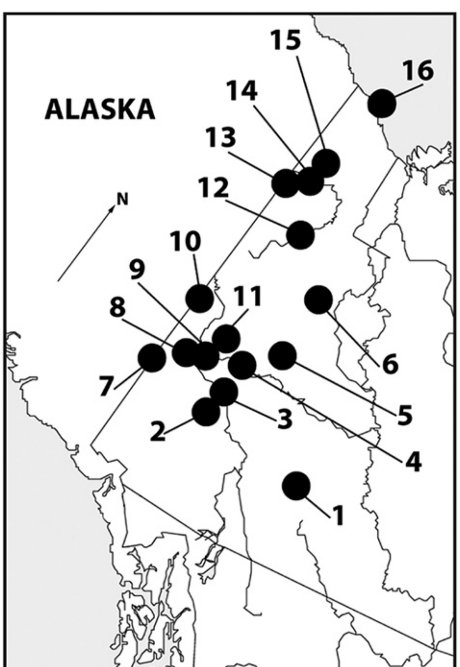

Fig. 2. Main Yukon ice age vertebrate faunal localities. 1. Ketza River, 2. Big Creek area (Revenue Creek, Happy Creek and Boliden Creek), 3. Fort Selkirk area, 4. Ash Bend, 5. Dublin Gulch, 6. Hungry Creek, 7. Scottie Creek and the Little John Site, 8. Thistle Creek, 9. Brewer Creek, 10. Sixtymile area (Loc. 3, etc.), 11. Dawson City area (Midnight Dome, Hunker Creek, Last Chance Creek, Dominion Creek, Sulphur Creek, Gold Run Creek, Eldorado Creek, Quartz Creek, etc.), 12. Whitestone Mammoth site, 13. Bluefish Caves, 14. Porcupine Loc. 100, 15. Old Crow Basin (Locs. 11A, 11(1), 44, 47, 94, etc.), 16. Herschel Island (several localities).

3. Materials and methods

The bones and associated evidence convey important information. Most vertebrate fossils are identified using morphological evidence, comparing shape and size of bones (especially tooth characters) with those of known ancient and modern species. Detailed examination of bone surfaces of Yukon ice age vertebrates has yielded valuable data on: human influence (cut, abrasion and impact marks; e.g. Fig. 12); predation and scavenging (tooth marks); environment (rootlet tracks); physical damage and disease (surface swellings and breaks from blows, e.g. Fig. 12, or falls; and growths, bone fusion and scoring near joints due to osteoarthritis) (Tener and Harington, 2003). These animals had similar physical problems to today's species. X-rays of ice age carcasses and limb bones have also provided information on internal structures and fractures, respectively. Further, evidence associated with fossil bones can yield much valuable paleoenvironmental information, such as that derived from scores of widespread Arctic ground squirrel (*Spermophilus parryi*) middens (nesting grasses, seed caches and droppings) about 30 000–24 000 BP from frozen ground in the Klondike (Zazula et al., 2007).

Where possible the fossils are carefully excavated in place from the surrounding matrix, and the stratigraphic position is noted. However, most specimens have been washed out of their original position and are collected from stream margins, or on surfaces at the base of placer mining cuts. In some cases, where small bones of fishes, birds and rodents are sufficiently concentrated, the matrix is screened.

Some principles follow regarding establishment, based on the bones, of geological age, relationships among the vertebrates, and ancient diet. If the fossils are found in place in a sequence of sediment layers, usually the older specimens are nearer the bottom and the younger nearer the top. Thus approximate geological age of bones can be roughly determined by their place in such a stratigraphic sequence (e.g. Table 1; 8, 11, 12). John Westgate and his colleagues have contributed over several decades to establishing a time framework for the Yukon faunas spanning the last 2 million years through tephrochronology (the use of datable, readily

Table 1
Suggested chronological sequence of Pleistocene vertebrate taxa from selected localities and stratigraphic levels recorded in the Yukon Territory. (X - present, — not collected or identified so far, cf. - closely comparable specimen identified, * - extinct, ** - extinct in Yukon Territory or reintroduced, ? - estimated time present).

									Late Pleistocene[a]														
	Early Pleistocene[a]					Middle Pleistocene[a]			Illinoian Glacial (or earlier)	Sangamonian Interglacial				Early Wisconsinan	Mainly Middle to Late Wisconsinan								Lateglacial (about 12 000-9000 BP)
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
Fishes	—	x	—	—	—	—	x	—	x	x	—	—		x	—	x	x	—	—	—	—	—	x
*Beringian whitefish (*Coregonus beringiaensis*)	—	x	—	—	—	—	—	—	—	—	—	—		—	—	—	—	—	—	—	—	—	—
Broad whitefish (*Coregonus nasus)*	—	—	—	—	—	—	—	—	x	x	—	—		x	—	—	—	—	—	—	—	—	—
Whitefish (*Coregonus* sp.)	—	—	—	—	—	—	—	—	x	x	—	—		x	—	—	—	—	—	—	—	—	—
Inconnu (*Stenodus leucichthys*)	—	—	—	—	—	—	—	—	x	cf.	—	—		x	—	—	cf.	—	—	—	—	—	—
Arctic grayling (*Thymallus arcticus*)	—	—	—	—	—	—	—	—	—	x	—	—		x	—	—	x	—	—	—	—	—	—
Northern pike (*Esox lucius*)	—	—	—	—	—	—	—	—	—	—	—	—		—	—	—	x	—	—	—	—	—	—
Pike (*Esox* sp.)	—	—	—	—	—	—	—	—	—	x	—	—		—	—	x	—	—	—	—	—	—	—
Longnose sucker (*Catostomus catostomus*)	—	—	—	—	—	—	—	—	x	x	—	—		x	—	—	x	—	—	—	—	—	—
Sucker (*Catostomus* sp.)	—	—	—	—	—	—	—	—	—	—	—	—		x	—	—	—	—	—	—	—	—	—
Burbot (*Lota lota*)	—	—	—	—	—	—	—	—	x	x	—	—		x	—	—	—	—	—	—	—	—	—
Sculpin (*Cottus* sp.)	—	—	—	—	—	—	—	—	—	—	—	—		x	—	—	—	—	—	—	—	—	—
Birds	—	—	—	—	—	—	x	—		x	—	—		x	—	x	x	—	—	—	x	—	x
Red-necked Grebe (*Podiceps grisigena*)	—	—	—	—	—	—	—	—	—	—	—	—		—	—	—	—	—	—	—	—	—	—
Horned Grebe (*Podiceps auritus*)	—	—	—	—	—	—	—	—	—	—	—	—		—	—	x	—	—	—	—	—	—	—
Red-throated Loon (*Gavia stellata*)	—	—	—	—	—	—	—	—	—	—	—	—		—	—	—	—	—	—	—	—	—	—
Arctic Loon (*Gavia arctica*)	—	—	—	—	—	—	—	—	—	—	—	—		—	—	—	—	—	—	—	—	—	—
Common Loon (*Gavia immer*)	—	—	—	—	—	—	—	—	—	—	—	—		—	—	—	—	—	—	—	—	—	—
Yellow-billed Loon (*Gavia* cf. *adamsii*)	—	—	—	—	—	—	—	—	—	—	—	—		—	—	—	—	—	—	—	—	—	—
Loon (*Gavia* sp.)	—	—	—	—	—	—	—	—	—	—	—	—		—	—	x	—	—	—	—	—	—	—
Swan (*Cygnus* sp.)	—	—	—	—	—	—	—	—	—	—	—	—		—	—	—	—	—	—	—	—	—	x
Ducks and geese (Anatidae)	—	—	—	—	—	—	—	—	x	—	—	—		x	—	x	—	—	—	—	—	—	—
Mallard (*Anas platyrhynchos*)	—	—	—	—	—	—	—	—	—	—	—	—		—	—	—	—	—	—	—	—	—	—
Pintail (*Anas acuta*)	—	—	—	—	—	—	—	—	—	—	—	—		—	—	—	—	—	—	—	—	—	—
American Widgeon (*Anas americana*)	—	—	—	—	—	—	—	—	—	cf.	—	—		—	—	cf.	x	—	—	—	—	—	—
Blue-winged Teal (*Anas discors*)	—	—	—	—	—	—	—	—	—	—	—	—		—	—	—	—	—	—	—	—	—	—
Birds cont'd																							
Common Teal (*Anas crecca*)	—	—	—	—	—	—	—	—	—	—	—	—		—	—	—	—	—	—	—	—	—	—
Lesser Scaup (*Arythya affinis*)	—	—	—	—	—	—	—	—	—	—	—	—		—	—	—	—	—	—	—	—	—	—
Ring-necked Duck (*Arythya collaris*)	—	—	—	—	—	—	—	—	—	—	—	—		—	—	—	—	—	—	—	—	—	—
Oldsquaw (*Clangula hyemalis*)	—	—	—	—	—	—	—	—	—	x	—	—		—	—	x	—	—	—	—	—	—	—
Common Eider (*Somateria mollissima*)	—	—	—	—	—	—	—	—	—	—	—	—		—	—	x	—	—	—	—	—	—	—
Common Scoter (*Melanitta nigra*)	—	—	—	—	—	—	—	—	—	—	—	—		—	—	—	—	—	—	—	—	—	—
White-winged Scoter (*Melanitta fusca*)	—	—	—	—	—	—	—	—	—	—	—	—		—	—	—	—	—	—	—	—	—	—
Surf Scoter (*Melanitta perspicillata*)	—	—	—	—	—	—	—	—	—	—	—	—		—	—	—	—	—	—	—	—	—	—
Ptarmigan or grouse (Tetraonidae)	—	—	—	—	—	—	—	—	x	x	—	—		x	—	x	x	—	—	—	—	—	—
Snow Goose (*Chen caerulescens*)	—	—	—	—	—	—	—	—	—	cf.	—	—		—	—	—	x	—	—	—	cf.	—	—
Harlequin Duck (*Histrionicus histrionicus*)	—	—	—	—	—	—	—	—	—	—	—	—		—	—	—	x	—	—	—	—	—	—
Red-tailed Hawk (*Buteo jamaicensis*)	—	—	—	—	—	—	—	—	—	—	—	—		—	—	—	x	—	—	—	—	—	—
American Golden Plover (*Pluvialis dominica/ fulva*)	—	—	—	—	—	—	—	—	—	—	—	—		—	—	—	x	—	—	—	—	—	—
Black-bellied Plover (*Pluvialis squatarola*)	—	—	—	—	—	—	—	—	—	—	—	—		—	—	—	cf.	—	—	—	—	—	—
Shorebirds (Charadriiformes)	—	—	—	—	—	—	—	—	—	cf.	—	—		—	—	—	—	—	—	—	—	—	—
Small sandpiper (*Calidris* sp.)	—	—	—	—	—	—	—	—	—	—	—	—		—	—	—	x	—	—	—	—	—	—
Eskimo curlew (*Numenius borealis*)	—	—	—	—	—	—	—	—	—	—	—	—		—	—	—	cf.	—	—	—	—	—	—
Solitary Sandpiper (*Tringa solitaria*)	—	—	—	—	—	—	—	—	—	—	—	—		—	—	—	cf.	—	—	—	—	—	—
Snowy Owl (*Nyctea scandiaca*)	—	—	—	—	—	—	—	—	—	—	—	—		—	—	—	x	—	—	—	—	—	—
Hawk Owl (*Surnia alula*)	—	—	—	—	—	—	—	—	—	—	—	—		—	—	—	x	—	—	—	—	—	—

(*continued on next page*)

Table 1 (*continued*)

									Late Pleistocene[a]														
	Early Pleistocene[a]					Middle Pleistocene[a]			Illinoian Glacial (or earlier)	Sangamonian Interglacial				Early Wisconsinan	Mainly Middle to Late Wisconsinan								Lateglacial (about 12 000-9000 BP)
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
Perching birds (Passeriformes)	–	–	–	–	–	–	–	–	–	x	–	–		–	–	–	–	–	–	–	–	–	–
Say's Phoebe (*Sayornis* cf. *saya*)	–	–	–	–	–	–	–	–	–	–	–	–		–	–	–	x	–	–	–	–	–	–
Olive-sided Flycatcher (*Contorpus* cf. *borealis*)	–	–	–	–	–	–	–	–	–	–	–	–		–	–	–	x	–	–	–	–	–	–
Swallows (Hirundinidae)	–	–	–	–	–	–	–	–	–	–	–	–		–	–	–	x	–	–	–	–	–	–
Common Raven (*Corvus corax)*	–	–	–	–	–	–	–	–	–	–	–	–		–	–	–	x	–	–	–	–	–	–
Chickadee (*Parus* sp.)	–	–	–	–	–	–	–	–	–	–	–	–		–	–	–	x	–	–	–	–	–	–
Robin (*Turdus migratorius*)	–	–	–	–	–	–	–	–	–	–	–	–		–	–	–	x	–	–	–	–	–	–
Hermit or Gray-cheeked Thrush (*Catharus guttatus/minimus*)	–	–	–	–	–	–	–	–	–	–	–	–		–	–	–	x	–	–	–	–	–	–
Waxwing (cf. *Bombycilla* sp.)																	x						
Tree or Chipping Sparrow (*Spizella arborea/ passerina*)																	x						
Lincoln's Sparrow (*Melospiza lincolnii*)	–	–	–	–	–	–	–	–	–	–	–	–		–	–	–	cf.	–	–	–	–	–	–
Snow Bunting (*Plectrophenax nivalis*)	–	–	–	–	–	–	–	–	–	–	–	–		–	–	–	x	–	–	–	–	–	–
Amphibians	–	–	–	–	–	–	–	–	–	–	x	–		–	–	–	–	–	–	–	–	–	–
Wood frog (*Rana sylvatica*)	–	–	–	–	–	–	–	–	–	–	x	–		–	–	–	–	–	–	–	–	–	–
Frog (*Rana* sp.)	–	–	–	–	–	–	–	–	–	–	–	–		–	–	–	x	–	–	–	–	–	–
Mammals	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Masked shrew (*Sorex cinerus*)	–	–	–	–	–	cf.	–	–	–	–	–	–		–	–	–	–	–	–	–	–	–	–
*Plains shrew (*Planisorex* cf. *dixonensis*)	–	–	–	–	x	–	–	–	–	–	–	–		–	–	x	–	–	–	–	–	–	–
Pygmy shrew (*Microsorex* sp.)	x	–	–	–	–	–	–	–	–	–	–	–		–	–	–	–	–	–	–	–	–	–
Shrew (*Sorex* sp.)	–	–	–	–	–	–	x	–	–	–	–	–		x	–	–	–	–	–	–	–	–	–
Shrew (Soricidae)	x	–	–	–	–	x	x	–	–	x	–	–		x	–	x	–	–	–	–	–	–	–
Bat (Chiroptera)	x	–	–	–	–	–	–	–	–	–	–	–		–	–	–	–	–	–	–	–	–	–
Human (indirect evidence) (*Homo* sp.)	–	–	–	–	–	–	–	–	–	–	–	–		–	–	x	x	–	–	–	–	–	x
*Jefferson's ground sloth (*Megalonyx jeffersonii*)	–	–	–	–	–	–	–	–	–	x	–	–		–	–	x	–	–	–	–	–	–	–
*Giant pika (*Ochotona whartoni*)	–	–	–	x	?	x	–	–	x	x	–	x		x	–	x	–	–	–	–	–	–	–
American pika (*Ochotona princeps*)	–	–	–	–	–	–	–	–	x	x	–	–		–	–	x	–	–	–	–	–	–	–
Pika (*Ochotona* sp.)	x	–	–	–	–	x	x	–	–	–	–	–		–	–	–	–	–	–	–	–	–	–
Snowshoe hare (*Lepus americanus*)	–	–	–	–	–	–	–	–	x	x	–	–		x	–	x	–	–	–	–	–	–	–
Arctic hare (*Lepus arcticus*)	–	–	–	–	–	–	x	–	x	x	–	–		x	–	x	–	–	–	–	–	cf.	–
Hare (*Lepus* sp.)	cf.	–	–	–	–	–	–	–	–	x	–	–		–	–	–	–	–	–	–	–	–	x
Woodchuck (*Marmota monax*)	–	–	–	–	–	–	–	–	–	–	–	–		x	–	–	–	–	–	–	–	–	–
Least chipmunk (*Eutamias minimus*)	–	–	–	–	–	cf.	–	–	–	–	–	–		–	–	–	–	–	–	–	–	–	–
Arctic ground squirrel (*Spermophilus parryi*)	–	–	–	–	–	cf.	cf.	–	x	x	–	–		x	–	x	–	–	–	–	x	–	–
Ground squirrel (*Spermophilus* sp.)	x	–	–	–	–	–	x	–	–	–	x	–		–	–	–	–	–	–	–	–	–	cf.
American beaver (*Castor canadensis*)	–	–	–	–	–	–	x	–	x	x	–	–		x	–	x	–	–	–	–	–	–	–
Giant beaver (*Castoroides ohioensis*)	–	–	–	–	–	–	x	–	x	x	–	x		x	–	x	–	–	–	–	–	–	–
Beaver (Castoridae)	–	x	–	–	–	–	–	–	–	–	–	–		–	–	–	–	–	–	–	–	–	–
*Hopkins' lemming (*Predicrostonyx hopkinsi*)	cf.	–	–	x	–	–	–	–	–	–	–	–		–	–	cf.	–	–	–	–	–	–	–
Collared lemming (*Dicrostonyx* sp.)	–	–	–	–	–	x	x	–	x	x	x	–		x	–	x	–	–	–	–	–	–	–
Brown lemming (*Lemmus sibiricus*)	cf.	–	–	cf.	–	cf.	x	–	x	x	cf.	–		x	–	x	–	–	–	–	–	–	–
Red-backed vole (*Clethrionomys rutilus*)	–	–	–	cf.	–	–	cf.	–	–	x	–	x		x	–	–	–	–	–	–	–	–	–
Bog lemming (*Mictomys* sp.)	x	–	–	–	–	–	–	–	–	–	–	–		–	–	–	–	–	–	–	–	–	–
Muskrat (*Ondatra zibethicus*)	–	–	–	–	–	–	cf.	–	x	x	–	x		x	–	x	–	–	–	–	–	–	–
*Deering vole (*Phenacomys deeringensis*)	–	–	–	x	–	–	x	–	–	–	–	–		–	–	–	–	–	–	–	–	–	–
Heather vole (*Phenacomys intermedius*)	cf.	–	–	–	–	–	–	–	–	–	–	–		x	–	x	–	–	–	–	–	–	–
*Matthews' vole (*Guildayomys matthewsi*)	–	–	–	–	–	x	–	–	–	–	–	–		–	–	–	–	–	–	–	–	–	–
*Deceit vole (*Microtus deceitensis*)	x	–	–	–	–	–	x	–	–	–	–	–		–	–	–	–	–	–	–	–	–	–

*Morlan's vole (*Microtus morlani*)	–	–	–	–	–	x	–	–	–	–	–	–		–	–	–	–	–	–	–	–	–	–
Singing vole (*Microtus miurus*)	–	–	–	–	–	–	–	–	x	x	x	–		x	–	x	–	–	–	–	–	–	–
*Primitive vole (*Allophaiomys deceitensis*)	x	–	–	cf.	–	–	–	–	–	–	–	–		–	–	–	–	–	–	–	–	–	–
Tundra vole (*Microtus oeconomus*)	–	–	–	–	–	–	–	–	cf.	cf.	x	–		–	–	–	–	–	–	–	–	–	–
Meadow vole (*Microtus pennsylvanicus*)	–	–	–	–	–	–	–	–	–	–	–	x		x	–	–	–	–	–	–	–	–	–
Yellow-cheeked vole (*Microtus xanthognathus*)	–	–	–	–	–	–	–	–	–	cf.	x	–		x	–	x	–	–	–	–	–	–	–
Vole (*Microtus* sp.)	–	–	–	–	–	x	–	–	–	–	–	–		–	–	–	–	–	–	–	–	–	–
White-footed mouse (*Peromyscus leucopus*)	–	–	–	–	–	–	–	–	–	–	x	–		–	–	–	–	–	–	–	–	–	–
Large whale (Cetacea cf. *Balaena mysticetus*)	–	–	–	–	–	–	–	–	–	–	–	–		–	x	–	–	–	–	–	–	–	–
White whale (*Delphinapterus leucas*)	–	–	–	–	–	–	–	–	–	–	–	–		–	cf.	–	–	–	–	–	–	–	–
Coyote (*Canis latrans*)	–	–	–	–	–	–	–	–	–	–	–	–		–	–	x	–	–	–	–	–	–	–
Wolf (*Canis lupus*)	–	–	–	–	–	–	x	–	cf.	x	–	–		x	x	x	x	x	cf.	–	x	–	cf.
*Xenocyon (*Xenocyon lycaonoides*)								x															
Arctic fox (*Alopex lagopus*)	–	–	–	–	–	–	x	–	x	–	–	cf.		x	x	x	x	x	–	–	–	–	–
Red fox (*Vulpes vulpes*)	–	–	–	–	–	–	–	–	–	–	–	cf.		–	x	–	x	–	–	–	x	–	–
*Giant short-faced bear (*Arctodus simus*)	–	–	–	–	–	–	–	–	–	–	–	–		–	–	x	–	x	x	–	–	–	–
Black bear (*Ursus americanus*)	–	–	–	–	–	–	–	–	–	–	–	x		–	–	x	–	–	–	–	–	–	–
Brown bear (*Ursus arctos*)	–	–	–	–	–	–	–	–	–	–	–	–		–	–	–	–	–	–	–	cf.	x	–
Polar bear (*Ursus maritimus*)	–	–	–	–	–	–	–		–	–	–	–		–	x	–	–	–	–	–	–	–	–
Bear (*Ursus* sp.)	–	–	–	–	–	–	–	–	–	–	–	–		x	–	x	cf.	–	–	–	cf.	x	–
Weasel (*Mustela* sp.)	–	–	–	–	–	x	x	–	–	–	–	–		–	–	–	–	–	–	–	–	–	–
*Jackson's weasel (*Mustela jacksoni*)	x	–	–	–	–	–	–	–	–	–	–	–		–	–	–	–	–	–	–	–	–	–
Ermine (*Mustela erminea*)	–	–	–	–	–	–	–	–	–	–	–	x		x	–	x	x	–	–	–	–	–	–
Least weasel (*Mustela nivalis*)	–	–	–	–	–	–	–	–	–	–	–	–		–	–	–	x	–	–	–	–	–	–
**Black-footed ferret (*Mustela nigripes*)	–	–	–	–	–	–	–	–	–	–	–	–		–	–	–	x	–	–	–	x	–	–
Noble marten (*Martes nobilis*)	–	–	–	–	–	–	–	–	–	–	–	–		–	–	x	–	–	–	–	–	–	–
American marten (*Martes americana*)	–	–	–	–	–	–	–	–	–	–	–	–		–	–	x	–	–	–	–	–	–	–
Fisher (*Martes pennanti*)	–	–	–	–	–	–	–	–	–	x	–	–		–	–	x	–	–	–	–	–	–	–
Wolverine (*Gulo gulo*)	–	–	–	–	–	–	–	–	–	x	–	–		–	–	x	–	–	–	–	x	–	–
**Badger (*Taxidea taxus*)	–	–	–	–	–	–	–	–	–	–	–	–		–	–	–	–	x	x	–	–	–	–
*Short-faced skunk (*Brachyprotoma obtusata*)	–	–	–	–	–	–	–	–	–	x	–	–		–	–	–	cf.	–	–	–	–	–	–
Otter (*Lontra canadensis*)	–	–	–	–	–	–	–	–	–	–	–	–		–	–	x	–	–	–	–	–	–	–
*Hyaena (Hyaenidae)	–	–	–	–	?	–	–	–	–	–	–	–		–	–	x	–	–	–	–	–	–	–
Mountain lion (*Felis concolor*)	–	–	–	–	–	–	–	–	–	–	–	–		–	–	–	x	–	–	–	–	–	–
Lynx (*Felis canadensis*)	–	–	–	–	–	–	–	–	–	–	–	–		cf.	–	x	–	–	–	–	–	–	–
*Steppe lion (*Panthera leo spelaea*)	–	–	–	–	–	–	–	–	–	–	–	–		x	–	x	x	x	x	x	x	x	–
*American scimitar cat (*Homotherium serum*)	–	–	–	–	–	–	–	–	–	–	–	–		–	–	x	–	–	–	–	–	–	–
Walrus (*Odobenus rosmarus*)	–	–	–	–	–	–	–	–	–	–	–	–		–	x	–	–	–	–	–	–	–	–
Small seal (*Pusa* or *Phoca* sp.)	–	–	–	–	–	–	–	–	–	–	–	–		–	x	–	–	–	–	–	–	–	–
Ringed seal (*Pusa hispida*)	–	–	–	–	–	–	–	–	–	–	–	–		–	x	–	–	–	–	–	–	–	–
*American mastodon (*Mammut americanum*)	–	–	–	–	–	–	–	–	–	x	–	–		–	x	x	–	–	x	–	x	–	–
*Southern mammoth (*Mammuthus meridionalis*)	–	x	–	–	x	–	–	–	–	–	–	–		–	–	x	–	–	–	–	–	–	–
*Steppe mammoth (*Mammuthus trogontherii*)	–	–	–	–	–	–	x	–	–	–	–	–		–	–	–	–	–	–	–	–	–	–
*Woolly mammoth (*Mammuthus primigenius*)	–	–	–	–	–	–	–	–	–	x	–	x		x	x	x	cf.	x	x	cf.	x	x	–
*Mammoth (*Mammuthus* sp.)	–	–	–	–	x	x	–	–	x	–	–	–		x	x	x	x	x	x	cf.	x	x	–
*Horse (*Equus* sp.)	–	–	–	–	–	x	x	–	x	–	–	–		x	x	x	x	x	x	x	x	x	–
*Large horse (*Equus verae*)	–	–	–	–	–	cf.	–	–	x	x	–	–		x	–	x	–	cf.	–	–	cf.	–	–
*Scott's horse (*Equus scotti*)	–	–	–	–	–	–	–	–	–	–	–	–		–	–	cf.	–	cf.	–	–	–	–	–
*Yukon horse (*Equus lambei*)	–	–	–	–	–	cf.	–	–	–	–	–	–		–	x	x	x	x	x	x	x	x	–
**Kiang (*Equus* (*Asinus*) *kiang*)	–	–	–	–	–	–	–	–	–	–	–	–		–	–	–	–	–	x	–	–	–	–
*Flat-headed peccary (*Platygonus compressus*)	–	–	–	–	–	–	–	–	–	–	–	–		–	–	–	–	–	–	–	–	–	–
*Large camel (Camelini cf. *Paracamelus gigas*)	–	–	–	–	–	–	–	–	x	?	–	–		–	–	x	–	–	–	–	–	–	–
*Western camel (*Camelops hesternus*)	–	–	–	–	–	–	–	–	–	–	–	–	x	–	–	–	–	–	–	–	x	–	–
**Wapiti (*Cervus elaphus*)	–	–	–	–	–	–	–	–	–	–	–	–		–	–	x	x	–	–	–	x	–	x
*Giant moose (*Alces latifrons*)	–	–	–	–	–	–	–	–	–	–	–	–		–	–	x	–	–	–	–	–	–	–
American moose (*Alces alces*)	–	–	–	–	–	–	–	–	–	–	–	–		–	–	x	cf.	x	cf.	cf.	x	–	cf.
Moose (*Alces* sp.)	–	–	–	–	–	–	–	–	–	–	–	x		x	–	x	x	x	x	x	x	x	–
Caribou (*Rangifer tarandus*)	x	–	–	–	–	–	x	–	x	x	–	–		x	x	x	x	x	x	x	x	x	x

(*continued on next page*)

Table 1 (*continued*)

	Late Pleistocene[a]																						
	Early Pleistocene[a]					Middle Pleistocene[a]			Illinoian Glacial (or earlier)	Sangamonian Interglacial				Early Wisconsinan	Mainly Middle to Late Wisconsinan								Lateglacial (about 12 000-9000 BP)
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
**Bison (*Bison* sp.)	–	–	–	–	–	–	×	–	–	×	–	×		×	×	×	×	×	×	×	×	×	×
*Alaskan bison (*Bison alaskensis*)	–	–	–	–	–	–	–	–	–	–	–	–		–	–	–	–	×	×	–	–	–	–
*Steppe bison (*Bison priscus*)	–	–	–	–	–	–	–	–	–	–	–	–		–	×	×	cf.	×	×	cf.	×	×	–
*Western bison (*Bison bison occidentalis*)	–	–	–	–	–	–	–	–	–	–	–	–		–	–	–	–	–	–	–	–	–	–
**Saiga (*Saiga tatarica*)	–	–	–	–	–	–	–	–	–	–	–	–		–	–	–	×	–	–	–	–	–	–
Muskoxen (Ovibovini)	–	–	–	–	–	–	–	–	×	×	–	–		–	×	×	×	–	×	–	×	–	–
*Soergel's muskox (*Soergelia* sp.)	–	–	–	–	–	–	–	–	×	–	–	–		–	–	×	–	–	–	–	–	–	–
*Helmeted muskox (*Bootherium bombifrons*)	–	–	–	–	–	–	–	–	–	–	–	–		–	×	×	–	–	cf.	–	×	–	–
*Staudinger's muskox (*Praeovibos priscus*)	–	–	–	–	–	–	–	–	–	–	–	–		–	–	×	–	–	–	–	–	–	–
**Tundra muskox (*Ovibos moschatus*)	–	–	–	–	–	–	–	–	–	–	–	–		–	×	×	×	–	–	–	×	–	–
Dall sheep (*Ovis dalli*)	–	–	–	–	–	–	–	–	–	–	–	–		–	–	–	×	×	–	×	×	×	–

[a] Localities: 1. Fort Selkirk, 2. Porcupine Loc. 100, 3. Dawson (Midnight Dome), 4. Old Crow Loc. 94, 5. Old Crow Loc. 11A, 6. Thistle Creek Organic 1, 7. Old Crow Loc. 47, 8. Old Crow Loc. 14N (Tedford et al., 2009), 9. Old Crow Basin (reworked lower lake beds), 10. Old Crow Loc. 44, 11. Thistle Creek Organic 2, 12. Old Crow Basin (base of interlake beds), 13. White River Locality (62°34′41″N, 139°59′47″W, Grant Zazula personal communication, 2011). 14. Old Crow Basin (upper interlake beds), 15. Herschel Island, 16. Old Crow Loc. 11A – mixed Early Pleistocene to Holocene, 17. Bluefish Caves (about 33,000–10,000 BP), 18. Dawson Loc. 10, 19. Dawson Locs. 32–33, 20. Dublin Gulch Loc. 1, 21. Sixtymile Loc. 3, 22. Big Creek Locs. 1–3 (note that some of these specimens may be of Sangamonian age), 23. Little John Site. Where localities for taxa are not designated here, they are recorded in Canadian Museum of Nature Quaternary Zoology collections and in). 9. Old Crow Basin (reworked lower lake beds), 10. Old Crow Loc. 44, 11. Thistle Creek Organic 2, 12. Old Crow Basin (base of interlake beds), 13. White River Locality (62°34′41″N, 139°59′47″W, Grant Zazula personal communication, 2011). 14. Old Crow Basin (upper interlake beds), 15. Herschel Island, 16. Old Crow Loc. 11A – mixed Early Pleistocene to Holocene, 17. Bluefish Caves (about 33 000–10 000 BP), 18. Dawson Loc. 10, 19. Dawson Locs. 32–33, 20. Dublin Gulch Loc. 1, 21. Sixtymile Loc. 3, 22. Big Creek Locs. 1–3 (note that some of these specimens may be of Sangamonian age), 23. Little John Site. Where localities for taxa are not designated here, they are recorded in Canadian Museum of Nature Quaternary Zoology collections and in Fitzgerald (1978, 1980, 1991).

identifiable, widespread volcanic ash deposits as time markers) (Preece et al., 2000; Westgate et al., 2001a,b, 2008). All numerical geological ages beyond radiocarbon dating are derived from tephrochronology. Finally, Accelerator Mass Spectrometry radiocarbon dating has enabled more precise dating, using minute bone samples, covering the last 50 000 years. As the number of dates on the various species increases, we gain more information on "who was where, when" during the Wisconsinan (Harington (ed.), 2003, Radiocarbon Date Table). Ancient DNA analysis of the bones has provided critical information on identification and relationships among species, as well as dispersal history and population changes through time – especially, so far, regarding brown bears, steppe lions, and steppe bison (Fig. 11) (Leonard et al., 2000; Barnes et al., 2002; Shapiro et al., 2004; Barnett et al., 2009). Information on ancient diets and ecology has come from analyses of carbon and nitrogen stable isotopes in bones and teeth (Matheus, 1995).

4. Faunas

The northernmost Yukon Pleistocene vertebrate site, consisting of several localities, is Herschel Island, which was part of the mainland when sea level was lower during glacials. Two marine mammal specimens representing a small seal (*Pusa* or *Phoca*) and a large whale like a bowhead (Cetacea cf. *Balaena mysticetus*) may be of last interglacial age (Harington, 1990a, b). Woolly mammoth, Yukon horse (*Equus lambei*), steppe bison, helmeted muskox (*Bootherium bombifrons* – the most northerly recorded Canadian specimen) and tundra muskox (*Ovibos moschatus*) are probably of Wisconsinan age, and most specimens were collected from Pauline Cove (Harington, 1990a). A partial cranium of a Yukon horse from the northeastern coast yielded a radiocarbon date of about 16 000 BP (Harington, 2003, 1990a,b) indicating the island had been formed and deglaciated by that time. More recently-collected Pleistocene mammal remains from Herschel Island, with their approximate radiocarbon dates, are: steppe bison (46 900 BP); tundra muskox (51 700 BP, 17,200 BP); horse (*Equus* sp.) (53 000 BP, 47 000 BP, 45,130 BP, 36 160 BP, 17 490 BP); American mastodon – the northernmost Canadian record, and one suggesting an open spruce forest environment of last (Sangamonian) interglacial age (>45 130 BP); walrus (*Odobenus rosmarus*) (45 630 BP, 15 290 BP). Although the sample is small, the apparent dominance of horses is in contrast to the often steppe bison-dominated faunas of interior Yukon and Alaska. In addition, the great span of radiocarbon dates indicate terrestrial occupation of the area much earlier than previously thought (Zazula et al., 2009).

The Old Crow Basin is the richest area for ice age vertebrate remains in Canada, having yielded more than 50,000 specimens representing nearly 80 mammal species. The bones are mainly exposed through natural erosion of the winding Old Crow River. They range in age from about 1.4 Ma (million years ago) to Late Wisconsinan (about 12 000 BP). Approximately 150 fossil localities are known within the basin. Among the most interesting mammals represented are: Jefferson's ground sloth (*Megalonyx jeffersonii*), giant pika (*Ochotona whartoni*), giant beaver (*Castoroides ohioensis*), giant short-faced bear (*Arctodus simus*), short-faced skunk (*Brachyprotoma obtusata*), hyaena (Hyaenidae), scimitar cat (*Homotherium serum*), giant camel (Camelini), and the primitive muskox *Soergelia*. Old Crow Loc. 94, associated with the Little Timber Tephra, is about 1.35 Ma and represents an Early Pleistocene interglacial. This fauna contains mammoth, horse, the primitive rodent *Allophaiomys*, a heather vole (*Phenacomys deeringensis*), red-backed vole (*Clethrionomys*), primitive brown (*Lemmus*) and collared (*Predicrostonyx hopkinsi*) lemmings, as well as the giant pika. Another early *in situ* fauna from Old Crow Loc. 47 is more than 80 000 BP and includes fish (*Pisces*), bird (*Aves*), shrew (Soricidae),

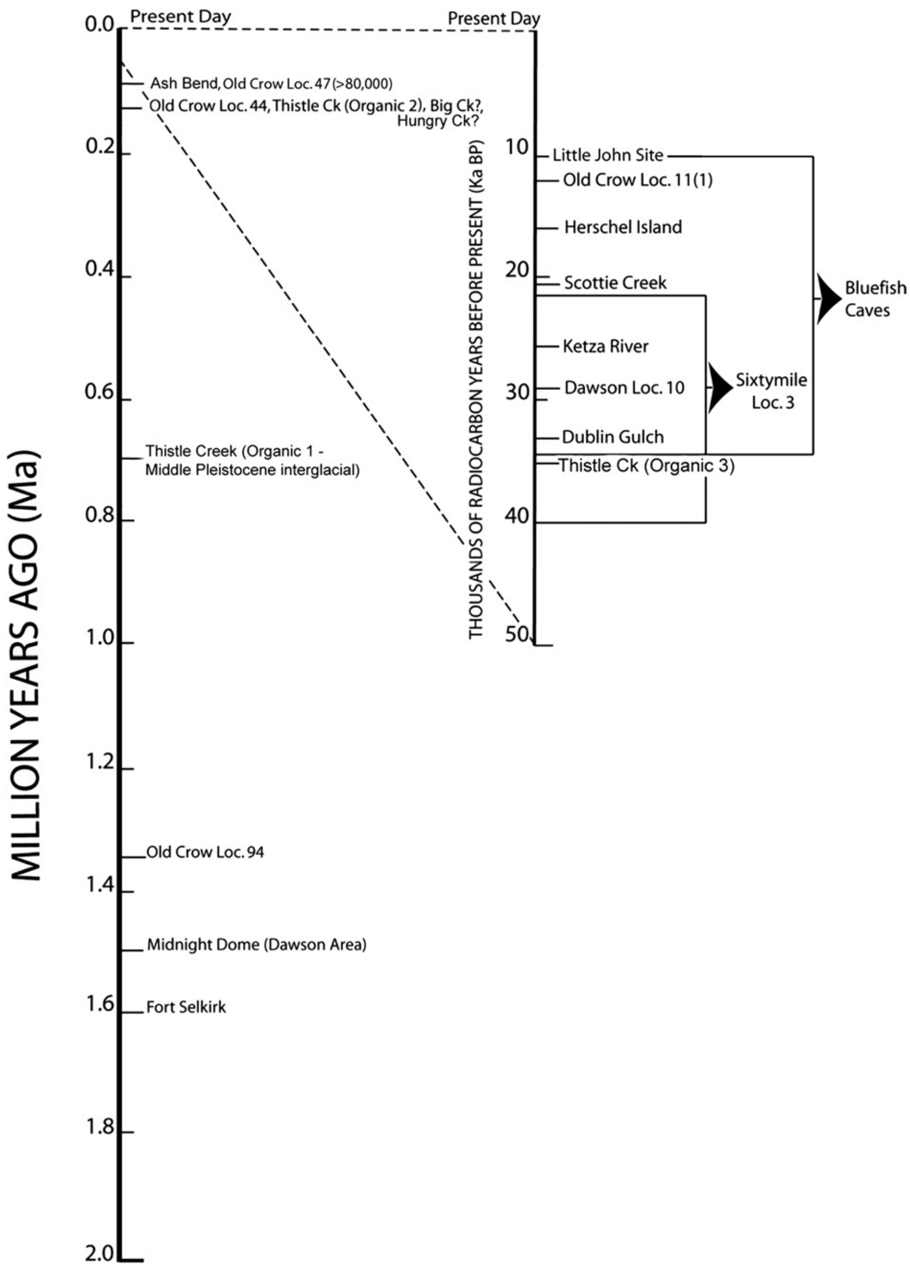

Fig. 3. Diagram showing the approximate chronological sequence of Yukon Pleistocene vertebrate faunas. New evidence indicates the Herschel Island fauna, here centred on 16 000 BP, actually covers a span of more than 50 000 years.

rodent (Rodentia, including giant beaver and American beaver), weasel (Mustelidae) and rabbit (Lagomorpha) remains, in addition to fossils of steppe mammoth (*Mammuthus trogontherii*), fox (*Alopex*), wolf (*Canis lupus*), horse, caribou and bison. I tentatively consider it to be Middle Pleistocene based on the steppe mammoth specimens, and I am particularly grateful to Richard Morlan (personal communication, 2003) for providing preliminary identifications of the Loc. 47 fauna. The *in situ* Old Crow Loc. 44 fauna of Sangamonian age (about 130 000 BP) contains remains of 7 fish, 7 bird and 31 mammal species (Harington, 1977, 1990b). Many of these species [e.g. fish, duck, goose, shorebird, beaver (*Castor canadensis*), giant beaver, muskrat (*Ondatra zibethicus*) and American mastodon] have aquatic affinities, and suggest the presence of ephemeral shallow ponds and lakes in a river floodplain with some sandy margins – perhaps with spruce-larch forest nearby according to identified wood from 15 tree trunks found in place. Two other localities are of particular interest. Old Crow Loc. 11(1) has produced scores of well-preserved *in situ* steppe bison (*Bison priscus*) remains – apparently representing a herd that died catastrophically about 12 000 BP (Harington, 1977; Fig. 4). These are the last-recorded steppe bison in the region. Old Crow Loc. 11A, a virtual "supermarket" for bones, is a point bar deposit containing hundreds of vertebrate fossils extending in age from Early Pleistocene to Holocene (Harington, 1987b; Fig. 5). The following Pleistocene bird species have been collected throughout Old Crow Basin, many from Old Crow Loc. 29 (Fig. 6): 2 grebes, 4 loons and 12 ducks. An undated shaft of a right humerus of a Common Loon (*Gavia immer*) was modified by humans (Fitzgerald, 1978, 1980, 1991). Pleistocene fishes from the Basin include: broad whitefish (*Coregonus nasus*), inconnu (*Stenodus leucichthys*), Arctic grayling

Fig. 4. Back view of a steppe bison skull found in place at Old Crow Loc. 11(1) that was radiocarbon dated to about 12 000 BP – among the most recent known steppe bison fossils from the region (C.R. Harington).

Fig. 6. Screening small vertebrate remains (e.g. fish, bird and mammal) at Old Crow Loc. 29. Jerry Fitzgerald dumps the screened fossils into a specimen bag held by Charlie Thomas, a member of the Vuntut Gwitchin First Nation from Old Crow (C.R. Harington).

(*Thymallus arcticus*), northern pike (*Esox lucius*), longnose sucker (*Catostomus catostomus*), burbot (*Lota lota*) and sculpin (*Cottus*) (Cumbaa et al., 1981). An extinct species of whitefish (*Coregonus beringiaensis*) of Early Pleistocene age has been reported recently from nearby Porcupine Loc. 100 (Cumbaa et al., 2010). Some worked bones from Old Crow Basin comprise evidence of people in this part of Eastern Beringia during the 40 000–25 000 BP interval (e.g. Harington, 1980). Evidently human bone-flaking technology represented part of a cultural adaptation to northern habitats in this part of Eastern Beringia during the Late Pleistocene – a view having precedent in similar examples from Eurasian sites (Cinq-Mars and Morlan, 1999).

A two-thirds complete skeleton of an adult female woolly mammoth from nearby Whitestone River (a tributary of Porcupine River upstream from Old Crow), dating to about 30 000 BP, is remarkable because it was found by following up a First Nation's legend (Harington, 2008b; Fig. 7). A perfect giant beaver mandible was recovered at Porcupine Loc. 100 – a series of high bluffs on Porcupine River about 8 km downstream from Old Crow (Harington, 1977). These bluffs range in age from Pliocene or Early Pleistocene (remains of a squashed beaver dam was found at the base) to Holocene.

Bluefish Caves (I–III) is one of the most important sites in Canada because it contains: (1) evidence for some of the earliest people in North America (from about 25 000 to 10 000 BP); (2) a well-marked transition between Pleistocene and Holocene sediments, flora and fauna, and (3) a substantial number and variety of fossils of both large and small mammals adapted to northern

Fig. 5. A "supermarket" for ice age fossils (e.g. steppe bison, woolly mammoth and horse). A day's collection (large bones only) from Old Crow Loc. 11A (C.R. Harington).

Fig. 7. Excavating the Whitestone Mammoth skeleton from the river bed. Peter Lord is placing the bones on the bank in the approximate position in which they were found (C.R. Harington).

Fig. 8. Left side of a black-footed ferret carcass dated at nearly 40 000 BP from Sixtymile Loc. 3. This is the best-preserved Yukon ice age mammal carcass (C.R. Harington).

conditions, as well as those of migratory birds. A significant specimen from Cave II is a mammoth limb bone flake and its parent core (both were dated providing an average age of 23 500 BP). Further, a split caribou tibia reminiscent of a broken fleshing tool has been dated to 24 800 BP. The Pleistocene large mammal fauna includes: mammoth, steppe bison, Yukon horse (*E. lambei*), Dall sheep (*Ovis dalli*), caribou, moose (*Alces*), wapiti (*Cervus elaphus*), saiga (*Saiga tatarica*), tundra muskox (*Ovibos* moschatus), steppe lion, steppe ferret (*Mustela eversmanni* – at 33 550 BP the earliest dated mammal from the site), cougar (*Felis concolor*), brown bear, wolf and many smaller mammals including 9 species of microtine rodents (Microtini); at least 23 bird species, and 2 fishes (Cinq-Mars, 1979, 1990; McCuaig-Balkwill and Cinq-Mars, 1998; Cinq-Mars and Morlan, 1999; Harington and Cinq-Mars, 2008). Pollen, plant and insect macrofossils recovered from the nearby Bluefish River indicate the Bluefish Caves fauna lived for at least part of the time in a grassy steppe-tundra environment during the cold, dry conditions of the Last Glacial Maximum (LGM, about 18 000 BP) (Zazula et al., 2006a).

Between 1975 and 1986, a gold placer site in the Sixtymile area (Loc. 3) yielded hundreds of excellent mid-Wisconsinan (about 60 000–25 000 BP) specimens, including remains of the rare western camel (*Camelops hesternus*), helmeted muskox and tundra muskox. Carcasses of a black-footed ferret (*Mustela nigripes*) from this site (Fig. 8), and of an arctic ground squirrel from a few kilometers away (Fig. 9), gave radiocarbon ages of about 39 500 and 47 500 BP respectively (Harington, 2003, 1997). Brown bear bones

Fig. 9. X-ray image of a complete skeleton of a 47 000 BP Arctic ground squirrel from Sixtymile. The animal was mummified and coiled up head to tail, presumably having died during hibernation (C.R. Harington).

from Sixtymile Loc. 3 and Dawson Loc. 16 yielded radiocarbon ages between 36 000 and 41 000 BP indicating that this species lived in west-central Yukon before the LGM (Leonard et al., 2000; Barnes et al., 2002). The Sixtymile area also provided the first evidence of Late Wisconsinan (about 26 000–25 000 BP) open spruce forest in Yukon in the form of dated spruce stumps and an American mastodon tooth. Unlike woolly mammoths who inhabited grassy plains, American mastodons evidently preferred open spruce forest habitat.

Ice age vertebrate remains near Dawson City (Fig. 10), like those at Sixtymile, Brewer Creek, Thistle Creek, Dublin Gulch and the Big Creek area (Harington, 2003), are mainly exposed during placer mining for gold. Nearly 70 fossil localities are recorded in the region (Harington, 1977, 1989b; Fraser and Burn, 1997; Froese et al., 2009). Most of the bones, when found in place, occur in frozen organic silt ("muck" is the miners' term) just above the surface of gold-bearing gravel, and most are Late Wisconsinan (about 30 000–15 000 BP). One of the most spectacular specimens from the area is a partial Yukon horse carcass from Last Chance Creek that dates to 26 280 BP (Harington and Eggleston-Stott, 1996; Harington, 2002; Zazula et al., 2003). Another remarkable Dawson area specimen from Nugget Gulch (Dawson Loc. 63), consists of most of a left forefoot of a steppe bison covered with dried muscle, skin and chestnut brown hair up to 7 cm long. It is similar to a mummified, hairless lower hind foot of an immature steppe bison from Dawson Loc. 10 dated to 20 370 BP (Harington, 2007). It is worth noting that Dawson Tephra (about 25 000 BP) has covered original grassy

Fig. 10. Placer miner Paul Favron with a complete Yukon horse skull that he found on Dominion Creek near Dawson City and generously donated to the Canadian Museum of Nature (C.R. Harington).

Fig. 11. Giant short-faced bear protecting a steppe bison carcass from a wolf pack. Ravens and woolly mammoths in the background (George Teichmann).

surfaces at several Dawson area localities (e.g. Nugget Gulch where fossils on a grassy terrain surface indicate the presence of humans, wolves, Yukon horses, Dall sheep and steppe bison about 30 000 BP (see Fig. 12D); Quartz Creek; Trail Gulch; Bear Creek; and Goldbottom Creek) (Fraser and Burn, 1997; Harington and Morlan, 2002; Zazula et al., 2006b). Nearly 90 percent of the finds from Dawson Loc. 10 include: steppe bison (46 percent), Yukon horse (19 percent), mammoth (11 percent), Dall sheep (11 percent) and caribou (3 percent). At many Dawson area localities skeletal remains of arctic ground squirrels, their nesting grasses, seed caches and droppings have yielded insights concerning the nature of the former Mammoth Steppe environment (Zazula et al., 2007). Gold Run Creek (Dawson Locs. 31 to 33), 50 km southeast of Dawson yielded type skulls of the Yukon giant short-faced bear (*Arctodus simus yukonensis*) and the Yukon horse (Harington, 1977, 1996a; Harington and Clulow, 1973). Artist George Teichmann, with advice from then Yukon paleontologist John Storer, has vividly portrayed a giant short-faced bear protecting a freshly-killed steppe bison from wolves (Fig. 11). Other specimens of interest include: badger (*Taxidea taxus*), American mastodon, steppe lion, kiang (*Equus* (*Asinus*) *kiang*), and Alaskan bison (*Bison alaskensis* – see McDonald, 1981). At Midnight Dome overlooking Dawson City, fine sands underlying a volcanic ash layer at least 1.5 Ma has produced primitive (Early Pleistocene) remains of vole (*Microtus*) and lemming (*Dicrostonyx*) groups (Storer, 2006).

Two Stewart River sites, south of Dawson City, are worth mentioning although they yield few species. At Ash Bend, the fauna (steppe bison, mammoth and moose) immediately underlies Sheep Creek Klondike Tephra – a volcanic ash that dates to about 90 000 BP (Harington, 1987a; Westgate et al., 2008). Brewer Creek has yielded mainly steppe bison remains.

At Thistle Creek, southwest of Dawson City, three units preserve mammal faunas: Organic 1 (a Middle Pleistocene interglacial about 740 000 BP) contains 14 taxa including two new species (*Microtus morlani* and *Guildayomys matthewsi*), a shrew (*Sorex* cf. *S. cinereus*), mammoth, a small horse like the Yukon horse, the first Beringian record of a chipmunk (*Eutamias* cf. *Eutamias minimus*), two lemmings (*Lemmus* and *Dicrostonyx*) and giant pika; Organic 2 and 3 represent the last (Sangamonian) interglacial (about 130 000 BP), and last (prior to the LGM) interstadial, respectively, and contain remains of tundra vole (*Microtus oeconomus*), chestnut-cheeked vole (*Microtus xanthognathus*), white-footed mouse (*Peromyscus leucopus*), collared lemming, ground squirrel, horse and caribou (Storer, 2004a, 2006).

Pleistocene vertebrate remains from Dublin Gulch, the Big Creek area, Ketza River and Hungry Creek are of interest because those areas were glaciated. At Dublin Gulch, north of Mayo, species most commonly represented are horse (38 percent), bison (36 percent), Dall sheep and caribou (10 percent each). A horse metatarsal from the site yielded a radiocarbon age of 31 450 BP, indicating that the fauna occupied the area during the last interstadial (Harington, 1996b).

So far, Pleistocene vertebrate remains have been collected from three tributaries of Big Creek: (1) Revenue Creek, where steppe lion, woolly mammoth and steppe bison may be of Last Interglacial age; (2) Happy Creek, where mammoth, horse, caribou, steppe bison and Dall sheep were recorded; and (3) Boliden Creek, where brown bear (>43 400 BP), woolly mammoth, Yukon horse, caribou, bison and Dall sheep bones are possibly of Last Interglacial age too (Harington, 2003; Jackson et al., 1996).

At Ketza River, Pleistocene species include: hare, ground squirrel, collared lemming, mammoth, Yukon horse, moose and bison (26 350 BP). This fauna, like Dublin Gulch, may be of mid-Wisconsinan age (Jackson and Harington, 1991).

Hungry Creek has produced remains (e.g. ground squirrel, brown (?) and collared lemming, vole (?), and Yukon horse), possibly of Last Interglacial age, that underly glacial till (Hughes et al., 1981). In contrast, Scottie Creek, near the southern border with Alaska, has yielded remains of mammoth, Yukon horse and bison. A Yukon horse mandible dated at 20 650 BP suggests the fauna lived in southwestern Yukon during the LGM (Hare, 1994). The nearby 10 000 BP Little John Site is important for the presence of Nenana–Denali Complex people, hare, rodents, canines, caribou, wapiti, possibly moose, fish, swan (*Cygnus*) and other birds at the end of the Pleistocene (Easton et al., 2007, 2009; Wisner, 2010).

A significant Early Pleistocene fauna was found by a team directed by geologist Lionel Jackson at Fort Selkirk, near the junction of Yukon and Pelly rivers. There, the fauna from loess enclosed by volcanic deposits, dates to about 1.6 Ma. It includes many specimens of the most primitive vole (*Microtus deceitensis*), as well as shrew (*Microsorex*), heather vole (*Phenacomys* cf. *Phenacomys intermedius*), primitive collared (*Predicostonyx*), brown (*Lemmus*) and bog (*Mictomys*) lemmings, ground squirrel, bat (Chiroptera), pika (*Ochotona*), hare (cf. *Lepus*), an extinct, small weasel (*Mustela jacksoni*) and caribou. It represents a full-glacial assemblage, and one that, based on characters of *M. deceitensis*, is slightly younger than the earliest-known Eastern Beringian Pleistocene assemblage (about 1.8 Ma) from Cape Deceit, Alaska (Storer, 2003, 2004b, 2006).

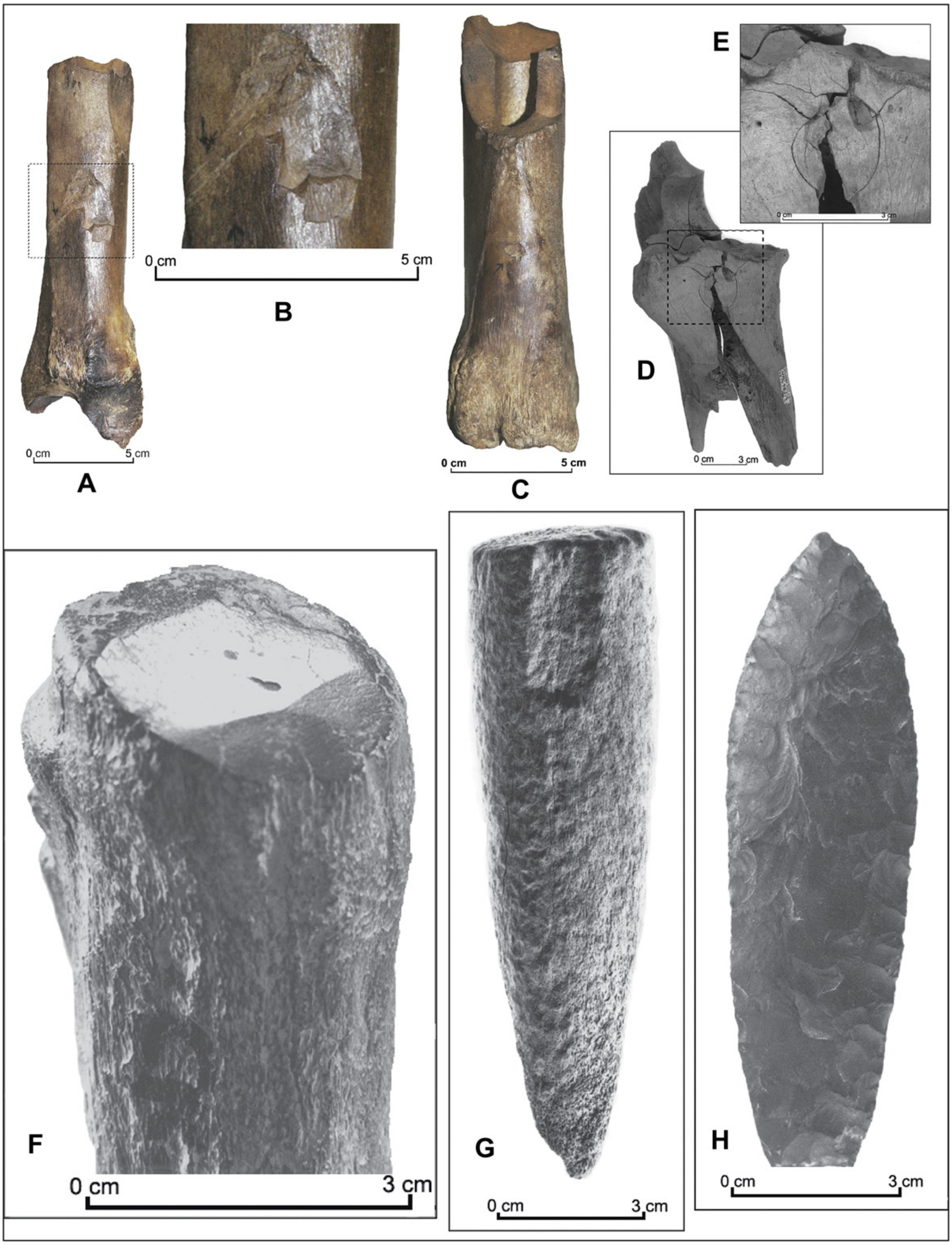

Fig. 12. Examples of evidence for human modification of Late Pleistocene bone from the Yukon Territory, and a chert biface from Old Crow Basin. A. Distal half of a left tibia of an adult steppe bison (*Bison priscus*, CMN 52937) from Dawson Loc. 12 (Hunker Creek) showing a large flake scar (top right) and a large batter mark with several subparallel drag (from a glancing blow?) or cutmarks adjacent to it (see arrow). B. Detailed view of large batter mark and marks to the left of it (see upper arrow on bone). C. View of opposite side of CMN 52937 showing particularly the spiral fracture evidently produced by a heavy blow near the middle of the shaft that removed a large flake from the opposite side. Presumably the bone was broken to obtain marrow. Radiocarbon dated to 39 700 ± 1400 BP (UCIAMS-71652). D. Anterior view of proximal end of a steppe bison right radioulna (*B. priscus*, CMN 46320; now CMC KlVj-13:1) from Dawson Loc. 63 (Nugget Gulch, a tributary of Eldorado Creek) showing a ring crack just below the proximal articular surface of the radius perhaps made by a person wielding a cobble-size hammerstone trying to expose the marrow. The focused blow resulted in a spiral fracture extending through both the radius and the ulna. E. Detailed view of the ring crack. Radiocarbon dated to 30 810 ± 975 BP (Beta-33192, ETH 5900). F. Proximal end of a caribou (*Rangifer tarandus*) antler beam with a multifaceted (five facets, each of which differs in orientation of linear striae), polished head (formerly my CMN field number CR-71-28; now CMC NbVl-2:6) from Old Crow Loc. 29 evidently resulting from use as a pestle, or as a tool for preparing hides, by humans. Radiocarbon dated to 24 800 ± 650 BP (CRNL-1233). G. Modified caribou (*R. tarandus*) antler beam, interpreted as a flintknapper's punch, was collected at Hunker Creek (63°55′N, 138°52′W) near Dawson City, Yukon Territory. This bullet-shaped punch had a big flake struck from its larger, slightly rounded upper surface – presumably when it was hit with a hammer-like object during the percussion flaking of stone tools. Radiocarbon dated to 11 350 ± 110 BP (Beta-27512, ETH-4582). H. Gray chert biface, presumably used as a spear tip. From CMN collections at Old Crow Loc. 138. Presumably of Lateglacial age. All of these specimens but the first were collected by the author.

5. Conclusions

Most of the following conclusions are based on Table 1.

1. Yukon Pleistocene vertebrate fossils include at least 8 species of fishes, 1 amphibian, 41 species of birds and 83 species of mammals. They extend in age from the earliest-known fauna at Fort Selkirk (about 1.6 Ma) to the Little John Site (about 10 000 BP).
2. Early Pleistocene faunas are characterized by the following extinct species (Table 1): Beringian whitefish, plains shrew, giant pika, Hopkins' lemming, Deering vole, Deceit vole, primitive vole (*Allophaiomys deceitensis*), Jackson's weasel, hyaena, and southern mammoth. Caribou (which still survive in the Yukon Territory), ground squirrel, collared and brown lemmings and their relatives, as well as giant pika have had a particularly long duration. Further, a compressed beaver dam in the basal unit of Porcupine Loc. 100 indicates beavers (Castoridae) have been present for nearly 2 million years in the northern Yukon.
3. Faunas considered to be of Middle Pleistocene age include: masked shrew, giant pika, chipmunk, ground squirrel, collared lemming, brown lemming, Matthews' vole, Morlan's vole, an unknown species of weasel (*Mustela* sp.), wolf, another canid (*Xenocyon lycaonoides*) and steppe mammoth. The last species and the voles may characterize faunas of this age. It is worth noting that horses like *Equus verae* and *E. lambei* have had a particularly long duration since the Middle Pleistocene. Soergel's muskox may also have appeared in the Yukon Territory as early as the Middle Pleistocene (Harington, 1989a).
4. Vertebrate remains collected from reworked lower lake beds of Old Crow Basin thought to be of Illinoian (or earlier) age comprise: broad whitefish, inconnu, longnose sucker, ducks and geese, ptarmigan or grouse, giant pika, American pika, snowshoe hare, Arctic hare, Arctic ground squirrel, American beaver, giant beaver, collared lemming, brown lemming, muskrat, singing vole, tundra vole, wolf, Arctic fox, mammoth, large horse, large camel, caribou and Soergel's muskox (see 3.)
5. Faunas of Sangamonian interglacial age include: broad whitefish, Arctic grayling, pike, longnose sucker, burbot, American Widgeon, Oldsquaw, ptarmigan or grouse, Snow Goose, shorebirds, perching birds, wood frog (the earliest record of a species that still lives in the Yukon Territory), shrew, Jefferson's ground sloth, giant pika, American pika, snowshoe hare, Arctic hare, Arctic ground squirrel, American beaver, giant beaver, collared lemming, brown lemming, red-backed vole, white-footed mouse, wolf, Arctic or red fox, black bear, ermine, fisher, wolverine, short-faced skunk, American mastodon, woolly mammoth, large horse, large camel?, western camel, moose, caribou, bison and muskoxen. Several of the extinct species probably originating in more southerly parts of North America, such as Jefferson's ground sloth, giant beaver, short-faced skunk, American mastodon and western camel may have reached the northernmost part of their range during this relatively warm phase of the Late Pleistocene, although the giant beaver may have arrived slightly earlier. For a perspective on vertebrates of the Sangamonian interglacial in Canada see Harington, 1990b.
6. The larger, better-known Wisconsinan faunas are dominated by the characteristic Mammoth Steppe species, such as steppe bison, horse (especially the Yukon horse), woolly mammoth and caribou. Wisconsinan deposits have also produced well-preserved carcasses or fragmentary carcasses of black-footed ferret, Arctic ground squirrel, Yukon horse and steppe bison. Indirect evidence of humans, including modified mammoth, caribou and steppe bison bone, radiocarbon dated between about 40 000 and 25 000 BP, is also an important feature of the Wisconsinan faunas. A caribou antler punch and chert biface are apparently of Lateglacial age (Fig. 12).
7. Some Quaternarists, mainly archaeologists, have supported in published form the case for human presence in Eastern Beringia between about 40 000 and 25 000 BP (e.g. the late Rob Bonnichsen, Jacques Cinq-Mars, Dick Harington, Steven Holen, the late Bill Irving, the late Dick Morlan, and the late Hansjürgen Müller-Beck). Many of their findings have been published in reputable, peer-reviewed journals and monographs. Others prefer to attribute Yukon, mid-Wisconsinan broken bones and bone tools thus described to natural geological and cryological processes such as rock falls (both from cave ceilings and down steep river banks) and breakage or polishing by ice during heavy spring runoff (e.g. Dixon and Thorson, 1984; Thorson and Guthrie, 1984); trampling by mammoths (Haynes, 1991), and cracking or crushing of bones (probably not massive mammoth bones) by the powerful jaws and teeth of such animals as giant short-faced bears and wolverines. Nevertheless, in most cases, the authors mentioned above have been careful to explain why causes other than human modification of bone were unlikely. The authenticity of the discovery of the 23 500 BP mammoth limb bone core and flake, found *in situ* in the lower loess deposit of Bluefish Cave II (Cinq-Mars and Morlan, 1999) has not specifically been disputed. Even Haynes agreed in 1984 that none of the examples of fragmentation from elephant trampling caused by drought-induced crowding around African waterholes thus far approaches the complexity of the mammoth bone core and flake recovered from Bluefish Cave II or some of the evidently human-modified cores from Old Crow Basin (Cinq-Mars and Morlan, 1999, p. 206; Morlan, 2003b, pp. 126–128). One of the greatest weaknesses of evidence for mid-Wisconsinan humans in the Yukon is the lack of actual sites or living floors dating to that period. Perhaps such evidence may be found eventually (where sediments are less disturbed by working and reworking) on higher ground near the margin of Old Crow Basin, or on one of several deeply-buried grassy terrain surfaces found near Dawson City dating to about 30 000 BP like that at Nugget Gulch.
8. Not only are patterns being noticed in the techniques used to modify Yukon mid-Wisconsinan bones, but in the rationale used for making them (e.g. to expose marrow, to butcher for meat and to use as bone tools). Furthermore, a rationale for the movement of early people from Yukon to the heartland of North America exists. Two modified bones from Bluefish Caves along with a series of AMS-dated mammoth bone cores and flakes from Old Crow Basin and a steppe bison radioulna from Nugget Gulch near Dawson City imply that an early phase of human tool-making, often involving mammoth bone, began in Eastern Beringia as early as 40 000 BP and ended about 25 000 BP (Cinq-Mars and Morlan, 1999; Harington and Morlan, 2002). Further, Holen's (2006) evidence for human-modified mammoth skeletons from Kansas and Nebraska in the western United States suggests an entry-route from Yukon to the heartland of North America east of the Rocky Mountains (the "ice-free corridor") before 18 000 BP. Brown bears (Matheus et al., 2004), woolly mammoths (Lister and Bahn, 2007) and steppe bison (McDonald, 1981; Shapiro et al., 2004) likely reached the southern refugium in the unglaciated United States during the mid-Wisconsinan warm period about 26 000 BP, so that route may have been feasible for humans too (Holen, 2006; Harington, in press). As a corollary, it would be useful to collect and examine carefully for signs of human working even fragmentary bones (especially mammoth bones) from mid-Wisconsinan deposits near Edmonton, Alberta.

9. The Little John Site, a Lateglacial multicomponent archaeological site in the far southwest of the Yukon Territory (bordering on the earlier Scottie Creek paleontological site) indicates penetration of Nenana–Denali Complex people to southernmost Eastern Beringia (Easton et al., 2007, 2009; Wisner, 2010). By this time, the fauna is modern (e.g. fish, swan, human, rodent, hare, wapiti, moose, caribou, and bison). The large Pleistocene mammals, such as woolly mammoths, American mastodons, horses, giant short-faced bears, steppe lions, western camels, giant moose and steppe bison, had become extinct in the Yukon Territory. Although the cause of this extinction is not known, perhaps it can be attributed to rapid climatic and environmental change near the close of the Pleistocene, exacerbated by human hunting (Harington, 1977, 1989b; Barnosky et al., 2004).
10. Valuable future work on Yukon Pleistocene vertebrates could involve (1) the search for mid-Wisconsinan sites with living floors, and for more caves like Bluefish Caves, as well as completing the excavation of Bluefish Cave III; (2) regular monitoring of sites along Old Crow River, Dawson City area, and Sixtymile for productive fossil vertebrate localities – new exposures can occur every spring; (3) more systematic analyses of vertebrate fossils for ancient DNA and stable isotopes to provide phylogeographic, paleodiet and paleoecological information on such species as American mastodons, camels, beavers and giant beavers, ground sloths, badgers, etc.; (4) more radiocarbon dates, including more precise AMS dates, on various taxa in an effort to ascertain times (and possible causes) of extinction of Yukon Pleistocene mammals. Presently, a new series of AMS dates on American mastodons has shown that virtually all samples are older than earlier AMS dates had indicated (G. Zazula, personal communication, 2010), and this may apply to other species. Further, where possible other dating methods should be applied to Yukon Pleistocene faunas.

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