

Microfauna at Tse'K'wa: Paleoenvironmental Reconstruction in the Peace River Region, Northeast British Columbia

by

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ABSTRACT

The transition from the late Pleistocene to the early Holocene is known to have been a time of dramatic climatic and environmental changes, however there is still much that is not known about this period in North America. The Peace River Region of Northeast British Columbia is especially interesting because it is located in the hypothesized biogeographic corridor, allowing previously uninhabitable land to become open for colonization by plants, animals and humans at the end of the last ice age. Tse'K'wa (formerly known as Charlie Lake Cave), is a unique site within the Peace River Region that has well preserved fauna, well stratified and dated layers, and spans the late Pleistocene/early Holocene transition. This study uses the Tse'K'wa microfauna to understand local and regional environmental change, and its implications for human occupation in Northeast British Columbia. This study examines vertebrates deposited at Tse'K'wa between about 10,500 and 9,000 BC. A sequence of four assemblages documents a change from open to forested habitats, as well as the development of local wetlands. The nature and timing of these faunal changes correlates well with palynological studies.

Keywords: Tse'K'wa; Charlie Lake Cave; Northeast British Columbia; Peace River Region; Late Pleistocene/Early Holocene Transition; Paleoenvironments

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Chapter 1

INTRODUCTION

One of the fundamental questions of North American archaeology is the role of the environment in the arrival of Paleoindians in the Americas. Because the first people probably arrived in the Americas during the last ice age, a particular focus has been on the viability of various routes. The Peace River Region has become central to these studies since it is located in the middle of the proposed Ice Free Corridor (IFC), a proposed route between ice sheets that allowed early people to gain access to the continents south of the glaciated landscapes of the north.

Tse'K'wa (formerly known as Charlie Lake Cave) is an important archaeological site because it is located in the IFC, is one of the few sites that predates 10,000 cal BC, spans the entire transition from Pleistocene to modern environments, is well stratified, and exhibits excellent preservation of faunal remains, particularly the small fauna (Driver et al. 1996). Some of the microfauna from Tse'K'wa have been studied (Driver 1988, 1998a, 1998b, 1999a) but other assemblages have not yet been reported. Understanding the microfauna can provide insights to early environments in Northeast British Columbia because their small body size, reproductive capacities, and ecological requirements make them ideal for paleoenvironmental studies (Hadly and Barnosky 2009; Rowe and Terry 2014; Rickart et al. 2011). Because of their short life spans, rapid reproduction and inability to migrate, it is easier to see if these small mammal species are increasing or decreasing through time, thus indicating possible environmental states. For this study, we focused on the microfauna in an attempt to further understand

environmental change at Tse'K'wa. Overall, the approach of this thesis works under the assumption that different taxa have different environmental requirements and so the faunal community at Charlie Lake will change to reflect variations in the environment.

This thesis will expand our knowledge of environmental conditions under which early peoples colonized the post-glacial landscapes of Northeast British Columbia. By looking at the well-dated, excellently preserved faunal remains, this thesis hopes to look at regional changes in post-glacial environments in order to infer conditions of the corridor region during the late Pleistocene/early Holocene transition. In addition, this research hopes to add to our understanding of the early history of local First Nations and the peopling of Northern North America.

This thesis will attempt to compare and integrate the data from Tse'K'wa to the rest of the region's environmental and archaeological history. There is a lack of comparable archaeological sites in the Peace River Region that makes it difficult to understand the relationship between environmental changes and the movement of humans in the region.

The thesis is organized in the following manner: chapter 2 is a background chapter. This section of the thesis gives an overview of the environmental, ethnographic, and archaeological setting for the Peace River Region. It discusses the current environment as well as the environmental history of the site. The Peace River Region has a history of rapidly changing landscapes, glacial and post-glacial influences, and a transition from an ice-covered landscape to a more modern forested environment. This transition has been extensively studied in an attempt to understand the role of the IFC in human migrations to the Americas, though the timing of deglaciation as well as

other details have been heavily debated. This study does not focus on these debates, but rather provides more local details of deglaciation. Chapter 2 also reviews the ethnographic history of the region, focusing on the Dane-zaa who are a prominent First Nations group that still live in the area and currently own the Tse'K'wa site. This section of the chapter also discusses sustenance, group size, and Dane-zaa yearly rounds through the region. Finally, Chapter 2 discusses the archaeological setting of the Peace River region. This discussion also includes an overview of the different archaeological models outlining possible migration routes for early Paleoindians arrival in the New World. In addition, I summarize recent CRM work. This overview includes a summary of archaeological, genetic, and other evidence that has been found to date. Finally, this section discusses some of the issues archaeological study faces when it comes to the Peace River region, including site visibility and preservation, dating complications, and a constantly shifting landscape.

Chapter 3 focuses on Tse'K'wa itself. It gives an overview of the site's location and formation and summarizes past publications on the site. An excavation history is given, starting with the site's discovery in 1974 and the full excavations in 1983, 1990, and 1991. The importance of the site to Paleoindian archaeology is discussed. The site's stratigraphy is also described but focuses on the lower subzones that are relevant to the study (Zones I-IIIa). Next, cultural components are summarized from Handy's (1993) thesis. This section also summarizes Driver and Vallières (2008) study of the bison found at the site and their hypotheses of site use. Next, the chapter summarizes ancient DNA (aDNA) studies on the bison assemblage done by Shapiro et al. (2004) and Heintzman et al. (2016), as well as a recent study on environmental DNA (eDNA) from

the sediments in Charlie Lake itself (Pedersen et al. 2016). These studies discuss dispersals of bison and the transition from glacial to post-glacial landscapes, and add to our understanding of deglaciation in the Peace River region. Finally, this section gives an overview of the radiocarbon dates that have been gathered for Tse'K'wa. As a result of the site's excellent preservation, there has been a lot of work done on the radiocarbon dates that provides a clear picture of the site's consistent use since 10,500 cal BC. These dates have been helpful in clarifying the Zones and Subzones and allowed a distinction between these layers that proved useful for understanding the microfauna at Tse'K'wa.

Chapter 4 is dedicated to procedures for collection and identification of faunal remains. It begins by discussing the methods used in excavations that were reported in site reports and publications. This includes the size of units that were excavated, and collection of the fauna from the site. Next, identification procedures are discussed and this includes a discussion of the specimens that are included in the study, their provenience, and the significance of small mammals. Finally, Chapter 4 describes the taxa that were found. The habitat requirements, modern distributions and other information are summarized for each identified bird and mammal species. More importantly, it is stated whether or not the species is still present in the region today or if they are perhaps extirpated from that region. In the case of the microtine specimens, the mandibles played a major part in the identification of species; as a result, this section includes comparative photos of the archaeological specimens and modern specimens. These photos help to corroborate the identifications made of the microtine species.

Chapter 5 is a continuation of methods as well as data analysis. It begins by discussing taphonomic influences that may be present at the site and were noted on specimens. These influences include weathering, carnivore modifications, avian pellets, and human modifications such as burning and butchering. Next, sample size is discussed; this section shows that, while sampling may always be an issue in paleoenvironmental studies, the microfaunal assemblage at Charlie Lake has an adequate sample size to work with. This section also gives more details of the analytical methods. It discusses the use of presence and absence data, as well as discussing why Number of Identified Specimens (NISP) was used but Minimum Number of Individuals (MNI) was not. Finally, Chapter 5 provides an analysis of the small fauna at Tse'K'wa. The analysis includes an assessment of local habitats and evidence of change through time, with a comparison to pollen core and eDNA data from nearby Charlie Lake (Pedersen et al. 2016).

Finally, Chapter 6 provides a summary of the main findings of the thesis and the conclusions made from the analysis. This chapter also discusses potential future work in the region.

Chapter 2

BACKGROUND

This chapter provides a background to the study area. First, the Peace River Region will be defined and modern environmental conditions of the area will be described. I then introduce the traditional way of life and history of the local First Nations. I summarize the glacial history of the region, with particular attention to the final glacial and post-glacial periods, followed by a short summary of regional archaeology and its results.

2.1 The Peace River Region Today

Tse'K'wa is located in the Peace River region of northeast British Columbia (Figure 1). The study region is defined as the area north of Fort St. John, as far as the Beatton River with Grande Prairie, Alberta as the southern limit (Figure 2 and Figure 3). To the west, the Rocky Mountains act as another boundary while the northward bend to the Peace River is the eastern boundary.

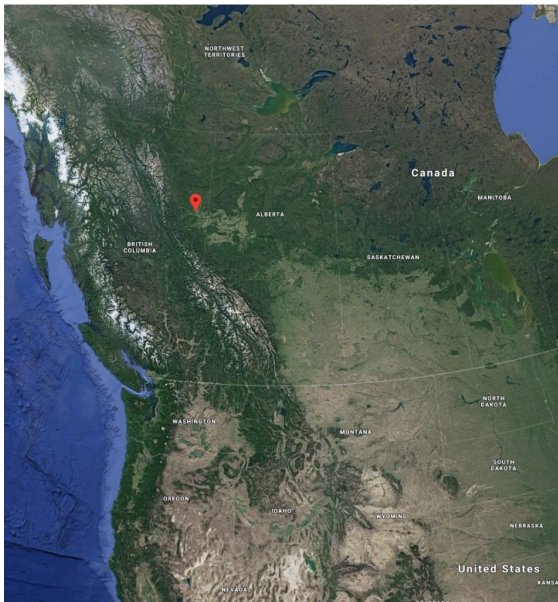


Figure 1 Location of Tse'K'wa

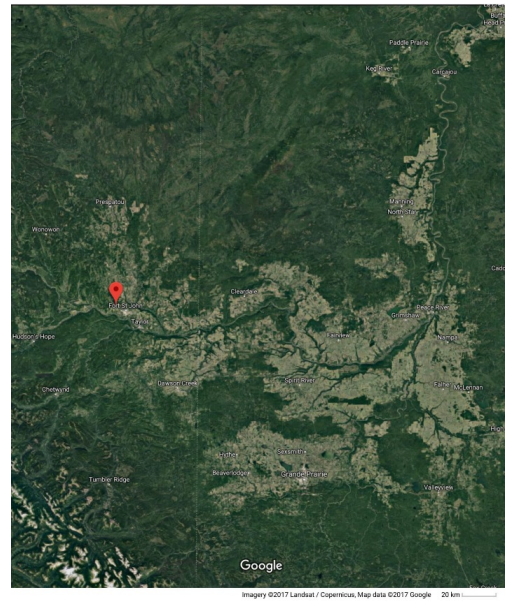


Figure 2 Close up of the study area

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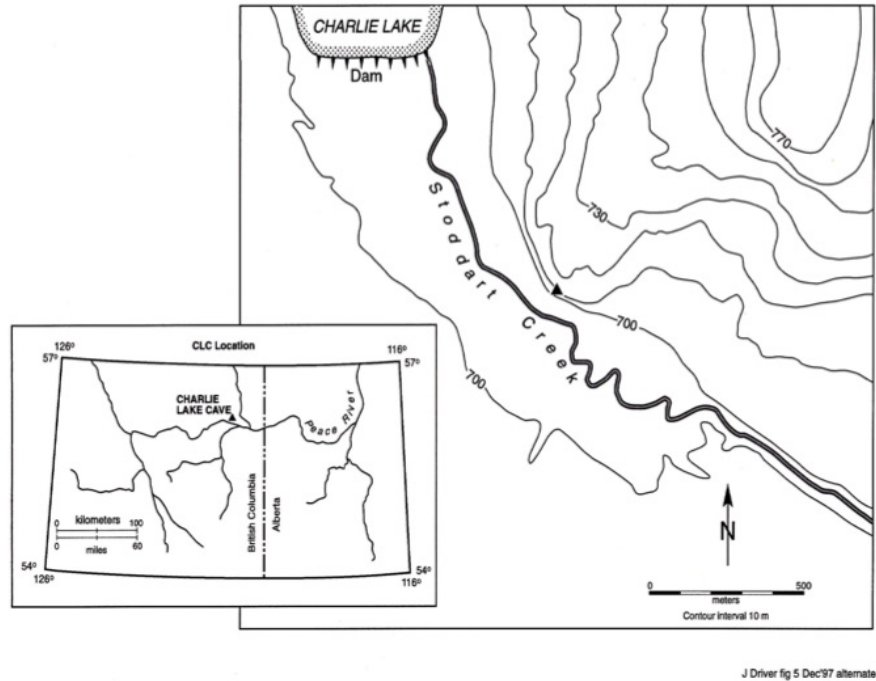


Figure 3 Topographic view of Tse’K’wa and Stoddart Creek

The bedrock geology of the Peace River Region contains sedimentary rocks (Cretaceous) (Hartman 2005:7). Recently, dinosaur tracks have been found in the region and date to the Early Cretaceous period (The Canadian Press 2016, Hume 2016). The bedrock is composed of “nearly horizontal sandstone and shale... [and] lies within a few feet to a few tens of feet of the surface” (Matthews 1983:2). Surface exposure of this sandstone is rare, although Tse’K’wa is located in a sandstone escarpment (Driver et al. 1996). Bedrock is overlain by Pleistocene deposits, including till, outwash gravels and glacial lake silt. These deposits and their subsequent modifications result in most of the modern topography. Surficial materials contain rocks that originate from both the Rocky Mountains and the Canadian Shield; this shows that both Cordilleran and Laurentide glacial systems influenced the region during the Pleistocene (Bobrowsky and Rutter 1992:14).

Rivers in the region cut through the landscape before the last glaciation, in many cases into the bedrock, and they create the overall appearance of the landscape as a plateau with hummocky terrain incised by paleovalleys (Clague and Hartman 2008:551-556; Hickin et al. 2008). Many of these paleovalleys are visible today and, upon closer inspection, have provided insight into the region's deglaciation. The paleovalleys were separated into the earlier and later paleovalley system and are wider than today's valleys (Clague and Hartman 2008:552). The upper paleovalley system is not as well preserved, but it was determined to be wider than the lower paleovalleys (Clague and Hartman 2008:552). Matthews (1978) determined that the wider paleovalleys developed over a long period of time. In addition, the paleovalleys showed that they were infilled with successions of glacial, interglacial, and preglacial deposits (Hickin et al. 2008) and some valleys were reoccupied more than once, such as the Prophet River valley (Trommelen et al. 2005). These paleovalleys show a west to east orientation, indicating that the paleo-rivers were flowing from the Rocky Mountains, much like today. The Peace River valley is a modern valley that was formed during the last deglaciation when Glacial Lake Peace drained (Hartman and Clague 2008). More recent features of the region's river valleys show slumping and instability (Leslie and Fenton 2011:14). Landslides that have become common in the region characterize this instability. These landslides are not new phenomena, however; landslides have been occurring throughout the Holocene (Morgan et al. 2008:1220).

Sand dunes are also present in the southern end of the region. These developed as a result of the draining of the glacial lake that dominated the region when unconsolidated silt and sand were exposed to wind erosion (Leslie and Fenton 2011;

Hickin 2013). These dunes are typically made of sand and silt and are part of the aeolian features in the region. The dunes, valleys, rivers, and hills have provided a dynamic environment with elevations that range from 326m asl to 838m asl (Leslie and Fenton 2011:1).

Glaciofluvial units form undulating and elongated ridges. These units are associated with both the moraine and glaciolacustrine deposits which altered the unit (Leslie and Fenton 2011:11). Colluvial units are expressed by undulating slopes. Colluvial units include morainal, glaciolacustrine, and bedrock material and consist of sandy or clayey silt (Catto 1991:9). Fluvial and lacustrine sediments are the result of modern influences of the rivers and lakes with little to no influence from the late Pleistocene glaciers.

Organic units are associated with fens and bogs that develop above the glaciolacustrine and morainic materials (Catto 1991:10). The organic units also tend to occupy areas that are poorly drained (Leslie and Fenton 2011:9). Today the land is fertile because of the glaciolacustrine influence. As a result, there has been a lot of agricultural development in the region (Catto 1991).

The Peace River region today “is part of the white and black spruce biogeoclimatic zone which is characterized by long cold winters, short warm summers, and little to moderate precipitation in all seasons” (Alldritt-McDowell 2004). In terms of vegetation, the area is dominated by a boreal forest containing coniferous and some deciduous trees (Hickin 2013). Species such as pine, white and black spruce, poplar, fir, and birch are common in the area today. There is also the presence of alder and aspen. Other species of plants found in this region include cranberries, Canadian buffalo berries, wild roses, reed grass, fireweed, feather mosses and various other plants (Bliss et al. 2015).

The region also transitions into an open grassland with specialized grasses. These include sand grass, sand dropseed, and wild barley. Sedges, bulrushes and cattails are also common in the wetter environments (Bliss et al. 2015). An extensive list of the plant species found in the region can be read by the study conducted by BC Hydro for the Site C Hydro Project (Simpson et al. 2009: 297).

Describing the avian life in the Peace River region is more difficult since these tend to be migratory species, and the region is a migration route. However, some of the species include various species of passerines, such as common ravens, American crows, blue jays, a variety of sparrows, warblers and swallows. Water fowl can also be found in the region, including species such as ruddy ducks, geese, and teals. Western grebes, grouse and pigeons can also be found as well as the common nighthawk.

Charadriiformes species includes a variety of gulls and terns, killdeer, a few species of plover and sandpipers. Owls can also be found in the region and include snowy owls, barred owls, northern pygmy owls, great horned owls, short-eared owls and others. A full list of Peace River birds can be found at the Avibase's Bird Checklist (Lepage 2017).

The Peace River region is rich in diversity not only when it comes to bird species, but also mammals of which there are 59 species (Chillborne 2009). Some of the well-known mammals includes ungulates such as white-tailed deer, moose, and elk. Other large mammals include black bears and grizzly bears, coyotes and also a few wolves. Among the rodent species, there are squirrels, muskrats, packrats, beavers and various species of voles such as the southern red-backed vole, meadow voles, and the long-tailed vole. Lagomorph species are represented by snowshoe hare while Canadian lynx and the North American cougar are the extent of the felid species. Mustelids such as the striped

skunk, American marten, fisher, least weasel, American mink, wolverines, river otter, and stoats are also found in the region. There are also several species of bats. These species are often listed by conservation groups who are interested in preserving the biodiversity of the region that is endangered by Site C (Cassells 2016; Chillborne 2009).

2.2 Dane-zaa First Nations

There are six different First Nations communities in northeast British Columbia (Table 1): The Saulneau, the Cree, the Sekani, the Slavey, the Chipewyan, and the Dane-zaa (Ridington 2013). Two of these First Nations (Saulneau and Cree groups) moved into the region during the colonial period. The Sekani, Slavey, Chipewyan, and Dane-zaa First Nations have lived in the region for much longer, pre-dating European contact. These groups have a long-standing connection to northeast British Columbia and the Dane-zaa's oral traditions depict a long-standing occupation of the Peace River Region and association with Charlie Lake (Brody 2004).

First Nations	Subgroups	Language Family	Arrival Estimate
Cree	the Plains the Woods Swampy Moose James Bay	Algonquian	Postcontact Migration (18 th /19 th Century)
Dene	Chipewyan Dane-zaa Slavey	Athabaskan	Precontact
Saulteau	Ontario Saulteau Manitoba Saulteau Western Saulteau	Algonquian	Postcontact Migration (18 th /19 th Century)
Sekani	Kwadacha McLeod Lake Tsay-Keh Dene	Athabaskan	Precontact

Table 1 First Nations of Northeast British Columbia

Prior to settlement in Reserves, the Dane-zaa made seasonal rounds from the Rocky Mountains in the west to Grande Prairie, Alberta in the east (Ridington 2013). In the spring and summer, different bands would come together for gatherings in the northwest of the region. At this time, beavers were hunted and berries were picked (Ridington et al. 2007). The locations of these gatherings are also important to note because they occurred in the Peace River Region.

In the spring, Charlie Lake became the focal point of resource procurement for the Dane-zaa who camped in the region to fish (Ridington 2013:238). Post-colonial spring rounds were a time for fishing, beaver hunts, and maintenance of gardens (Ridington 2013; T8FNs 2012). The gatherings in summer also took place in the Fort St. John area and was a time of leisure where fish and berries were often abundant and collected for subsistence. These gatherings allowed trade, matchmaking, ceremonies and other important social activities (T8FNs 2012). These gatherings are critical in the Dane-zaa

way of life and Ridington (2013) has also observed that these gatherings increased group size as the Dane-zaa came together at this time.

In the fall, group size decreased again into small bands to hunt moose, waterfowl, and small game (Ridington et al. 2007). Bison, too, was once an important part of Dane-zaa subsistence. Archaeological evidence shows “extensive burning, which indicates that the Dane-zaa and their ancestors intentionally managed the grassland habitat to support a stable bison population” (Ridington 2013:70). Feasting was also an important activity in the fall for the Dane-zaa (T8FNs 2012). Ethnographic studies also give insight to gender roles found in Dane-zaa hunting. A division between male and female roles still exist, however women have been documented to participate in the hunts of small animals (Brody 2004).

In winter, trapping becomes the method of food procurement among small family groups. Trapping large hare provides another important resource for the Dane-zaa First Nations (Goddard 1916:214). It is important to note that these seasonal rounds were not fixed. “Seasonal rounds shifted each year according to the location of game” (T8FNs 2012:27). That being said, land is an important part of Dane-zaa lifeways. Many Dane-zaa groups wintered in Clear Hills or Grande Prairie.

“Ties to the land, meaning all of their traditional lands... are inexorably tied to who [the Dane-zaa] are, how they live, and how they think” (T8FNs 2012:25). While their rounds may have shifted, the region that the Dane-zaa inhabited holds meaning to their culture. Traditionally, they lived on both sides of the Peace River (Goddard 1916), however the arrival of European settlers changed this as well as many other facets of

Dane-zaa life including hunting as well as the relationship they had with other First Nations in the area.

Hunting was affected first by the fur trade which dominated the area in the 18th and 19th centuries. The demand for fur at the time was high, partly because of the decline in the Russian trade due to overexploitation (Ridington 2013). The New World had abundant fur-bearing taxa that Europeans quickly began to utilize and trade began between the groups. The Dane-zaa traded furs in exchange for guns; this then led to more successful hunts and a shift from traditional strategies (T8FNs 2012). This was not the only change that the fur trade brought, however. Much like Russia, the kill rate of the fur trade put a strain on the ecosystem, causing many animal populations to decline, so that hunting could no longer continue (Ridington 2013). The inability to fulfil the demands for fur quickly put a strain on the relationships between Europeans and First Nations until 1823 when conflict broke out at Fort St. John. Robin and Jillian Ridington (2013) document the conflict between a Native hunter who wanted to go back home to care for his family rather than continue hunting for fur. The European traders, however, would not let him go and poisoned him for trying to leave (Ridington 2013). The relationship between Europeans and the local First Nations were always strained, however the conflict escalated their differences. Retaliation and revenge killings as a result of the 1823 conflict put an end to trading at Fort St. John (Ridington 2013). Because the Dane-zaa had come to rely on trade with white traders, the group suffered much hardship until trade was reopened in Alberta in 1828 (T8FNs 2012:53).

European contact also created conflict between the Dane-zaa and their neighbors. The Dane-zaa were once closely linked to the Sekani group (Brody 2004:22), although

the Chipewyan and Slavey are also indigenous to this region. The only groups in the area that are not Athapascan-speaking are the Cree and Saulteau First Nations; the relationship between the Dane-zaa and the Cree were already strained prior to contact where they shared a border, but European presence pushed Cree bands further into Dane-zaa territories. Cree were porters, guides, and middlemen for the traders before the Dane-zaa, and as a result acquired firearms (Brody 2004). The firearms quickly gave the Cree an advantage over the Dane-zaa. As a result, the Cree pushed westward, partly driven by Europeans, which then displaced Dane-zaa groups (Goddard 1916). This westward push had a domino effect on Dane-zaa relations to their neighbors. The Dane-zaa once lived on both sides of the river however the movement of the Cree pushed the Dane-zaa into Sekani territory. Where once peaceful relations had been maintained, conflict with each other now existed (Ridington 2013).

The river became a focal point in the conflict with the Cree. Violence continued between the groups, however the situation often shifted. "[When] the Dane-zaa eventually acquired guns, the Cree were undermined by a smallpox epidemic" (Ridington 2013:99). The escalated violence, propelled by European contact, nearly decimated both groups until they decided to reconcile. The Dane-zaa and Cree both came to an agreement that the former would continue to live north of the river, while the later would stay to the south; subsequently, this is how the Peace River received its name (Ridington 2013). The change in Dane-zaa territory in the late 19th century was not only the result of movements between the Cree, Dane-zaa and Sekani. The influx of settlers at this time also impacted the relationship between the Dane-zaa and their traditional lands.

Prospecting became a major factor in the 1880s as more settlers flooded northeast British Columbia in search of gold (Ridington 2013). Because the Dane-zaa were already experiencing hardships from their conflict with the Cree and fur traders, the increase of settler trespassing for gold was the last straw and the Dane-zaa demanded a treaty (Ridington 2013). Treaty 8, which was signed May 30, 1900, resulted in the Dane-zaa forfeiting control over their land to the Canadian government with the promise that the Dane-zaa and other groups could continue their traditional way of life (Ridington 2013; T8FNs 2012). The Canadian government divided the land from the treaty into trap lines, encouraging First Nations to register trap lines which many families maintain even today.

Unfortunately, Treaty 8 was not the end of land disputes. After World War II, a sacred site called Suu Na chii k'chige was sold as compensation to veterans by the Department of Indian Affairs (Ridington 2013:282). The tribe tried to regain control over the land in the 1980s with the argument that the DIA gave the land rights away, knowing the region was full of wealth, and without providing full compensation to the tribe (Ridington 2013). The Dane-zaa took the case to court where it was agreed that the tribe deserved compensation and the sale of mineral rights were a violation by the DIA. Suu Na chii k'chige, however, was not given back to the tribe (Ridington 2013).

The issues with land use have continued into today. The land is rich in oil resources and so conflict between oil industries and the First Nations has occurred. "The oil and gas industry did not respect Dane-zaa rights. Companies constructed wells, seismic roads, and compressor stations without consultation. In the process, they often obliterated traditional village sites, graves, and trapping cabins" (Ridington 2013:344-

346). The relationship has been improving between the two, but the pressure to sell their land for energy developments remain. There are some Dane-zaa, however, that do own oil related companies and work closely with energy developers (Ridington 2013).

Ridington (2013) calculated that there are at least 1,500 Dane-zaa members today that live in different bands. Many Dane-zaa groups have begun to participate in environmental initiatives as well as developed plans to establish a park that protects culturally and ecologically significant sites (Ridington 2013:346, 355). In addition, reviving their cultural heritage has also become important. They have opened up a cultural center in order to celebrate their heritage and have recently purchased the Tse'K'wa site with the hopes of adding it to their cultural heritage initiatives (Fisher 2012). While the history of the Dane-zaa reflect the hardships that many First Nations experienced after contact, they are working towards a better future which promotes the preservation of their culture, communities, and their relationship to the land.

2.3 Late Pleistocene and early Holocene environments of the Peace River Region

The Peace River region's dynamic topography is largely a result of late Pleistocene glaciations. Understanding the nature and timing of these glaciations is crucial to understanding the peopling of the Americas; however, it remains difficult to determine with certainty a chronology of glacial events.

Drumlins, flutes, and transverse ridges provide clues to the geologic history of the region. These features indicate the presence of active ice flowing south to southwest with erosive capabilities (Leslie and Fenton 2011). Evidence of active ice from the

southeast is also present. These are represented by moraine ridges and indicate a re-advancement of ice (Leslie and Fenton 2011:13).

The late Pleistocene influence on the region can be seen in the surficial sediments. The majority of the sediments consists of silt and clay originating from Glacial Lake Peace; the distribution of these sediments follows the drainage systems (Hartman 2005:125). Matthews (1983) recognized six groups of deposits: the early glacial fluvial; the old till; the interglacial fluvial deposits; till; late glacial deposits; and post-glacial deposits. Catto (1991) also recognized different units: glaciolacustrine, morainal, glaciofluvial, colluvial, fluvial, lacustrine, and organic. The glaciolacustrine unit usually overlies other sediments and contains five to fifteen percent sand and pebbles (Catto 1991:5). The morainal units contain silty clay and are a diamicton. These units also contain minerals such as quartz, chert, feldspar, calcite, among many others that show Cordilleran, Montane, and Laurentide sources (Catto 1991:7).

The Peace River region is located in the center of the proposed IFC. The corridor was originally defined by Johnson (1933:22) as the unglaciated region east of the Rocky Mountains through which the First Americans migrated. There are a few conditions that are needed for this corridor to be accepted. First, an understanding of the influence of the different ice sheets must be understood. Matthews (1978) proposed three glaciers: the Laurentide Ice Sheet (LIS), the Cordilleran Ice Sheet (CIS), and Montane Ice. The timing of the ice sheets' advances and recessions are still uncertain and the extent of the ice sheets are still heavily debated (Catto et al. 1996:21). Early debates about the glaciers in relation to the corridor had to do with whether or not there was even a corridor to allow the First Americans into the New World.

Matthews (1983) observed multiple advances of the LIS, suggesting that as the LIS retreated, the CIS took its place and vice versa. Identifying the advance of the LIS is crucial in these investigations, because it was once uncertain if this ice sheet advanced enough to coalesce with the CIS, thus closing the corridor. Bobrowsky and Rutter (1992) argued that there was no evidence of coalescence in the southern part of the Rocky Mountains, but the northeast of British Columbia shows signs of coalescence. Evidence for ice flow direction is shown by flutes and drumlins that trend northeasterly and parallel to the glacial flow (Arnold 2006; Levson and Rutter 1996). The coalescence of these ice sheets is also evident in the presence of an erratics train consisting of boulders that were carried by the CIS eastward and deflected south when this ice sheet coalesced with the LIS. Jackson et al. (1999) determined through cosmogenic ^{36}Cl dating that the erratics were deposited during the late Pleistocene, indicating the corridor was blocked for at least part of the Late Wisconsin.

Whether or not this was one episode of coalescence is uncertain, although Catto et al. (1996) argue that there was one coalescence event. It is generally agreed by researchers that coalescence occurred during the Last Glacial Maximum around the time when a corridor is proposed to have existed. Evidence for this was explored by Hickin et al. (2016) in which stratigraphy from the river valleys near Murray and Pine rivers supports a late age for coalescence and at least two CIS advances. In addition, they determined that the streamlined landforms in the region post-date the Last Glacial Maximum (Hickin et al. 2016: 427). Since coalescence occurred, the question then becomes when did the ice sheets retreat, and when was the region suitable for habitation. Table 2 indicates proposed and generally accepted ages of ice sheet

maximums and retreats based on radiocarbon ages. Radiocarbon ages from pollen, wood, and bone allow researchers to establish a range of dates, although it does not allow a direct dating of glacial events. The ages provided in Table 2 have been calibrated using IntCal 13 (Reimer et al. 2013) through OxCal 4.2 (Bronk, Ramsey and Lee 2013) and will be represented as cal BC. From these dates, it is thought that a corridor probably did not exist 26,000 cal BC to approximately 15,000-11,600 cal BC because the glaciers were still present in the region. Glaciers are not the only geologic event preventing migration, however.

Event	Maximum	Retreat	Source(s)
Laurentide	24,200-26,000 cal BC	14,300 cal BC	(Catto et al. 1996; Dyke et al. 2002; Ives et al. 2013; Hickin 2016)
Cordilleran	15,000-16,000 cal BC	11,800-15,000 cal BC	(Dyke et al. 2002; Ives et al. 2013)
Montane	16,300 cal BC	14,300 cal BC	(Bobrowsky and Rutter 1992)
Glacial Lake Peace	15,000 cal BC	11,600 cal BC	(Hickin 2013; Hickin et al. 2015; Munyikawa et al. 2016; White 1983)

Table 2 Glacial Influences of Northeast British Columbia

The timing of deglaciation is difficult to constrain. Researchers can only estimate the rate of melting that took place as the ice sheets receded (Mandryk 1996). Despite this, researchers have investigated the region to search for signs of deglaciation. It is suggested that deglaciation initiated in the north and south of the proposed corridor simultaneously (Arnold 2002:442). The retreat of the LIS is particularly interesting to

note. Ullman et al. (2015) suggest that between 22,000 cal BC and 9,500 cal BC, the Laurentide Ice Sheet was relatively stable, though retreat did occur at the edges of the ice sheet between 13,500 to 12,000 cal BC. As ice from the LIS began to recede, water became impounded as the ice sheet blocked regional drainage (Leslie and Fenton 2011; Hickin 2013; Mandryk 1996). This is called Glacial Lake Peace. This glacial lake was dependent on the presence of the LIS, without which the water would have continued to drain eastward (Lemmen et al. 1994:808). Table 2 also depicts a tentative timeline for the presence of Glacial Lake Peace which coincides with the retreat of the CIS. This suggests that the formation of the lake occurred as a direct result of deglaciation (Lemmen et al. 1994). It is this lake that is responsible for much of the glaciolacustrine sediments throughout the region. Evidence for the age of the establishment of the glacial lake comes from wood which was recovered between Laurentide till and overlying sediments from the lake (Hartman 2005; Catto et al. 1996). Dating of the wood, however, poses a problem because no trees would have been present if the ice was just beginning to recede and the lake beginning to form unless it washed in from elsewhere. Still, dating the chronology of glacial lakes is difficult because most of them were sterile and therefore leave little material to date with radiocarbon (Fladmark 1979).

The glacial lake signifies deglaciation and a separation of the ice sheets, but it would have presented another barrier preventing the migration of early humans. For the majority of its establishment, the lake level was relatively stable (Hickin 2013:214). The levels changed, however as the lake began to drain as a result of Laurentide retreat. Hickin (2015) mapped and dated the shorelines of Glacial Lake Peace's and determined

four Phases. With the use of optical dating techniques, Hickin suggests that the drainage of Glacial Lake Peace is consistent with the 15,000 cal BC to 11,600 cal BC dates proposed by Hartman (2005). As ice continued to retreat, channels and outlets were opened, allowing the lake to drain (Lemmen et al. 1994:825). Glacial Lake Peace lasted throughout much of the deglaciation process. Hartman (2005) noted that the lake drained in stages, perhaps some stages more rapidly than others.

Establishing a sequence for the complete drainage of Glacial Lake Peace is dependent on the presence of life in the region as drainage occurred. Woolf (1993) examined the chronology of Glacial Lake Peace using radiocarbon. Through the dating of freshwater shells at Dawson Creek, he suggested that the final phases of Glacial Lake Peace occurred between 10,250 cal BC and 9,571 cal BC (Woolf 1993:61-62). The 10,250 cal BC date coincides nicely with bone dates reported by Fladmark et al. (1988) in relation to Tse'K'wa however the shell dates may not be reliable since freshwater shells can have hardwater effects (Zhou et al. 1999, Woolf 1993). It is clear, then, that the Peace River region was habitable for humans by at least 10,500 cal BC; however, *when* the region first became open for human habitation is still uncertain.

Arnold (2006) notes two criteria in order for a potential corridor to be suitable for human migration in the Americas. Both criteria require that the region from Beringia through the corridor and to the southern part of the ice sheets be suitable for human habitation. In order to determine this, the paleoecology of the region must be taken into account, particularly the establishment of vegetation and arrival of mammals. Palynology and vertebrate paleontology have proven quite useful in understanding the sequence of ecological recolonization (Bobrowsky and Rutter 1992). The remainder of

this section will focus on the paleoecology of the region from the late Pleistocene to the early Holocene.

Revegetation in a newly deglaciated region is a long process; this is partly due to the fact that vegetation responds to environmental changes slowly (Pielou 2008:98-100). The chronology of the first plants is still uncertain, although modern deglaciation in Alaska provides insights to how this process may have occurred in the past. As the glaciers in Glacier Bay, Alaska melts, plants begin to colonize the land before the soil is suitable for most plant growth. This results in nitrogen deficient plants (Pielou 2008:89). Pielou then goes on to argue that plants may appear in the record but it is not until nitrogen fixing plants are established before conditions can improve and revegetation can occur fully. Revegetation begin with patches of slow growth until a community could be established (Arnold 2006; Pielou 2008). In addition to a slow growth, the revegetation process is continuous, meaning plant communities are constantly changing. MacDonald (1987) argued that changes in vegetation were continuous from 11,000 cal BC to 3,800 cal BC, starting from sparse coverage and steadily growing to modern conditions.

Revegetation in the north appears to have begun earlier. In Alaska, for example, pollen indicates the establishment of tundra environments between 22,000 cal BC to 15,000 cal BC (Arnold 2006:40). Faunal assemblages, however, depict steppe environments rather than tundra (MacDonald and McLeod 1996). Pollen records indicate a dry environment dominated by sedges, sage, and other grasses, creating a mosaic of environments (Arnold 2006:40-41). These grasses and shrubs continue to dominate the region east of the Bering Land Bridge until later vegetation begins to

expand. By 13,600 cal BC to 9,500 cal BC, species such as *Betula* and *Populus* begin to appear (MacDonald and McLeod 1996). The shift towards *Betula* and *Populus* has two implications. The first is a change in habitats: where once an open steppe/tundra existed, now forests were beginning to be established. This would have changed faunal distributions in post-glacial Alaska. The second implication has to do with climate.

Populus especially signifies a warmer climate compared to modern day Alaska (MacDonald and McLeod 1996).

The revegetation process in northeast British Columbia shows a similar pattern, albeit later in time. The earliest radiocarbon age so far is the same date used to establish the presence of Glacial Lake Peace at 15,000 cal BC (Arnold 2006). Evidence for revegetation also exists in the sand dunes. Hickin (2013) argues that the stabilization of these dunes is heavily influenced by the presence of vegetation. In his thesis, Hickin used OSL dating throughout the region and determined that this stabilization occurred between 12,000 BC and 10,000 BC (Hickin 2013:292-298). Stabilization of the dunes, he argues, coincides with the establishment of boreal parkland which comes later in the sequence of revegetation after the tundra/steppe environments. Thus, revegetation must have occurred between 15,000 cal BC and 12,000 cal BC. The exact opening of the corridor and the establishment of habitable environments, however, are still largely uncertain.

Much like the northern part of the corridor, there is a general agreement that the landscape of the Peace River region was initially dominated by sedges, grasses, willow, and sage after the drainage of Glacial Lake Peace (Hickin 2013; Arnold 2006; White 1983; MacDonald and McLeod 1996; Burns 1996; White and Mathewes 1986). In

addition, an ecological delay would still be present in the region, meaning vegetation would not have been established directly after the draining of Glacial Lake Peace. Pollen records analyzed by White (1983) indicate that flora may have occupied the region at 11,600 cal BC, although contamination of the sample may have made this age appear older than it actually is. Although the revegetation of the region is thought to have taken place between 15,000 cal BC and 12,000 cal BC, there appears to be a significant gap in the pollen record to describe the process of revegetation. This gap could potentially be the result of a preservation issue. Arnold (2006) noted that a lack of evidence does not equate to a lack of vegetation. Instead, vegetation would have started as sparse patches as it slowly began to colonize the area (Arnold 2006; Pielou 2008; MacDonald and McLeod 1996). The smaller percentage of plant life would have lessened the likelihood that pollen was preserved for modern study.

Further evidence of steppe grasslands in the region after the drainage of Glacial Lake Peace comes from paleontological records. Megafauna such as bison date to at least 11,400 cal BC in the Grande Prairie region (Burns 2010:38). Heintzman et al. (2016) analyzed bison specimens found across the corridor region for genetic studies and radiocarbon dating. The authors determined that the coalescence of ice sheets in the Last Glacial Maximum was the first time in the Quaternary that the corridor was not open for a biogeographic corridor; in addition, they determined that once it was opened, the deglaciated region was inhabited by bison from both the northern and southern ends of the corridor (Heintzman et al. 2016: 8061). Pedersen et al. (2016) also evaluated the environment of the region during this transition and determined a steppe vegetation with bison and mammoth 10,600 cal BC. In addition, evidence of moose and elk suggests an

open forest around 9,500 cal BC, and finally a boreal forest 8,000 cal BC. Shapiro et al. (2004) analyzed ancient DNA of bison remains and concluded that after periodic separation of bison due to coalescence of ice, Beringian bison moved south where some genetic exchange with bison in the southern end of the corridor occurred. Understanding the presence of bison is important to the study of the paleoecology of the region in relation to the peopling of the Americas because this would have provided sustenance for humans traveling through the region.

Other evidence of steppe fauna can be found at Wally's Beach Site at St. Mary's Reservoir in southern Alberta which is dated to 11,200 cal BC (Kooyman et al. 2001). This site features many megafaunal species including camels, mammoths, and even the presence of humans; most notable of these species, however, are the horse remains which further demonstrate an open environment. The presence of these indicates that the environment south of the region was suitable for megafauna, and so humans would have also been able to utilize the area. Smaller vertebrates at Tse'K'wa also indicate open environments. The presence of bison, short-eared owl, and an unidentified species of ground squirrel are consistent with open environment; this assemblage was found in Zone IIa/IIb which dates between 10,770 cal BC and 9,500 cal BC (Driver 1988:1551).

MacDonald (1987) suggests that *Betula* migrated south from Beringia, reaching the Mackenzie River Basin between 15,000 cal BC and 11,800 cal BC. Other species such as *Picea*, *Pinus*, and *Typha* appear between 11,400 cal BC and 9,500 cal BC (White 1983; MacDonald 1987b:314-316; Wilson 1996b). The arrival of these species indicates the establishment of a boreal forest. In addition, these species indicate warm

temperatures indicative of the late Pleistocene/early Holocene transition (Wilson 1996b). MacDonald (1987) suggests that from 11,000 cal BC to 4,000 cal BC, changes in vegetation halt, resulting in a continuous range of vegetation. Faunal evidence of this transition is also present at Tse'K'wa. The ground squirrel taxa disappear from the assemblage after 9,500 cal BC; around this time snowshoe hare begins to become more significant (Driver 1988:1552). After this change in fauna, the assemblage begins to resemble modern faunal distributions. Driver argues, much like MacDonald, that there is little change after this time.

MacDonald and McLeod (1996) argue that the establishment of the boreal forest marks the end of the biogeographical corridor. Because the majority of the megafauna that once existed in the region depended on the open grasslands, the forested conditions would have prevented megafauna (particularly bison) from migrating through the corridor. It is suggested, however, that there were pockets of refugia throughout the corridor where they could continue to graze (Wilson 1996b:103). Still, the arrival of the boreal forest would have limited these populations and the people in the region would have had to adapt to new subsistence patterns.

The geologic history of the Peace River region can be summarized as follows. Three glacial systems heavily influenced the area between 26,000 cal BC to as late as 11,600 cal BC. Coalescence between two or more of these glaciers is still largely not understood, although it is evident that coalescence did occur sometime in the late Pleistocene. As the glaciers began to recede, the Laurentide Ice Sheet acted as a dam, allowing Glacial Lake Peace to form; this lake would have further prevented migration through the region. As a result, Jackson and Wilson (2004) conclude that passage

through the corridor could not have been possible until at least 11,860 cal BC. Still, the question remains of when the corridor became viable and what conditions through the corridor may have been like. It is unclear when vegetation and fauna began to recolonize the region after the drainage of Glacial Lake Peace. Pollen and faunal analyses have determined that the transition from a newly deglaciated to a vegetated landscape started with what appears to be an open grassland environment until trees slowly migrated into the region. At 9,500 cal BC, the region appears to have shifted to the modern boreal forest that exists in the region today. Fauna assemblages found in the area show similar patterns. Much of the early assemblages show the presence of species adapted to open environments; as the sequence progresses, these species disappear from the record.

2.4 Archaeological Setting

The Peace River region is located in an archaeologically crucial part of the world. The question of the path taken by the First Americans has been a lengthy debate in North American archaeology since the discovery of Folsom points (Figgins 1927). In fact, the arrival of the First Americans has been one of the most controversial archaeological debates to date (Dixon 1999). As a result, there is extensive literature on the subject of potential routes and not all of them will be discussed here. This section will discuss the complications of the archaeological study of this region and review the debate of the initial peopling of the Americas. Finally, this section will review the recent archaeological evidence found within the proposed interior route.

Many articles summarize the developments of the debate (e.g. Jackson and Wilson 2004; Dixon 1999; Bradley and Stanford 2004; Beck and Jones 2010; Fiedel

2000). It was uncertain how long people had lived in the Americas until a biface was found in association with extinct Pleistocene mammals (Jackson and Wilson 2004). This pushed the arrival of the First Americans back farther than anticipated. When Clovis points were discovered, human antiquity in the Americas was confirmed as far back as approximately 11,400 cal BC (Dixon 1999; Bradley and Stanford 2004). While these important technologies helped to establish an earlier date for humans in the Americas, it was uncertain whether or not these were the earliest evidence.

Clovis points were interpreted to be the evidence of the first populations of people in the Americas, characterized by their hunting technologies (Fiedel 2000:40). Although the idea of Clovis representing the original inhabitants was popular and few sites predated Clovis, other archaeologists were not convinced. Bradley and Stanford (2004), for example, argue that the Clovis assemblages that have already been found would have taken time to develop and therefore intermediate assemblages should be present. Pre-Clovis sites are more difficult to find and the archaeological community has dismissed a majority of them. The Monte Verde site in Chile, for example, yielded dates of human occupation as early as 15,700 cal BC, although it only recently gained acceptance as a promising Pre-Clovis site (Fiedel 2000). In Florida, the recent discovery of the Page-Ladson site puts Paleoindians in Southeast United States approximately 14,000 cal BC with Clovis like artifacts found in association with mastodon, camelid, and bison remains (Halligan et al. 2016). The acceptance of the Monte Verde date has pushed human occupation in the Americas back much farther than many archaeologists had been previously willing to accept.

The traditional model of the peopling of the Americas was proposed by Johnson (1933) and is known as the Ice Free Corridor (IFC) hypothesis. According to this model, the First Americans crossed the Bering Land Bridge, following big game through an interior route between two ice sheets. "Given the existence of Beringia and the Clovis-Folsom cultures, the IFC provides the most direct route connecting the two" (Easton 1992:29). However, as the previous section has noted, the route between Beringia and the southern end of the corridor would not have allowed early human groups to reach Monte Verde by 15,700 cal BC. Another route that has been advocated by Fladmark (1979) is a coastal route to the Americas, using refugia along the Northwest Coast which was originally proposed by Heusser (1960). Archaeologists had largely ignored the Coastal Route as a potential model because it was assumed that watercraft would not have been available to Paleoindians. Evidence of watercraft in the peopling of Australia changed this notion (Erlandson and Braje 2011). Further evidence comes from human skeletal remains in Chile dated to approximately 10,400 cal BC where isotopic analyses revealed an adaptation to marine life (Jackson et al. 2012). Although this date is not as old as the Monte Verde site, the evidence shows that early marine adaptations were possible and therefore the Coastal Route is a viable hypothesis.

Bradley and Stanford (2004) suggest that the First Americans traveled across the Atlantic, following ice and subsisting on marine resources (Bradley and Stanford 2004). This hypothesis seems unlikely, however, for various reasons. The first is that the hypothesis is based largely on the premise that Clovis lithic assemblages resemble those of the Solutrean industry in Europe which predate Clovis by thousands of years (Westley and Dix 2008:86). A second critique comes from genetic evidence, which

indicates that modern Native American groups have genetic links to Asian populations (Meltzer 1993:162; Kitchen et al. 2008:4). Raff and Bolnick (2014) summarize more recent findings. In this article, the authors suggest that humans moved into eastern Beringia around 26,000 to 18,000 years ago and the genetic characteristics this population evolved is now unique to Native American populations (Raff and Bolnick 2014:162). For this reason and the fact that the interior route appears to have been closed to migration, the coastal route is the current favored model of human migration into the Americas. Rasmussen et al. (2014) analyzed the genome of the remains of an infant from the Anzick burial site in Montana, dating to 10,750 cal BC. The analysis found that the sample Anzick—1 is more closely related to populations in Central and South America rather than Asia, adding more evidence to this south-to-north migration (Rasmussen et al. 2014; Skoglund and Reich 2016).

The genetic evidence also created controversy in the peopling of the Americas debate. It is uncertain when these populations initially diverged and whether or not the genetic evidence reveals a single episode of migration, or multiple. Kashani et al (2012) suggests that indigenous populations of the Americas diverged from Asian populations around 18,600 cal BC to 13,800 cal BC. Goebel et al. (2008), however, suggests divergence between 25,000 cal BC and 20,000 cal BC with mutations after 16,600 cal BC. The issue of genetic pause has also complicated the debate. Pitblado (2011) notes that there is evidence of bottlenecks as a result of this pause in east Beringia. She also argues that this may be the result of the coalescence between the CIS and LIS (Pitblado 2011:334). In contrast, O'Rourke (2011) suggests that the pause occurred in east Beringia. The evidence has been interpreted differently by different researchers.

Goebel et al. (2008) argues that the genetic evidence suggests a single gene pool from a single migration. A more popular interpretation, however, suggests two or more phases, beginning with a marine migration and later followed by the interior (Pitblado 2011:331). While there is certainly an issue of interpretation that complicates studies of the peopling of the Americas, there are many other issues in establishing an archaeological setting of the Peace River region.

The archaeology of the peopling of the Americas requires three criteria in order for sites to be accepted as evidence: the site is in fact archaeological; it must be *in situ*; and it must be dated with indisputable accuracy (Meltzer 1993:158). Finding archaeological sites that fit these criteria, however, has proven difficult. There are several challenges that archaeologists studying Paleoindians face; these include the dating problem, the issues of site visibility, and the scarcity of data.

Dating has always been a complication for archaeologists. Dating of glacial and post-glacial events are difficult, especially with the use of radiocarbon. For the concerns of archaeology, the lack of dates is not as prevalent; rather, it is the accuracy of the dates that generally create issues in interpretations. The issue of old carbon is one of considerable concern because it has the potential to generate spuriously old dates (e.g. White 1983). Unfortunately, it is difficult to distinguish which samples are contaminated. For the region of the interior route, hard water effects and old carbon are abundant in the area, increasing the risk of contamination (Beaudoin and Oetelaar 2003:190). In addition, some materials are more susceptible to the old carbon problem than others. MacDonald et al. (1987) for example, analyzed the accuracy of dates on aquatic mosses, which had been widely available; as a result, this material was most often used

to date sites. The study concluded, however, that the aquatic mosses actually generated spuriously old dates compared to terrestrial samples (MacDonald et al. 1987:839). This would mean that many of the earlier dated pollen core sites would need to be reanalyzed for accuracy.

Site visibility is also an issue. Although the issue of not knowing what we don't know is a commonality for all archaeologies, it is particularly true for understanding the arrival of the First Americans. Material being deposited is a major factor in what is seen archaeologically. For example, South America has little evidence of the bifaces that North American archaeologists look for in Paleoindian sites, which leads to South America being overlooked in discussions of early human migration (Bryan and Gruhn 2003). On the other hand, most of the lithics found are in North America and thus our understanding of early Paleoindian sites may be skewed to favor a northern origin of lithic traditions. In addition to the types of materials, visibility is also affected by time. Logically, it makes sense that as time progresses visibility decreases (Muckle 2006:19). It is difficult to establish with certainty the arrival of Paleoindians in the New World because there may not be any sites visible from this time period as a result of deglaciation, sedimentation, rising sea levels, and other factors that affect site visibility and preservation.

Another issue with visibility involves population size. While genetic evidence seems to suggest a pause in migration, there is no archaeological evidence of the pause occurring in Beringia (O'Rourke 2011). In addition, Dixon (2001) argues that if human remains and the presence of humans are occurring 11,400 cal BC to 10,900 cal BC, then a population large enough to increase chances of visibility must have existed;

however, since these early groups are thought to be small hunter-gatherer bands, there is less of a chance that these remains will be found (Dixon 2001:279).

Geologic factors also affect visibility. In order to fully understand the distribution of sites relating to the peopling of the Americas, the environmental and geologic contexts must be taken into account (Meltzer 1993). The landscapes of the interior of the northwest are incredibly dynamic. Since the ice sheets receded, the landscape has undergone several changes that have direct impacts on site visibility. The process of deglaciation would result in an unstable, active landscape affecting both site preservation and location (Beaudoin and Oetelaar 2003; Beaudoin et al. 1996). In the Peace River region where landslides are common (Clague and Hartman 2008), archaeological sites run the risk of being exposed, displaced, or further buried. Finally, the geology of the region can skew our interpretation of artifacts where naturally occurring phenomena appear to be influenced by human hands (Meltzer 1993).

Unfortunately, visibility in archaeological investigations of the First Americans is quite low. For the Coastal Route, a majority of sites have been submerged due to the rise in sea level caused by global deglaciation (Mandryk et al. 2001). In the interior, Tse'K'wa is one of the few sites that meet the criteria for a Paleoindian occupation site and spans the boundary between the late Pleistocene and early Holocene (Driver 1998a:143-144). In fact, there are relatively few sites south of Alaska that predate the Holocene (Wygall and Goebel 2012:46).

After the Peace River Region had become deglaciated and open for habitation by fauna and human groups, a tentative prehistoric sequence can be summarized, however the area still lacks a well-defined sequence confirmed from numerous well-

dated archaeological sites. Paleoindian hunters using fluted points or microblades are thought to have entered the region around 11,000 cal BC from the southern end of the corridor and migrated northward (Hoffecker et al. 2016; Spurling 1980; Handly 1993). It is thought that these groups were following big game such as bison, mammoths, and other megafauna to hunt. Over time, the region's lithics became more diverse and Handly (1993) suggests that the artifacts represent different components of human occupation ranging from the Paleoindian fluted points to the side-notched projectile points of the Middle Prehistoric Period (5,500 BC to 1,500 AD) and Late Prehistoric (1,500 AD to Historical). As the region transitioned from steppe to open forest, and finally boreal forest environments, more resources became available for the people moving throughout the region, allowing a more permanent use by humans in the Peace River Region.

Over the last several decades, the Peace River Region has been subject to various developments, particularly by the oil and gas industry (Riddington 2013). The BC Heritage Conservation Act requires that archaeological assessment be completed to ensure that archaeological sites are protected from damage by such developments (RSBC 1996). These assessments are documented and published to the Provincial Archaeology Reports Library (PARL). In order to investigate the culture history of the region and to establish a chronology of dated components and subsistence information, I searched for reports containing the Borden Block number HbRf to establish which reports related to the Peace River region. These reports are summarized in Table 4. From the year 2005 to 2015, I read through the reports containing "HbRf" and recorded whether or not there were bones located at the site. Of the 185 reports from 2005 to

2015, only about 11% contained faunal remains and of that 11%, none of the specimens were identifiable.

For pre-2005 reports, I searched for reports containing the phrase “HbRf”, but instead of reading all of the reports, I checked their summaries to determine whether or not an excavation was done. If the summary contained a mention of an excavation, I then read the reports to determine whether or not faunal remains were recovered and identified. Of the 283 reports dating between 2005 and 1979, only about 3% of the reports contained excavations with faunal remains and one of these reports contained Mesozoic remains rather than late-Pleistocene remains (Walde 1992).

Type of Lithics	Number of Reports (Out of 288)
Fluted Points	5
Flakes	20
Lithic Scatter	53
Surface Lithics	2
Microblades	3
Clovis	3
Cobble	1
Lanceolate	10
Debitage	1
Paleoindian Points	1
Projectile Points	2
None	187

Table 3 Lithic Types from Pre-2005 Site Reports

A majority of the lithics found at the sites from 1979 to 2015 were flake scatters, although a few site reports noted the presence of microblades, microblade cores, leaf-shaped blades, and fluted points (Table 3). One site, labeled 2005-110, in Northeast British Columbia produced obsidian flakes that were labeled as being either black or green (Kristensen and Downey 2005). Due to the poor preservation of the faunal

remains, there were no radiocarbon ages to create a stratigraphic understanding of prehistoric British Columbia and less than 10% of reports mentioned charcoal though very few of these reports used charcoal for radiocarbon dates (and those few with charcoal were rarely older than a few thousand years). This review of the regional archaeology only further shows the importance of Tse’K’wa as it is one of the few archaeological sites that have preserved specimens within a stratigraphic context.

Reports	Number of Reports	Faunal Remains
Pre-2005	288	3%
2005-2015	185	11%

Table 4 Site Reports in Northeast British Columbia

Over 450 archaeological studies of the HbRf block have resulted in very little evidence for the cultural and environmental history of the Peace River region. Although these sites do not provide much evidence for environmental reconstructions, there still remains the possibility that some sites have yet to be found (Muckle 2006). In the future, new evidence may be presented that change interpretations further, but it is likely that site discovery and excavation methods will have to change before that occurs.

The criteria required for archaeological sites to be accepted as evidence for the peopling of the Americas is difficult to apply to a majority of sites. Still, there are sites that have been excavated that fit these criteria. The remainder of this section will review archaeological investigations from Alaska, Yukon, Alberta, and British Columbia. There have been many excavations relating to this topic, particularly in Alaska; as a result, not all of these sites will be reviewed. Instead, I will focus mainly on recent excavations and exclude surface sites.

In archaeology from Alaska to British Columbia and Alberta, lithics play a major role in understanding early human occupations. As a result, typology is a major factor in prehistoric archaeology. This typology generally places lithic assemblages into cultural complexes and traditions; however, Alaskan archaeology has produced many complexes over the last sixty years, complicating interpretations. The development of these complexes has been discussed in greater detail elsewhere (e.g. Dixon 1999; Fiedel 2000; Bever 2001; Bever 2006; Carlson 1996; Dumond 2001; Goebel and Buvit 2011; Ives 2006; Mason et al. 2001; Powers and Hoffecker 1989; Saleeby 2010). It is important to note, however, that defining complexes are difficult because many of the characteristics overlap (Dixon 2001; Carlson 1996; Goebel and Buvit 2011). Table 5 depicts some of the complexes that have been proposed in the region in relation to the sites where they were found. For the purposes of this review, I will focus on the Nenana complex, the Denali complex, and Fluted Point Traditions.

Site	Tradition/Complex	Region	Ages (cal BC)	Source(s)
Tse’K’wa	Fluted Point/ Microblade	British Columbia	10,500-8,857	(Driver et al. 1996; Heintzman et al. 2016; Pedersen et al. 2016)
Vermilion Lakes	Fluted Point**/ Microblade/ Stemmed Point	Alberta	10,700-9,170	(Fedje et al. 1995)
Raven Bluff	Fluted Point	Alaska	12,000-10,000	(Goebel et al. 2013)
Pink Mountain	Fluted Point/ Microblade/ Stemmed Point	British Columbia	10,500-8,000 †	(Wilson 1989; Wilson 1996a)
KaVn-2	Denali**	Yukon	10,700-10,100	(Heffner 2001)
Anzick Burial Site	Fluted Point	Montana	10,700-10,000	(Rasmussen et al. 2014)
Wally’s Beach Site	Fluted Point	Alberta	11,200-10,882	(Kooyman et al. 2001)
Little John Site	Nenana/ Denali	Yukon	12,000-11,000	(Easton et al. 2011)
Walker Road	Nenana	Alaska	11,800-11,200	(Goebel et al. 1996)
Dry Creek	Nenana/Denali	Alaska	11,574-10,600	(Graf et al. 2015)
BEN-192	Fluted Point/ Denali	Alaska	12,500-11,800	(Goebel et al. 2013)
Broken Mammoth	Nenana/ Denali	Alaska	11,400-115	(Holmes 2001)
Bluefish Caves	Denali	Yukon	27,000*-11,800	(Hoffecker et al. 1993; Bourgeon 2015)
Swan Point	Nenana/ Denali	Alaska	12,100-1930 (AD)	(Holmes 2011)

Table 5 Cultural Traditions of Relevance to the Corridor

*Ages pertain to the site in general and not specific artifacts

** Tentative classification

† Based on artifact typology

The Nenana complex was originally defined by Powers and Hoffecker (1989). Although it was not the first complex to be defined, it is generally assumed to be the earliest. Nenana assemblages are characterized by a lack of microblades and the presence of Chindadn points (Dumond 2001). The site at Walker Road was one of the sites used to define Nenana. At this site, the assemblage was found beneath the previously defined Denali complex, suggesting that Nenana predated Denali.

The Denali complex was defined by West (1975). This complex is generally defined with wedge-shaped microcores and microblades, specialized burins, scraping tools, and lanceolate points (West 1996:303). Microblades have become a major interest in studying Paleoindian occupations of the New World. This tool type has been used to connect early Alaskans to Northeast Asia where microblades appear around 22,000 cal BC (Dumond 2001). The Denali complex is still largely misunderstood, however. Unfortunately, the variability that is associated with Denali has made interpreting the presence of the complex difficult (e.g. Bever 2001; Goebel and Buvit 2011). Although the definition of Denali is still largely uncertain, it has been considered as a potential influence on sites south of Alaska (e.g. Carlson 1996; Driver et al. 1996; Easton et al. 2011; Fladmark 1996; Heffner 2001). The site at Bluefish Caves in the Yukon, provides evidence of the Denali complex with the presence of wedge-shaped microcores, burins, and microblades, though these artifacts aren't clearly dated and there are taphonomic and stratigraphic issues that further complicate the dating of the site (Hoffecker et al. 1993; Yesner 2001).

After the Nenana complex was discovered, the general interpretation was that Nenana predated the Denali complex and microblades were a later adaptation. It is now uncertain, however, whether or not these complexes resemble a single culture or separate cultures (Wygol 2011). This is partly due to the uncertainty of the relationship between non-microblade and microblade assemblages. Wygal (2011) and Bever (2006) argues that the microblades and microcores may be an adaptation to cold environments. The complication arises from two sites where mixture of Nenana and Denali occur. The first of these sites is Swan Point, which dates back to 14,000 cal BC

(Holmes 2011). Swan Point also exhibits evidence of scavenging mammoth bone and ivory and long distance procurement of materials (Holmes 2011:167-184). It is also suggested that the site represents a small, short term campsite.

Broken Mammoth featured evidence of mixture between Nenana and Denali complexes. This site was dated 11,400 cal BC to 115 cal BC (Holmes 1996). Broken Mammoth is also interesting to note because of the association of the artifacts with extinct and extirpated mammals, particularly bison (Holmes 2001:155). In addition, the presence of a variety of fauna indicate that the people occupying this region used a wide range of resources (Yesner 2001:322). The mixture of Nenana and Denali at both Swan Point and Broken Mammoth suggests that there is indeed a relationship between the two complexes. Still, this relationship is uncertain, partly because these complexes are poorly defined (Dixon 1999; Goebel and Buvit 2011). Although these complexes were defined in Alaska, their presence can be seen farther south and towards the other end of the proposed corridor.

In addition to the Bluefish Cave Site, there are two more sites in the Yukon that display evidence of the Nenana and Denali complex such as the Little John Site. The lithic assemblage has been discussed in greater detail by Easton (2012). The assemblage contains the presence of microblade technology associated with a swan bone that dated to 9,000 cal BC (Easton et al. 2011:298). This would suggest a Denali influence although this is not the only complex that was found. “An undated component...represents the first identification of a Chindadn/Nenana complex assemblage within a stratified context to be found in Canada” (Easton et al. 2011:289). The Little John Site, then, resembles other sites in Alaska in where both Denali and

Nenana seem to be present. In addition, it exhibits a similar pattern to Broken Mammoth in that there is a wide variety of resources (Yesner et al. 2011).

The other site within the Yukon is known as the KaVn-2 site, which is located in the southwest of the province. This site dates to at least 10,700 cal BC (Heffner 2008:85). KaVn-2 yielded a small assemblage, making the interpretation of complexes difficult. Still, Heffner (2001) suggests the presence of a Denali complex at the site and may even be a transition between Nenana and Denali. KaVn-2 unfortunately had both a small lithic and faunal assemblage and does not provide much information about Paleoindian occupations.

There is also the potential of Denali influence in the middle of the corridor. Tse'K'wa, for example yielded a 9,000 cal BC wedge shaped core similar to those of the Denali complex (Driver et al. 1996; Fladmark 1996; Handly 1993). It is still uncertain if the appearance of microblades signifies the introduction of the technology to the area (Carlson 1996:9). Although microblades do appear in the southern part of the Interior Route, other traditions are more prominent in the area. Carlson (1996) identifies several early lithic tool traditions in British Columbia: the Fluted Point, the Plano, the Pebble Tool and the Microblade. There was also a mention of an Intermontane Stemmed Point Tradition, but this has not been included because it isn't as well defined or dated. The Plano and Pebble Tool Traditions, he suggests represent the arrival of Arctic people and may be similar to Nenana (Carlson 1996:9). The Fluted Point Tradition however is unique to the New World and has been a major source of evidence for Paleoindian occupation. Fluted points such as Clovis appear as early as 11,100 cal BC in the region

(Carlson 1996:7). Although the presence of these lithics is widespread, I will only focus on a few sites in Alberta and British Columbia.

Alberta features two relevant sites. The first is Wally's Beach Site at St. Mary's Reservoir. This site dates between 10,882 cal BC and 11,239 cal BC (Kooyman et al. 2001). The lithic assemblage of the site consists of mainly flakes, fragments and shatters, although a chopper, biface fragment, retouched flake tool, and a biface was also recovered from the site (McNeil et al. 2004:91). The lithic assemblage has been interpreted to be representative of the presence of Clovis and the Fluted Point Tradition. The lithic assemblage at Wally's Beach is interesting for another reason: due to the site's well-preserved features, Wally's Beach provides insight to both human and environmental conditions. The remains of mammoth tracks lacked the presence of juveniles, which suggests a decline of the species (McNeil et al. 2005). In addition, the assemblage was recovered in association with species of extinct mammals. The most interesting of these species is the horse remains which show evidence of human hunting (Kooyman et al. 2001; Kooyman et al. 2006).

Vermilion Lakes dates back as far as 10,700 cal BC (Fedje 1996). Although the early phase of the site revealed no projectile points, Fedje (1996) assumes that the time period is sufficiently old to date the site to the Fluted Point Tradition. Later phases produced stemmed points, and a backed knife that exhibits evidence of a microblade core (Fedje et al. 1995:97). Like other sites in the region, Vermilion Lakes appears to represent a short-term occupation where mountain sheep dominate the assemblage as opposed to bison (Fedje et al. 1995).

In British Columbia, the Pink Mountain site exhibits multiple occupations with multiple traditions. The lithic assemblage, as a result, includes fluted Clovis, microblades, and leaf-shaped points (Wilson 1996a: 32). Interpretations of these assemblages are difficult, however, because a majority of them were scattered across the site; many of these were surface finds or shallowly buried in unstratified, undated contexts (Wilson 1989). The fluted points that are present are similar in size and shape to Tse'K'wa specimens distinctive concave bases.

The traditions at Tse'K'wa include the Fluted Point Tradition and possibly the Microblade Tradition. Within the fluted point tradition, the basally thinned point from Tse'K'wa is comparable to those found in Alberta and Montana; this suggested a south-to-north migration into British Columbia rather than the traditional north-to-south migration (Fladmark et al. 1988:378). A microblade core was also found at Tse'K'wa in association with a complete raven skeleton, leading to the interpretation of a ritual site (Driver 1999b). These microblade cores are thought to be of northern origin, though they do appear in Southern Alberta where they are dated to the early Holocene (Driver et al. 1996).

Although the Fluted Point Tradition appears to have originated in the southern end of the Interior Route, there is evidence of fluted points in Alaska. One site, BEN-192 (Serpentine Hot Springs), features four fluted points in stratigraphic context that is associated with charcoal and bone (Goebel et al. 2013:4223). Microblades were also present the site (Goebel et al. 2013). The site has been dated between 11,800 cal BC and 12,500 cal BC based on charcoal. The fluted points themselves were dated to 12,500 cal BC, making it younger than most Clovis sites in the south (Goebel et al.

2013:4223). The fluted points at BEN-192 also represent the densest accumulation of fluted points at an Alaskan site. Goebel et al. (2013) concludes that the site is too young to be antecedent of Clovis in the south; it is unclear if this site represents diffusion or dispersal of humans northward.

The relationship between the Nenana and Denali complex and the Alaskan lithic tradition and Fluted Point traditions is still uncertain. The significance of the presence or absence of microblades at sites also creates doubts in interpretations. Wygal (2011) for example, suggests that microblades were a prerequisite for migration to the Americas and discusses the possibility that these tools were a response to harsh climates. The lithics have also been used in investigations of migrations into the Americas though it is still largely unclear what the relationship is between Nenana, Denali, and Fluted Point. The presence of microblades in the south could be the result of diffusion or migration from the north, although the presence of fluted points in later assemblages suggests a south-to-north movement. In addition, the similarities between tools from Montana to the one at Tse'K'wa also lend credibility to this northward movement.

Archaeological investigations in the study of the peopling of the Americas are difficult to conduct. Although this archaeology is subjected to many of the same issues that archaeologists in general face such as dating and site visibility, there is also the problem of a lack of reliable sites in such a broad area that interpretations vary considerably. Although archaeologists seem to sway between the Coastal Route and the Interior Route, both lack enough data to be conclusive. The question remains: how did humans reach the Americas and under what conditions? While current interpretations seem to lean more towards the Coastal Route, the fact remains that the

Interior Route opened at some point, though the nature and timing are still largely uncertain. Tse'K'wa, however, is uniquely situated in the region of the proposed corridor, which may provide further insight.

Chapter 3

TSE'K'WA (CHARLIE LAKE CAVE)

This section introduces Tse'K'wa as a source of valuable information about Paleoindians in northeastern British Columbia and the environmental conditions in which they lived. Various publications exist on the site (Driver 1988; 1996; 1998a; 1998b; 1999a; 1999b; 2001; Driver et al. 1996; e.g. Fladmark et al. 1988; Fladmark 1996; Handly 1993; Driver and Hobson 1992; Driver and Vallières 2008), focusing on the stratigraphic sequence, dating, cultural sequence, and faunal analysis. There has been an emphasis on the earliest materials from the site, but this section covers the entire stratigraphic and cultural sequence. Topics such as location, site structure and formation, history of excavations, stratigraphy and dating, and cultural components will be discussed.

3.1 Tse'K'wa

Tse'K'wa is found in the Peace River Region of Northeast British Columbia (56° 16' 35" N and 120° 56' 15" W), northwest of Fort St. John (Fig. 3), and is characterized by a series of short-term occupations throughout the late Pleistocene and Holocene (Driver et al. 1996). To the north of the site, a modern house was built which would have disturbed other potential archaeological remains in the immediate area. The site is located in what would have been the IFC and has provided insight to Late-Pleistocene environments and cultures. As stated in Chapter two, the regional geologic history describes coalescence of ice sheets and a subsequent glacial lake that would have made the site uninhabitable prior to ca. 11,600 cal BC; when these barriers were

gradually removed from the landscape, Charlie Lake and the cave would have been open for habitation.



Figure 4. The cave at Tse'K'wa and the excavated gully

The formation of Tse'K'wa is discussed in greater detail by Driver et al. (1996). The bedrock of the site is Cretaceous sandstone in which the cave was formed (Fig. 4). The cave itself is endogenous and probably formed during the last glaciation as a result of hydraulic scouring (Handly 1993: 21). Driver et al. suggest that subglacial water created the cave through eroding joints and fissures of the sandstone. The site also features a sandstone boulder called the parapet, which may have detached along a vertical fault in the sandstone after the cave formed (Handly 1993: 21).

The site also features a gully, where a majority of excavations took place (Figure 5 and Figure 6). The gully is defined by the upslope surface of the parapet and the vertical bedrock face where the parapet detached. It was formed after the parapet detached from the cliff-face, after Glacial Lake Peace drained and the area was exposed (Driver et al. 1996:266). Since the last glaciation, the gully has been filled by sediments which include both redeposited glacial lake silt from the hill above and weathered local sandstone (Fladmark et al. 1988; Driver et al. 1996: 266). The cave itself is shallow, consisting mostly of a bedrock floor with a 30 to 40 cm of unstratified sediment (Fladmark 1983). Regardless of the formation processes, the rapid sedimentation has led to a well preserved and stratified site that is beneficial to archaeological studies of early human occupations in the Americas (Driver et al. 1996: 275). As noted above, it is one of a few well-dated, stratified sites in the region, and the only one to span the Holocene and contain identifiable faunal material in any quantity.

The Tse'K'wa site was first noted by Dr. Knut Fladmark in 1974 and two visits to the site resulted in shallow test excavations. It was more fully excavated in 1983 (Fladmark et al. 1988). In this first significant excavation, twelve one-by-one meter

units were opened up and excavated in the gully and two units were opened in the cave area, though these yielded little cultural materials (Handly 1993: 4). The lack of artifacts within the cave may have been due to modern humans digging in the cave and recovering artifacts on their own (Driver et al. 1996). Despite this, a fluted point was discovered in one of the gully units. This created a buzz in the archaeological community because it was one of the few sites that provided long cultural and paleoenvironmental sequences from Paleoindian occupations to historic times that also had well preserved, datable fauna (Vallières 2004).

In 1990 and 1991, excavations led by Fladmark and Dr. Jon Driver added nine more one-by-one meter units. These excavations ranged from the Paleoindian layers to the present within the gully below the cave. A few test pits were excavated above the cave and below the parapet; most of the cultural materials were found within the gully itself or the test units above the cave.

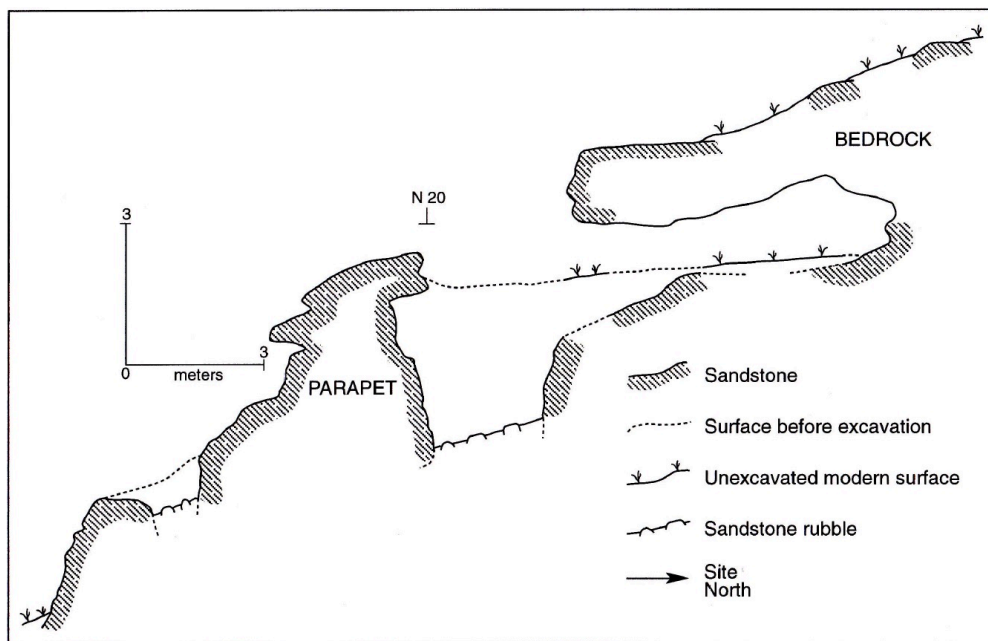


Figure 5. Diagram of the gully with depictions of the cave and parapet. Source: Driver 1999b.

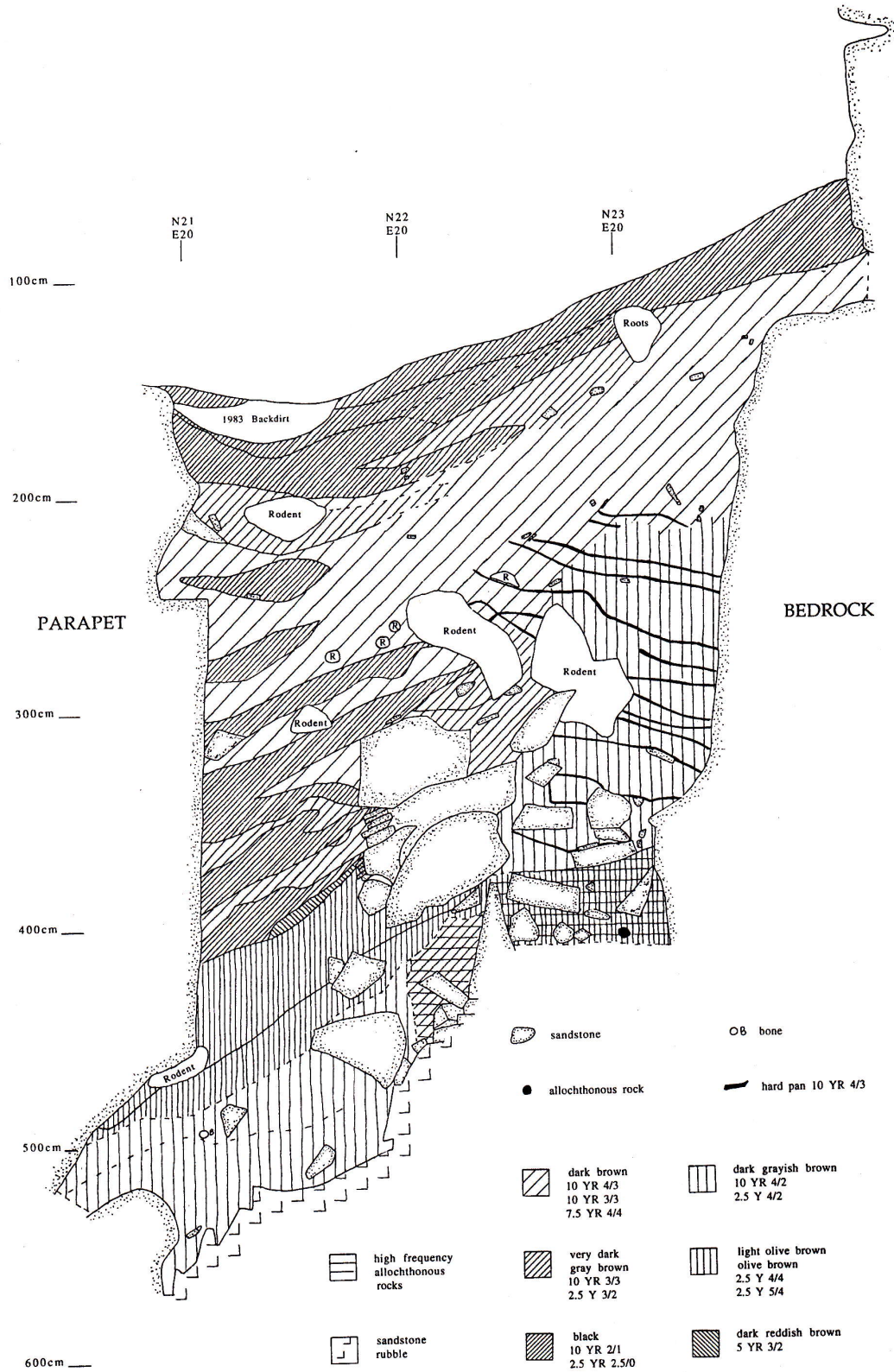


Figure 6. Stratigraphy within the gully. Source: Driver 1996.

3.2 Stratigraphy

Excavations at Charlie Lake were done in stratigraphic layers. These layers were then divided into arbitrary levels and combined into Zones and Subzones after excavations were finished. There are four Zones in total; there were originally five, but the Zone IV and V were later combined. Zone I is at the bottom of the sequence and it consists of a coarse sandstone rubble in sand, silt, and clay (Driver 1988).

Zone II is made up of a silty sediment with quartz, quartzite, chert, shale, and schist pebbles. It was further broken up into 4 subzones (IIa-IId); Subzone IIa and IIb contain the earliest archaeological materials and their sediments contain more pebbles and silt-clay with an age of approximately 10,500 cal BC to 10,000 cal BC. Subzone IIc and II d are dated later to 9,900 to 9,000 cal BC (Driver 1999a). Zone IIIa contains sandy and humic layers and has a higher organic content than the previous zones (Driver 1988).

Subzone IIIa is the only subzone from this zone that is relevant to this study and is defined by its medium fine sand. Radiocarbon dates from this Subzone gives an age of 9,490 to 7,800 cal BC (Table 6). It is Zone I through Subzone IIIa that is relevant to this study and then only Zones IIa-IIIa have faunal material that will be used in this analysis because they are the only layers that date to the late Pleistocene/early Holocene transition.

3.3 Cultural Components

The site is also defined by cultural components. There are ten components in all based on stratigraphically separated assemblages of lithic artifacts (Driver et al. 1996). Only three of these components relate to Paleoindian occupation, Components 1-3. Component 1 is associated with butchered bison and the projectile point discussed

above (Driver et al. 1996). Other material includes six retouched flakes, a bead, and quartzite core tools (Fladmark et al. 1988). Handly (1993) notes that fifty-five unformed tools were found in Component 1 as well as two exterior retouched tools, one alternately retouched tool, and two tools that showed use wear patterns. Consequently, only one formed tool was able to be recorded but it is complete and shows evidence of reworking. In addition, two cores were recorded in Component 1, and were made from quartzite.

Component 2 lacks distinctive artifacts and is characterized by a smaller assemblage. There were twenty-eight debitage artifacts, three unformed tools (which shows signs of modification but may not have been significantly changed), and one core (Handly 1993). Component 3 features 160 debitage artifacts, one unformed tool, and one wedge-shaped microblade core (Handly 1993). The core appears to have had six blade removals, though the last three blades do not appear to have been removed successfully. The microblade core is made from mottled chert and was broken obliquely with a retouched edge.

The microblade core from Component 3 was especially interesting because it was found in direct association with a partial raven skeleton (Driver 1999b). The raven was laying on its left side and is fairly complete, though none of the cranial elements are present (Handly 1993). The core was found at the feet of the raven along with a fragment of ochre that was found slightly east in the same stratigraphic zone (Handly 1993). Driver (1996) suggested that the raven and microblade core could be interpreted as a ceremonial deposit. The nature of preservation of the raven skeleton as well as the microblade and ochre could suggest intentional burial (Handly 1993).

After Component 3, there are 7 other Cultural Components that were defined, but they are not associated with Zone IIa-IIIa and are not included in this analysis. All fauna above Zone IIIa and in these other components resembles modern fauna from the region rather than late Pleistocene/early Holocene communities.

Component 1 and 2 were also strongly associated with the bison assemblage of Tse'K'wa, which includes 51 positively identified bison specimens. Driver and Vallières (2008) analyzed the bison assemblage from these components and analyzed the taphonomic processes that affected the specimens. They note that carnivore damage is the most obvious process, but it was not able to explain the preservation of limb bones which are usually attractive to carnivores (Driver and Vallières 2008: 247-248). Instead, the authors suggest several potential hypotheses for the assemblage. The first is that Tse'K'wa may have been a primary kill site; this is supported by articulated specimens, lack of burning, and little evidence of lithic production. This hypothesis is not without problems, though; there are no partial or fully articulated skeletons and a lack of crania which are typical features of a kill site. In addition, there was only one projectile point. The authors then conclude that there is not adequate evidence to support this hypothesis and it is more likely that the specimens were brought to the site from a nearby killsite (Driver and Vallières 2008).

The second hypothesis suggests that the site was residential or a butchering site. Because a large amount of the specimens were mid and lower limbs, the authors conclude that this does not reflect a maximization of meat. The authors then suggest that the long bones may have been brought to the site for bone marrow, but the

absence of femurs and other bones with a high marrow content and the lack of fragments suggest otherwise (Driver and Vallières 2008).

The third hypothesis is that the processing site was located above the gully and the specimens were discarded or moved as a result of downslope movement (Driver and Vallières 2008). The problem with this hypothesis is similar to the first two hypotheses; there is little weathering on the specimens to suggest natural movements.

The final hypothesis that Driver and Vallières suggest is that Tse'K'wa was a cache for bison limbs and write that this is their favored interpretation. They suggest that the bison assemblage from Tse'K'wa reflects a succession of utilized and abandoned meat caches (Driver and Vallières 2008). While this is supported by both bone breakage and complete specimens, there is a lack of ethnographic and archaeological data on Paleoindian caches in the Peace River Region. Still, the lack of residential evidence, the presence of heavy butchery tools in the lithic assemblage, and the nature of faunal specimens seem to support this hypothesis above the others (Driver and Vallières 2008).

3.4 Ancient DNA Analyses

Since Tse'K'wa is considered an important and unique site, it has been included in several regional studies, particularly aDNA analyses. The bison remains especially have been the focus of regional aDNA studies to determine the timing of the IFC's opening, when the region became habitable, and understanding whether or not the bison moved into the region from the north or the south of the corridor. Other DNA studies focus more on the environmental changes during the late Pleistocene/early Holocene transition and use Charlie Lake in their analyses or as a comparison.

Shapiro et al. (2004) used the bison from Tse'K'wa as part of a larger genetic study on Beringian bison within the corridor. DNA was collected from 442 bison fossils from Alaska, Canada, Siberia, China, and the lower 48 United States (Shapiro et al. 2004). The absence of faunal remains in this area suggests that the region was uninhabitable by large mammals such as bison between 26,000 cal BC to 11,000 cal BC (Shapiro et al. 2004: 1563). The authors describe different clades of bison in the corridor region including bison from the northern end of the corridor, as well as bison from the southern end. The Peace River Region was the only place to have a subset of both northern and southern bison, though it was determined that the oldest bison haplogroup came from the southern part of the corridor. Modern bison were determined to be from the southern clade of bison. These data suggest that large fauna were moving through the region from both the north and the south, and thus implies human groups would have been able to follow. It also implies that bison and humans are likely to have moved northward rather than southward as it was initially thought, which supports the conclusion that Tse'K'wa represents a northward movement of people (Fradmark et al. 1988).

Heintzman et al. (2016) produced a more recent study on bison genetics where they split their bison specimen into clade 1 and clade 2 based on their mitochondrial lineages. At Tse'K'wa, bison from both clade 1a and 2b are present and date from 10,500 to 9,500 cal BC, which implies that the region was habitable for large herbivores and modern humans (Heintzman et al. 2016). The fact that bison from the north and the south were both present in the Peace River Region suggests that the entire corridor was ice free at this time. Building on the work of Shapiro et al. (2004), Heintzman et al.

suggest that, although there were dispersals of bison from both the north and south, these were limited by changing environments in the northern part of the corridor; the open grasslands that bison prefer were already changing to a forested landscape, thus preventing further dispersal. In addition, the dispersal direction of the bison from clade 2b are less certain than that reported by Shapiro et al. (2004). These findings conclude that the corridor would not have been open for the initial movement of humans through the Peace River Region. The authors argue that the south to north movement of bison through the corridor was favored as opposed to the north to south movement.

Another eDNA analyses was done by Pedersen et al. (2016); this study collected pollen cores from Charlie Lake and nearby Spring Lake and used both radiocarbon dating, pollen, microfossils, and metagenomics DNA from cores taken from the lakes. The authors discovered that the intake of pollen indicates steppe vegetation in the Charlie Lake area approximately 10,600 to 9,600 cal BC, followed by an open forest (Pedersen et al. 2016: 46). Although these pollen cores solidify the dating of Tse'K'wa's timeline, the authors admit that a plant's reproductive process and taphonomic history may affect the data; it is possible that the region was habitable earlier but the vegetation was not identified in the pollen record. A similar issue is found with eDNA: "faunal remains from the adjacent Charlie Lake Cave... are rich in waterfowl and other birds and fish not detected by eDNA" (Pedersen et al. 2016: 47-48). This study, like Heintzman et al. (2016), suggests that the region would not have been open for the first dispersal of humans to North America, but later groups may have used the corridor to travel from Beringia to the rest of the Americas. Like Shapiro et al. (2004) and Heintzman et al. (2016), Pedersen et al.'s data were consistent with the oldest clade of

southern bison in the northern part of the corridor (which postdates 10,500 cal BC) but found no evidence that this occurred earlier (Pedersen et al. 2016).

3.5 Radiocarbon Dating

For Tse'K'wa, dating is important due to the site's location within the hypothesized IFC. As dating techniques are revised, the dates on the Tse'K'wa site are often reevaluated and refined although there are still complications that arise (see Chapter 2). Still, it is clear that Tse'K'wa is unique both in its datable fauna and the time span it presents.

Tse'K'wa spans from ca. 10,500 cal BC to the present (Driver et al. 1996; Driver 1988; Vallières 2004) and is therefore useful in understanding the changing environments that occurred at the end of the Pleistocene into the Holocene. The preservation of the faunal material makes Tse'K'wa one of the better dated sites in the region. In addition to preservation, the stratigraphy and dates are well defined. There is a good separation for ages from Subzone IIa, IIb, and IIc and this corresponds with a shift in fauna (Driver et al 1996) suggestive of environmental change. There was some evidence of rodent burrows during excavation, but these were easily identified and were generally rare, narrow, and short (Driver et al. 1996). Table 6 provides the radiocarbon ages that have already been acquired from the late Pleistocene/early Holocene Transition and represents the Paleoindian components of the site. The radiocarbon dates in the early subzones fit well with to the stratigraphy of the site. The earliest subzones (IIa and IIb) appear to have been deposited very close together in time, roughly 10,700 to 10,000 cal BC. This is followed by subzones IIc and IId, with ages in the 10,000 to 9,000 cal BC range. Subzone IIIa has an age of about 9,199 to 8416 cal

BC which is seen by Driver as more reliable than the charcoal dates (J. Driver personal communication October 2017).

Although the issue of dating is a well-known complication for the region (see Chapter 2), Tse'K'wa features datable fauna that have consistently placed human occupation by 10,500 cal BC. Due to the lack of comparable sites in the Peace River Region, Tse'K'wa is a unique archaeological site; as a result, it is difficult to determine through archaeology alone when the region was viable for human occupations. Not only is the preservation of Tse'K'wa's faunal material adequate for study, but the site's stratigraphy is well sequenced. With the added capability of radiocarbon dates, Tse'K'wa can provide information on the local paleoenvironment at the end of the late Pleistocene and the transition to the early Holocene.

Table 6 Radiocarbon Dates from the Paleoindian Components of Tse'K'wa.

Specimen	Unit	Layer	Level	Year of Analysis	Zone	Taxa	Element	Lab	14C	σ	cal. BC	Range	Notes
3429	3	15	6	1986	II	Bison	Humerus	RIDDL 393	9990	150	9548	10085-9169	ORIGINAL
3429	3	15	6	2014	II	Bison	Humerus	UCIAMS 142218	10170	40	9867	10043-9647	RE-DATE
None	3	15	10	1986	II	Squirrel	Femur	RIDDL 392	10100	210	9733	10521-9185	
15004	24	106	4	1991	Ila	Bison	Humerus	CAMS 2129	10500	80	10439	10651-10119	ORIGINAL
15004	24	106	4	1991	Ila	Bison	Humerus	UCIAMS 142221	10440	40	10332	10530-10121	RE-DATE
1840	5	12	1	1984	IIb	Bison	Tibia	SFU 300	10450	150	10311	10699-9852	probably same element as 16431
16431	26	105	3	2014	IIb	Bison	Tibia	UCIAMS 11347	10430	30	10308	10522-10117	RE-DATE
1848	5	14	1	2003	IIb	Bison	Humerus	OxA 11961	10378	36	10247	10405-10068	ORIGINAL
1848	5	14	1	2014	IIb	Bison	Humerus	UCIAMS 142219	10285	40	10058	10376-9831	RE-DATE
1849	5	14	1	1984	IIb	Bison	Humerus	SFU 454	10770	120	10688	10965-10427	ORIGINAL
1849	5	14	1	2014	IIb	Bison	Humerus	UCIAMS 142220	10290	40	10066	10378-9835	RE-DATE
20037	27	105	3	2014	IIb	Bison	Tibia	UCIAMS 142222	10260	40	10015	10160-9817	
15002	26	105	4	1991	IIb	Raven	Scapula	CAMS 2317	10290	100	10083	10522-9649	
16431	26	105	1	1984	IIb	Bison	Tibia	UCIAMS 11346	10435	25	10320	10523-10118	probably same element as 1840
16422	26	105	1	2003	IIb	Bison	Carpal	OxA 12085	10505	45	10474	10632-10190	
15001	28	105	4	1991	IIb	Bison	Phalanx 3	CAMS 2134	10560	80	10525	10706-10172	
12708	26	105	3	2014	IIb	Bison	Carpal	UCIAMS 11347	10430	30	10413	10168-10481	
2294	4	5	8	2003	IIb/IIc	Bison	Radius	OxA 12084	10340	40	10188	10389-10007	probably same animal as 2292
2292	4	5	6	1984	IIb/IIc	Bison	Ulna	SFU 378	10380	160	10213	10681-9640	probably same animal as 2294
1830	5	11	4	1984	IIc	Bison	Sacrum	SFU 355	9760	160	9157	9750-8678	
1829	5	98		2014	IIc	Bison	Tibia	UCIAMS 142224	9980	40	9426	9620-9264	
15000	26	98	2	1991	IIc	Bison	Phalanx 1	CAMS 2136	9670	150	8999	9592-8567	
20042	29	98	7	2014	IIc	Bison	Innominate	UCIAMS 142217	10060	35	9598	9770-9362	
20043	29	98	8	2002	IIc	Bison	Tibia	OxA 1058	10230	55	9950	10160-9715	Reported elsewhere as OxA10588
15003	27	92	1	1991	IIla	Raven	Scapula	CAMS 2318	9490	140	8806	9199-8416	Dates microblade core

Although Tse'K'wa spans the entirety of the late Pleistocene to historical deposits, this thesis will only focus on the earliest part of the site. This includes Subzones IIa through IIIa and thus includes the Late-Pleistocene to Early-Holocene transition. The Early Prehistoric components of the site in particular can aid in our understandings of post-glacial conditions with the aid of the faunal assemblages. Furthermore, the lithics of the site show potential connections to the south and north of the IFC while the faunal remains can reflect how environments shifted through this crucial period in time.

Chapter 4

DATA COLLECTION

4.1 Collection Process

The Charlie Lake fauna was collected during the 1983, 1990 and 1991 excavations. Although the site had been tested briefly in 1974, the small excavation unit did not sample earlier deposits at the site. Significant excavations began in July of 1983, led by Dr. Knut Fladmark (Fladmark 1983). These first excavations concentrated on the platform area of the site where most of the cultural material was found. Although some 1x1 meter grids were opened in the front and back of the cave they yielded little cultural material. Eight other full and half 1x1 meter units were excavated as well as four partial units, making a total of 9.2 square meters of excavations (Fladmark 1983).

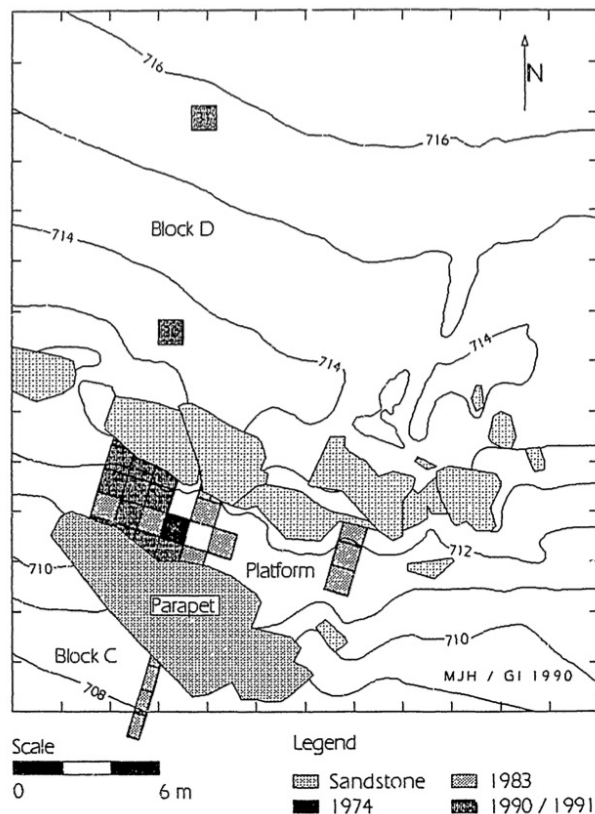


Figure 7. Excavation Map of Tse'K'wa. Source: Handly 1993.

Fladmark reported that 7 units were 3.5 to 4 meters deep (Fladmark 1983: 29). All excavations were done by trowel and dry screened through an 1/8" mesh screen except for unit 2 which was shovel screened. During excavations, chisels and sledgehammers were used to break sandstone blocks that got in the way (Fladmark et al. 1988). The 1983 units were completely backfilled.

In 1990 and 1991, another crew was led by Dr. Jon Driver and Fladmark to continue excavations on the platform and gully. The 1983 units were exposed and the backfill was removed. 14 units were excavated on the platform and gully in the 1990 and 1991 field seasons, and a number of test units were excavated away from the main site (Figure 7). Stratigraphic layers were identified based on color and texture of the sediments (identified as layers) and then further divided into 10 centimeter levels (Driver et al. 1996). The 1990 season excavated the upper half of deposits, and the excavation area was shored and covered. In 1991, the lower layers were excavated. All material was dry screened through 1/8" mesh.

Collected faunal specimens from all seasons were bagged and brought back to Simon Fraser University for further analysis. Because this thesis focuses on earlier material it reports fauna recovered in 1983 and 1991.

4.2 Identification Procedures

Specimens

The faunal remains used for this study were taken from Units 3 through 7, 9, 20, and 23 through 29. Some of the identifications were previously done by Dr. Jon Driver and Randall Preston who was a previous research assistant. The rest of the identifications were done as a part of my thesis and included any specimens that had not been catalogued and identified. The material includes small bones recovered from

1/8" mesh screen. During the excavations, a few owl pellets were found which appeared as bone clusters full of microfaunal bones and provided an explanation as to how some of the smaller specimens were brought to the site. These bone clusters were collected whole and set aside during excavation. To ensure comparability with the remainder of the assemblage recovered through on-site screening, only those specimens that would have been recovered in a 1/8th inch screen are included in this thesis. Bones that would pass through 1/8th mesh were excluded from analyses.

The microfauna from Tse'K'wa present a unique opportunity to study late Pleistocene to early Holocene environmental change. Here, microfauna includes small mammals such as microtine rodents, squirrels, lagomorphs, and birds such as passerines, water birds, among others. Ravens and canids have also been identified and are among the largest of the specimens.

Identifications

Before identifications were made, the material was cleaned in water to make identifications more accurate and sorted into identifiable and unidentifiable categories. Specimens were determined to be unidentifiable if they were too fragmentary or damaged to determine skeletal element or taxonomic class. Each specimen was described in a spreadsheet using a set of standardized descriptive codes. The codes are archived in the Simon Fraser University online research repository. The codes were based on the codes used in previous analyses by Dr. Jon Driver and Randall Preston. The codes were used to describe the following characteristics: taxon; skeletal element; portion of element; body side (if applicable), state of epiphyseal fusion, breakage, and other taphonomic information. In addition, all specimens were given a

catalog number and the length and width were measured. Taxa codes were split into four series; Mammals (1000), Birds (2000), Reptiles (3000) and Amphibians (4000). Fish were not given a series because they were recorded separately. Unidentifiable material was recorded in a separate spreadsheet with individual catalog numbers and measurements.

Once identifiable materials were separated into Class, the specimens were further divided into Orders and Families and element types at the Simon Fraser University Zooarchaeology Lab. Fish, reptiles, and amphibians were not identified beyond Class. The bird specimens were taken to the Burke Museum, University of Washington, Seattle for further identification where we attempted to identify them as precisely as possible. Because small passerine bird skeletal remains are difficult to identify, most were identified only as "Passerine."

Small mammals, like the birds, were divided into element types and Families. We brought these to the Slater Museum of Natural History at the University of Puget Sound for further identification. Microtine mandibles were first separated into types based on the dental morphology in order to make identifications easier. In order to identify the microtine mandibles, we compared the size and shape of occlusal surfaces. Once at the museum, I compared the microtine mandible types with multiple examples of modern specimens in order to identify which species were present; once I made a determination, Dr. Driver looked at the mandibles to make his own identification and we compared notes in order to make a final identification that was then recorded. We followed a similar procedure for long bones, but these are less distinguishable and so

identifications were less precise. Squirrel, vole, and other long bones were identified to Family based on size and characteristics of the elements.

In order to narrow down the possible species present, we initially looked at the species that are still present in the region today. We assumed that these were the species most likely to be present at some point in the site history and so we started our comparisons with these. In the case of ground squirrels, which are known to be extirpated in the region, we assumed that species of ground squirrels that live close by may have once been present in the Peace River Region in the past. If a specimen did not match any of these modern species, we broadened our comparisons to include other potential species.

4.3 Data Presentation

The data presented in this thesis includes the data from my own analysis, identifications made by Randall Preston in 1991 and the 1983 analysis by Jon Driver. The data will be made available in the SFU research repository where the code system, specimen data, and data from the regional site reports can be found (<https://doi.org/10.25314/ab37e3e1-7537-44ab-85be-b344b935ce93>).

4.4 Description of Identified Taxa

This section describes the taxa that were identified in the faunal assemblage and provides details on their habitat requirements, subsistence behaviors, migrations, and other relevant data.

Fish

Fish material were separated from the rest of the fauna and counted based on skeletal elements. There were two categories for the fish specimen quantification:

“Vertebrae” and “Other”. The “Other” designation were all fish remains that were not identified as vertebrae. Fishspecimens were counted but not given individual catalog numbers and ultimately set aside without further identification. Previous unpublished work indicates that all fish at the site are suckers (*Catostomidae*) (J. Driver, personal communication, September 2017)

Amphibians

We found 182 specimens that could be classified as Amphibian. These specimens are most likely a species of frog though we were unable to identify these further.

Reptiles

Seventy-one specimens in Zone IIIa were recorded as reptile and are thought to be a species of snake. We did not identify these specimens any further.

Birds

***Gaviiformes* (Loon)**

Loons are long-bodied divers that inhabit coastal waters, wooded lakes and tundra ponds (National Audubon Society 2016). In the summer, loons can often be found in the coniferous forest zone with large lakes full of small fish while the winter season finds loons on the ocean in shallow waters or large ice-free lakes. Their diet consists mostly of small fish but have been known to eat crustaceans, mollusks, frogs and some aquatic plants (National Audubon Society 2016).

Loons are migratory species that range across Canada and in some parts of the northern United States. In the winter, the loon can be found as far south as northern Mexico, hugging both the Pacific and the Atlantic coast. The Common Loon (*Gavia immer*) is still present in the Peace River Region today, though other North American loon species are found further north.

We identified one cranial specimen to the *Gaviiformes* Order. Based on distributions, the Common Loon is most likely the species present although this cannot be confirmed through zooarchaeological methods.

Aechmophorus sp. (Large Grebe)

We suggest that specimens designated as *Aechmophorus* are most likely Western Grebes (*Aechmophorus occidentalis*) rather than Clark's grebe, though it is possible that we have both since they are quite similar. Western Grebes are a social species, commonly found in flocks and colonies. This species of grebe inhabits rushy lakes, bays and ocean, fresh water lakes and areas with large open water and marsh vegetation (National Audubon Society 2016). In the summer, grebes are found mostly in marsh environments or lakes while in winter they are found in sheltered bays on the coast or in lakes.

Western grebes are diving and swimming birds and subsist mainly on fish, although they also eat crustaceans, insects, and salamanders. Western grebe necks are structured to allow spear-like thrusting which may be used for fishing (National Audubon Society 2016).

These grebes still migrate through the Peace River Region, though they are not found year-round. The species range is distributed across the coast from British Columbia to northern Mexico or further inland for breeding. Breeding locations range from the northwest United States, as far north as Alberta and as far south as New Mexico.

Podiceps auritus (Horned Grebe)

Compared to the Western grebe, Horned grebes are less gregarious and don't gather in flocks or colonies as often. Like the Western grebe, they live in marshes

during the summer and along the coast in winter. Their habitats include lakes and ponds, surrounded by northern forests, prairies, or close to tundras (National Audubon Society 2016).

Like other grebes, the Horned grebe is a diving bird that can swim underwater or catch prey from the surface. They usually subsist on insects, crustaceans and fish although this diet varies with habitat and season (National Audubon Society 2016). Horned grebes also eat tadpoles, leeches, salamanders, and plant materials in the summer.

Horned grebes are still present in the Peace River Region. Horned grebes migrate to western Canada and Alaska to breed but winter along the coast of North America.

***Anas platyrhynchos* (Mallard)**

Mallards are large dabbling ducks that can be found throughout North America. They are identified by their large bodies and rounded heads with wide, flat bills and live in almost any wetland habitat, including Prairie Potholes and ephemeral wetlands (Cornell Lab of Ornithology 2015a). Mallards tend to form pairs before breeding seasons and are known to be a migratory species.

Mallards eat a wide variety of food and are generalist foragers. Their diets often include seeds and aquatic vegetation, animal matter such as insect larvae, earth worms, snails and freshwater shrimp.

Mallards nest close to water, and rely on grasses and vegetation to cover their nests (Cornell Lab of Ornithology 2015a), suggesting the need of open grasslands as well as aquatic environments. Their modern range includes the Peace River Region, indicating a long-term presence in the region.

***Anas* species (Teal Size)**

Teals are known as the smallest dabbling duck in North America (Cornell Lab of Ornithology 2015b). They are described as having short bodies and large heads with short necks and small bills. Based on modern distribution, green-winged teal (*Anas crecca*) is the most likely species represented.

This species breeds mostly in isolated river deltas and are often found in forest wetlands, mixed prairie regions, and the Prairie Potholes Region (Cornell Lab of Ornithology 2015b). Their nests are usually made in grasslands or sedge meadows, and they tend to favor beaver ponds. Like other ducks, they are generalists and feed on seeds, aquatic invertebrates, vegetation, and whatever else might be abundant.

***Bucephala albeola* (Bufflehead)**

Buffleheads are small diving ducks that forage underwater and subsist on aquatic insects in fresh water or crustaceans in the ocean. They may also eat mollusks and plant material depending on the season. They can be found in lakes, rivers and ponds although in winter they are found in salt bays (National Audubon Society 2016).

Buffleheads nest around ponds in open mixed coniferous and deciduous forests as well as burned areas or aspen groves.

Buffleheads migrate in small flocks. In fall, they migrate to the coast or southern and western United States. Breeding grounds are not as extensive, occurring in small patches in Alaska, southern British Columbia, Alberta and Saskatchewan. They are not common in the Peace River Region, though they are not considered extirpated to the region.

***Oxyura jamaicensis* (Ruddy Duck)**

Ruddy ducks are surface divers that are recognized by their compact bodies, thick necks, and over-sized tails. They breed in the Prairie Pothole Region of North America

and Mexico; they are found in marshes and wetlands and nest adjacent to lakes and ponds. This is a migrating species that flock to aquatic habitats such as lakes, rivers, ponds and can also be found in coastal estuaries (Cornell Lab of Ornithology 2015c).

Ruddy ducks feed on aquatic invertebrates, especially midge larvae, and aquatic plants and seeds such as pondweed, arrowhead, muskgrass, bulrushes, water lilies, duckweed and others. Their diets also include animal matter such as water fleas, worms, amphipods, crustaceans, diving beetles, and other available species (Cornell Lab of Ornithology 2015c). Ruddy ducks are also known to be attacked by horned grebes and American coots during the breeding season.

***Chordeiles minor* (Common Nighthawk)**

Nighthawks are members of the *Caprimulgidae* family which consist of nocturnal birds, characterized by long wings with short legs and bills. Common Nighthawks can hunt in both day or night and nest on open ground (National Audubon Society 2016). They inhabit open country, sometimes seen in cities and towns; common Nighthawks are often found in forests, open pine woods, prairies as well (National Audubon Society 2016).

Nighthawks feed mainly on flying insects such as beetles, moths, termites and winged ants that are often found near bright lights, though they do sometimes feed on terrestrial insects. They forage in flight but nest on the ground in the open or on top of a raised object.

Common nighthawks migrate to South America in the winter though during the breeding season they can be found across the continental United States and most of Canada. They are still extant in the Peace River Region today.

***Fulica americana* (American Coot)**

American coots are a type of water bird that swim in the open in flocks. They live in ponds, lakes, and marshes though in winter they can be found in fields, ponds, and salt bays. To forage for food, they dabble in the surface, dive underwater, or graze on land where they eat plant materials as well as insects, tadpoles, fish, prawns, and eggs from other birds (National Audubon Society 2016). American coots nest in marshy areas where their nests float on a platform of bulrushes and sedges.

In the southwest and west of the United States, American coots live year-round though some may migrate from the southeast and coasts towards Canada. The Peace River Region is located within the breeding grounds for the American coot today. They require shallow fresh water with vegetation for their nests (National Audubon Society 2016).

***Pluvialis dominica* (American Golden Plover)**

American Golden Plovers are one of many waders that live in prairies, mudflats, shores, and summer tundras. They can often be found along beaches, flooded fields, and short-grassed prairies (National Audubon Society 2016). The species nests at higher elevations, generally in a tundra environment.

American Golden Plovers feed on insects such as flies and beetles, grasshoppers, caterpillars and larvae. They have also been known to eat snails, mollusks, crustaceans, seeds, and berries depending on the season (National Audubon Society 2016).

Migrations for this species is northward in spring through the Great Plains and as far north as the Northwest Territory, Yukon, and Northern Alaska. In the fall, the American Golden Plover move towards South America. Although the migration route is

close to the Peace River Region, the American Golden Plover is not common near Tse’K’wa today. We found four specimens that we tentatively identified as American Golden Plover, however it is possible that they could be classified as killdeer (*C. vociferus*).

***Charadrius vociferus* (Killdeer)**

Killdeer are often found near water, though they also live in fields, lawns, and pastures. They are often found on open ground or near river banks and mudflats and nest in shallow water and coastal estuaries (National Audubon Society 2016). The killdeer consumes insects such as beetles, caterpillars, larvae, and have been known to eat earthworms, crayfish, arachnids and snails among other species.

Killdeer migrate north towards the northern United States and much of Canada, including the Peace River region. For the southern United States and northern Mexico, killdeer live year-round.



Figure 8. Passenger pigeon right proximal scapula

***Ectopistes migratorius* (Passenger Pigeons)**

Passenger pigeons (Figure 8) are an extinct species of *Columbiformes* that is known to have lived in the eastern part of North America, as far west as Alberta and some individuals in Mexico (BirdLife International 2016). We have identified two specimens to this species due to the distinctive nature of the skeletal remains.

In a previous analysis by Driver and Hobson (1992), other passenger pigeon specimens were identified in four stratigraphic zones as early as Subzone IIIa. They suggest that this means passenger pigeons were migrating through the region in the summer.

Passenger pigeons nested near the Great Lakes region and wintered in Arkansas and south. They lived in mixed hardwood forests and consumed beechnuts, acorns, seeds and berries as well as worms and insects (Smithsonian 2016). The species congregated in large numbers and therefore needed a large forest in order to find enough food. The Passenger pigeon went extinct in the early 20th century as a result of overhunting, deforestation, and other complications (BirdLife International 2016).

***Asio flammeus* (Short-eared Owl)**

Short-eared owls are medium-sized owls with rounded heads and broad wings that have rounded tips. They live in grasslands and open areas, perching on the ground or in low trees where available. They can also be found in coastal grasslands, prairies, shrub steppes, tundra, marshes, and other environments (Cornell Lab of Ornithology 2015d).

Like most owls, this species feed mostly on small mammals such as mice, voles, lemmings, shrews, moles, rabbits, bats, weasels and muskrats, and their populations usually fluctuate with their mammalian prey (Cornell Lab of Ornithology 2015d). These

owls are also known to hunt terns, gulls, shorebirds, songbirds, rails, and other bird species.

Short-eared owls make their nests on the ground and line them with available grasses and down feathers. They typically nest on dry sites available in grasslands and prairies.

***Corvus corax* (Common Raven)**

The common raven is one of many passerines that we identified, though only one of the few that could be identified to the species level. It is the largest of the perching birds and has adapted to a series of habitats and climates from deserts to Arctic tundra (National Audubon Society 2016). The raven can be found in boreal and mountain forests, along the coast, tundra and deserts; they can also be found on prairies (National Audubon Society 2016).

Ravens are omnivorous but feed mainly on animal matter such as carrion, insects, rodents, lizards, frogs, and the eggs and young of other birds (National Audubon Society 2016). They nest on ledges of rock cliffs or tall trees.

Ravens generally live in permanently in one place across Canada, Alaska, and the western United States rather than migrate. They are still present in the Peace River Region today.

***Petrochelidon pyrrhonota* (Cliff Swallow)**

Passerines were one of the most common orders we identified, though the cliff swallow was the only swallow taxon that could be identified to the species level. They live in open lands such as farms, cliffs, lakes and prairies as well as clearings in forests (National Audubon Society 2016). They breed near cliff faces that have a supply of mud nearby to build their nests.

Cliff swallows forage in flocks and feed mostly on insects such as beetles, bugs, flies, and vespers as well as other small arthropods and some berries (National Audubon Society 2016). They nest in colonies, crowded close together on a vertical surface.

Cliff swallows migrate to winter in southern South America. Their range goes as far north as Alaska and as far east as Illinois and covers the majority of central and western North America.

Mammalia

Myotis sp. (Bat)

Only one mandible was identified as *Myotis*, though the specimen could not be identified to the species level. There are 16 species of bats that currently live in British Columbia (Brigham 2017) but the specimen identified is most likely a little brown bat (*Myotis lucifugus*) because of the size of the specimen and how common the species is in the region. In British Columbia, all the bat species are insectivores; little brown bats focus on free-flying insects found in wooded areas, fields, over water, and on water surfaces (Havens, 2006). Most bats live in areas with trees and caves for roosting but their habitats include dry grasslands, forests, and other environments (Brigham, 2017; Havens 2006). Little brown bats weigh between 5 and 14 grams and are between 60 and 103 millimeters in length (Havens 2006).

Lepus americanus (Snowshoe Hare)

Snowshoe hare are a member of the *Leporidae* family that average about 20 inches in length, have large hind feet and long ears (Saunders 1988). This species of hare lives in temperate, tundra, taiga, and forest habitats but can also be found near agricultural and wet areas (Shefferly 2007). These habitats must include a wood browse

for the winter months and dense forests to provide cover. They can be found in the tree line of North America and as far south as California and Nevada (Saunders 1988).

Snowshoe hares eat a wide variety of vegetation. Their primary diet is herbivorous consisting of green grasses, forbes, blue grass, dandelions, clovers, and horsetails (Shefferly 2007). They've also been known to eat raspberries, maples, birches, aspen, and alder and other vegetation such as white pine, spruce and sedges (Saunders 1988). In some cases, hares can eat carrion, particularly of conspecifics in the winter. Like other hares, snowshoe hares are coprophagic and re-ingest their fecal pellets that contain the nutrients that may not have been digested when food was first eaten (Kurta 1995; Wilson and Ruff 1999).

Snowshoe hares are common prey for several predators such as coyotes, wolves, foxes, lynx and mink (Kurta 1995; Wilson and Ruff 1999). Older specimens are more likely to escape predation by running while younger hares often freeze and rely on cryptic adaptations to avoid detection (Shefferly 2007). Hares are also a source of meat for humans such as the Dane-zaa (Ridington 2013). We identified many specimens as *Lepus americanus*, particularly in Subzone IIIa.

Large *Lepus*

There were several specimens of larger *Lepus* that we found but were not able to identify to the species level. We believe that these specimens could either be Arctic hare or a jackrabbit species though this cannot be determined through traditional zooarchaeological methods.

If the specimens turn out to be jackrabbit, then white-tailed jackrabbit (*Lepus townsendii*) is more likely. This species of hare lives in sagebrush plains, pastures, and

grain fields (Gosline, 2001). They are approximately 7.5 lbs on average with long ears and hind legs. In the past, white-tailed jackrabbits were known to live in British Columbia but have since been classified as extirpated. Now, they can be found throughout west-central Canada and the United States. They are also less social than most hares, joining groups only during breeding season, extreme winters, and when food is abundant (Gosline, 2001).

Another option for the large *Lepus* species are arctic hares (*Lepus arcticus*). Today, arctic hares are found in the northernmost part of North America, in Greenland, the Arctic Islands and Canada; they are also found as far south as Newfoundland and Labrador (Betzler 2015). Arctic hares live in mountainous tundras and rocky plateaus in polar regions. Some arctic hares live on the coasts if they are treeless. An adult arctic hare weighs approximately 6 to 11lbs, making them larger than white-tailed jackrabbits.

***Urocitellus* sp. (Ground Squirrel)**

Today, there are no ground squirrel species present in the Peace River Region but we found their remains at Tse'K'wa. We identified the specimens to the ground squirrel genus but could not determine the species by zooarchaeological means. The aDNA lab at SFU analyzed the left humeri of the ground squirrel specimens and determined them to be Richardson's ground squirrel (Royle and Yang 2017).

Richardson's ground squirrels live in central Alberta, western Montana and Minnesota (Bruening and Bruening 2002). Like arctic ground squirrels, Richardson's ground squirrels live in open areas, particularly plains with short grasses and avoids heavily forested areas. They mostly eat seeds, nuts, grains, and small invertebrates (Bruening and Bruening 2002).

Small Sciuridae

This classification is another that could not be identified to species. Only two specimens were designated to this classification in Subzone IIIa. It is most likely that these specimens are a subspecies of *Eutamias minimus* (Least Chipmunk), although this cannot be determined by zooarchaeological methods.

Least chipmunks live throughout North America, along the Rocky Mountains, the western Great Plains, Western Canada and Wisconsin, Minnesota, and Michigan (Schlimme 2000). This species lives in temperate boreal or taiga and scrub forests, preferring open spaces near rock cliffs and river bluffs (Schlimme 2000). They burrow in the winter but generally make their summer nests in rotting logs above the ground. They eat nuts, berries, fruits, grasses, fungi, and some small invertebrates such as snails and some insects. Predation includes weasels, some species of hawks, snakes and minks, red foxes and bobcats (Schlimme 2000).

***Marmota monax* (Woodchuck)**

Woodchucks are widespread in North America ranging as far south as Louisiana, Alabama, and Georgia, along the Atlantic Coast, and as far North as southern Alaska (Tobias 2011). Generally, woodchucks live in temperate grasslands or forests as well as riparian zones and some agricultural areas. They construct dens that differ seasonally and thrive as a result of human activities (Tobias 2011).

Woodchuck diets are herbivorous though they are known to eat eggs, insects and some mollusks. Generally, they are folivores with a diet of alfalfa, clover, and dandelions though they also eat leaves, barks, seeds and grains, and flowers (Tobias 2011). In order to avoid predation, woodchucks climb trees; their predators include carnivores such as wolves and coyotes, red and gray foxes, bears, lynx, hawks and

snakes (Tobias 2011). Only five specimens have been identified as *Marmota monax*, found in Subzones IIb, IIc, and IIIa.

***Castor canadensis* (Beaver)**

Beavers are another widespread species in North America, found in most places across the continent except for the far northern regions of Canada and drier desert regions (Anderson 2002). They live in dams built on the banks of ponds and lakes or on islands near the water made of foliage and mud. Their habitats are temperate, terrestrial, and freshwater and includes forests, rivers, and lakes (Anderson 2002). Beavers live in family groups of 8 or so individuals though we found only six specimens that could be identified as beaver.

Beaver diets includes bark and cambium from willow, maple, poplar, beech, birch, alder, and aspen trees (Anderson 2002). Other vegetation includes buds, roots and cellulose which they have adapted to digest where other mammals have not.

Wolves, lynxes, otters, humans, and bears are known predators for young beavers as a result of their small size (Anderson 2002). The fur trade has been a significant predation factor for beavers since beaver fur was a highly-coveted item in the last century.

***Peromyscus sp.* (Mouse)**

Deer mice (*Peromyscus maniculatus*) is the most likely the species present, although this could not be confirmed using zooarchaeological methods. Deer mice are distributed from Alaska and Canada and as far south as central Mexico, excluding the southeastern United States and some parts of coastal Mexico (Bunker 2001). They are found in both Nearctic and Neotropical regions and live in several ecological zones such

as alpine, northern boreal forests, deserts, grasslands, brushlands, fields, and other habitats.

Deer mice are small, weighing no more than 24 grams and are no longer than 222 mm long (Bunker 2001). Their molars are low crowned and cuspidate and they are a nocturnal species.

***Ondatra zibethicus* (Muskrat)**

Musk rats are another large rodent found in semiaquatic environments. They live in swamps, marshes, and wetlands across Northern America to the Gulf Coast (Newell 2000). They favor locations where water levels stay at a constant four to six feet that provide enough vegetation and allows them to shelter in bank burrows (Newell 2000). They live in temperate climates and always near water.

Musk rats live in family groups and are most active at dawn and dusk. They are mostly vegetarians though they have been known to eat some animal matter and cannibalism may also occur. Predation includes minks and otters, raccoons, coyotes, owls, and alligators in southern regions (Newell 2000).

***Neotoma sp.* (Woodrat/Packrat)**

Although we could not identify our one *Neotoma* specimen to the species level using zooarchaeological methods, it is most likely that the specimen belongs to *Neotoma cinerea*, or the Bushy-tailed woodrat because they are still present in the region today.

Bushy-tailed woodrats are found in western North America from Canada to New Mexico and Arizona (Trapani 2003). They live in a wide range of habitats from taiga grasslands, boreal woodlands, deserts, forests, mountains, and chaparral

environments. They require adequate shelter, generally inside rocks of cliffs or in abandoned buildings (Trapani 2003).

Bushy-tailed woodrats have a variable diet and could be classified as generalist herbivore. Their diet consists of woody vegetation and succulents as well as other plant materials that provide water so they do not have to drink (Trapani 2003). Predatory animals including owls are a threat to this species and they are considered a pest species to humans.

***Microtus xanthognathus* (Taiga Vole)**

Taiga voles (Figure 9) can be found throughout the boreal taiga zone from the west coast to the interior of Alaska as well as Alberta, the Northwest Territories, Manitoba, and the Yukon Territory (Kroening 2004). They live in Nearctic regions in a wide range of microhabitats including mixed woods, the banks of rivers and marshes, swamps, and open forests (Kroening 2004). Taiga voles require rhizomes for adequate food in the winter which require moist conditions to grow; they also need favorable burrowing conditions in mossy areas (Kroening 2004).

Taiga voles are considered herbivores and mycophagous, relying on a diet of grasses, rhizomes, berries, and fungi. Taiga voles also store their food for winter. These voles are prey for a number of predators, including owls and hawks, red foxes, gray wolves, martens and weasels, and lynx.

In a study by Hebda et al (2008), late Pleistocene taiga voles were found in the Peace River Region near Bear Flat. Their specimens were dated using AMS and were found to be from the late Pleistocene, dating between 12,000 to 11,000 cal BC. Their findings of taiga voles in the region provides further evidence that this species was in the region in the immediate postglacial period.

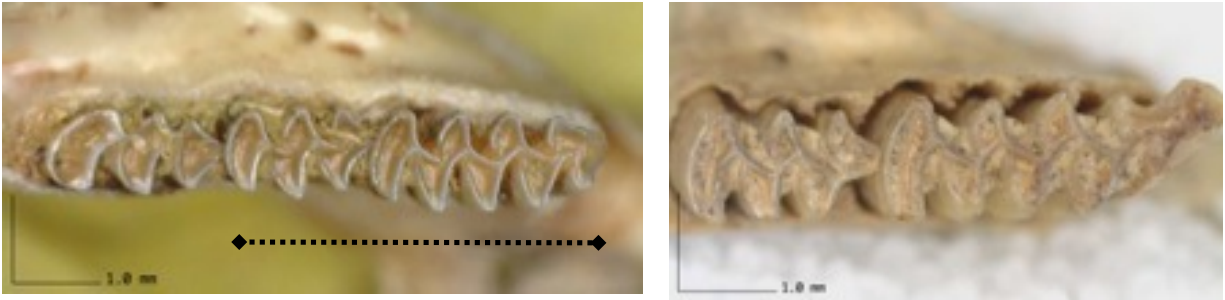


Figure 9. Modern *M. xanthognathus* tooth row (left) compared to specimen from Tse'K'wa (right)

***Myodes gapperi* (Southern Red-Backed Vole)**

Red-backed voles (Figure 10) are found throughout Canada as well as the northern United States in Nearctic regions (Ballenger 2011). These voles live in cool, mossy boreal forests and inhabit tundra and bog habitats.

Southern red-backed voles prefer coniferous forests but are adaptable so they can be found in deciduous or mixed woods. They are smaller than the taiga vole and are more omnivorous. Their diets are opportunistic and include foods such as insects, roots and tubers, woody vegetation, grains and seeds, and fungi (Ballenger 2011). Owls, hawks, mustelids, bears, foxes, wolves, coyotes, and lynx are likely predators.

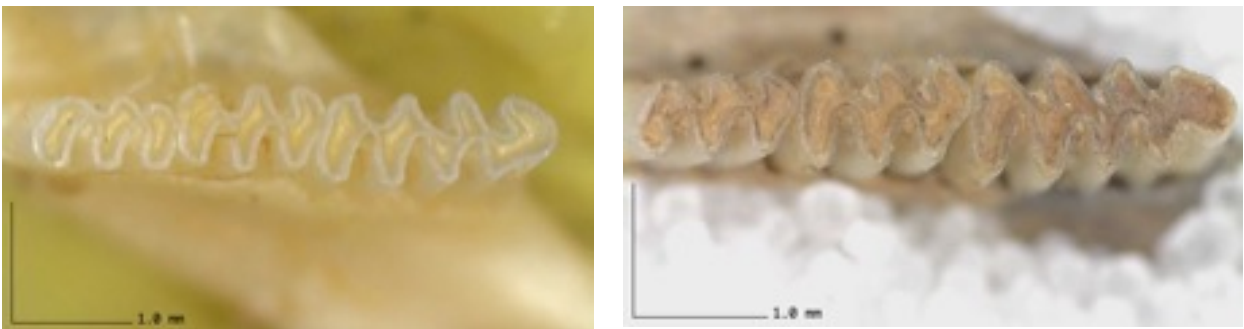


Figure 10. Modern *M. gapperi* tooth row (left) compared to specimen from Tse'K'wa (right)

***Microtus pennsylvanicus* (Meadow Vole)**

Meadow voles (Figure 11) are the most widespread vole in North America. They range from Alaska to the Atlantic Coast and as far south as New Mexico (Neuburger 1999). They are present in the Peace River Region today. Meadow voles can be found

in meadows and grasslands, marshes, rivers and lakes, or open woodlands. Generally, their habitats are found in temperate regions.

Meadow voles are slightly larger than Southern Red-backed voles and feed on fresh grasses, sedges, and herbs. They have also been known to feed on seeds, grains, succulents, and woody vegetation. In addition, meadow voles can be cannibalistic and may also eat insects or fungi (Neuburger 1999). Predators include owls, snakes, red foxes, and weasels.

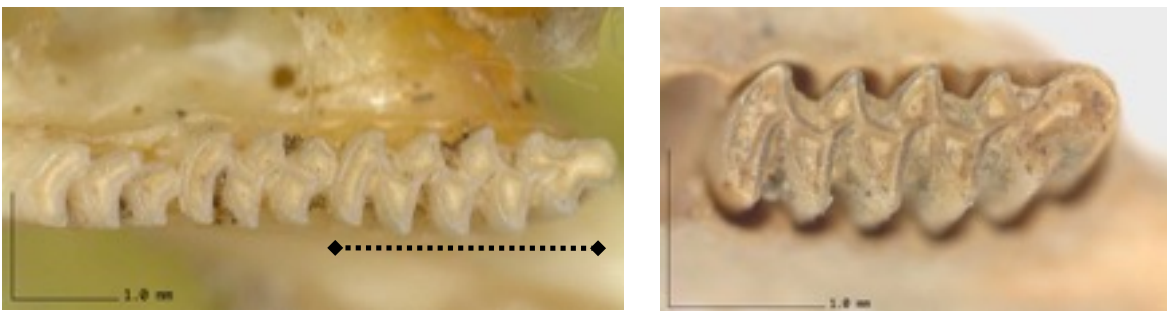


Figure 11. Modern *M. pennsylvanicus* tooth row (left) compared to specimen from Tse'K'wa (right)

***Microtus longicaudus* (Long-tailed Vole)**

Long-tailed voles (Figure 12) are larger than the Southern red-backed vole. They can be found throughout the western United States and Canada, and as far north as Alaska (Cosens, 2004). Their habitats include grassy areas, river banks, forests, and sagebrush grasslands. They can also be found in mountain meadows and riparian zones, so long as the voles can burrow underground (Cosens 2004).

Long-tailed voles eat green plants and woody vegetation, flowers, fungi, and seeds, and they have also been known to eat insects (Cosens 2004). Predators include several species of owls, falcons, weasels and ermine, and American Martens.

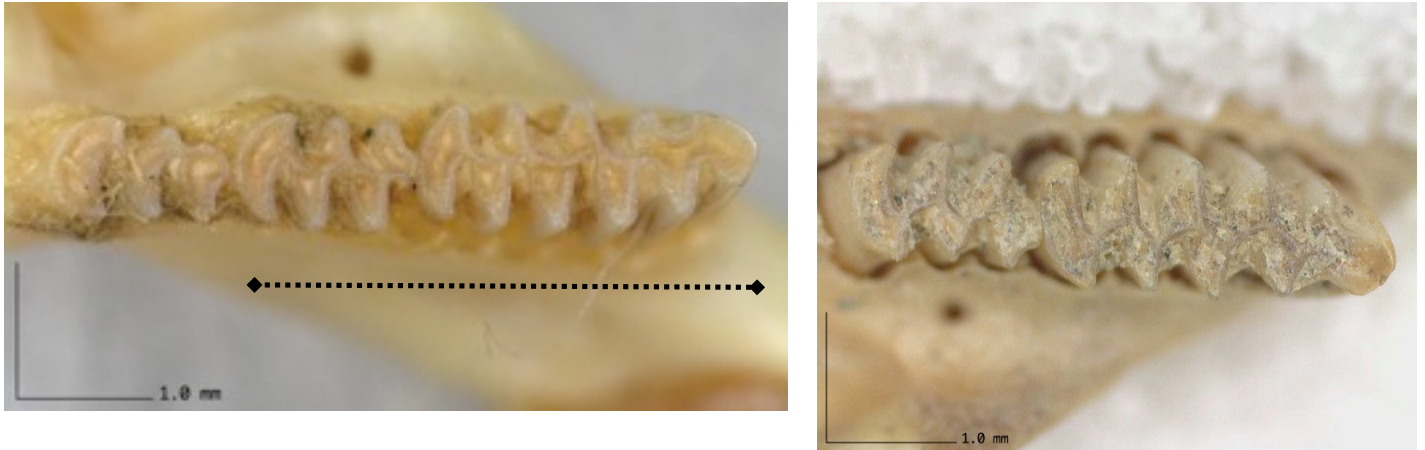


Figure 12. Modern *M. longicaudus* left side tooth row (left) compared to right side specimen from Tse'K'wa (right)

***Dicrostonyx* (Collared Lemming)**

There are two possible species of collared lemming (Figure 13) that could have been present at Tse'K'wa, the Richardson's collared lemming (*Dicrostonyx richardsoni*) and the Bering collared lemming (*Dicrostonyx groenlandicus*). Unfortunately, we were unable to distinguish the difference between the subspecies using teeth and thus left the identification as "*Dicrostonyx*."

Richardson's collared lemmings are found from the west coast of Hudson Bay to the Great Slave Lake in northern Canada and occur in tundra habitats with open, dry areas (Cassola 2016). They are not found in the Peace River Region today. They turn white in the winter and burrow into the snow or soil. Richardson's collared lemmings eat greens, berries, and roots.

Bering collared lemmings live in Nearctic and Palearctic regions of Alaska, Canada, and the Northwest Territories; they can also be found in Greenland and the St. Lawrence Island and Wrangel Island in Siberia (Poloskey 2000). They are terrestrial and fossorial though they have also been known to swim.

The diet of both these is mostly herbivorous and includes willow buds, fruits and flowers, grasses, and woody vegetation. They can also eat mosses and mushrooms

and may eat insects, though this is not known for sure (Poloskey 2000). Predators include owls, ermines, foxes and wolves, weasels, and hawks.

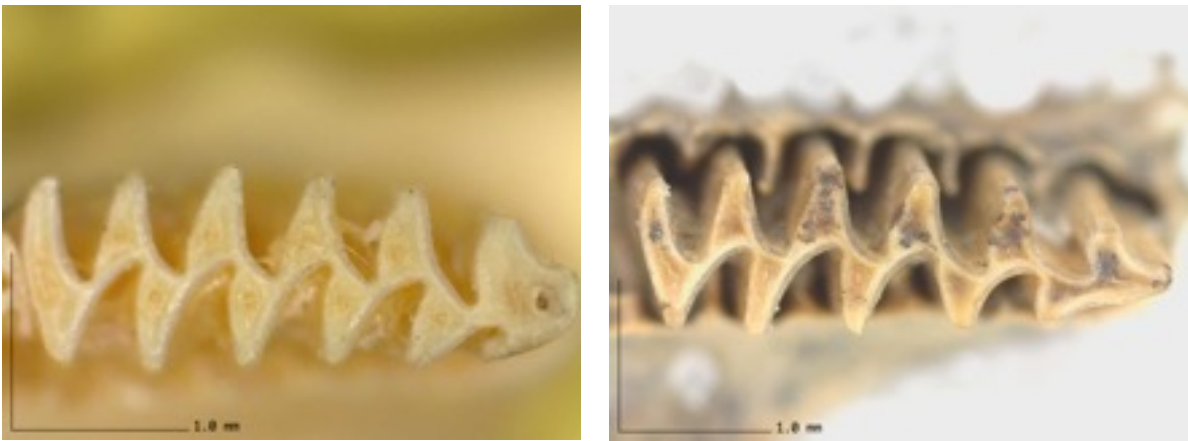


Figure 13. Modern *Dicrostonyx* tooth (left) compared to specimen from Tse'K'wa (right)

***Mustela nivalis* (Least Weasel)**

Least weasels are widespread throughout the Northern Hemisphere and can be found in North America from Alaska throughout Canada and the northern United States as well as Europe (Campbell 2014). They are highly adaptable and can live in various habitats, though they can most often be found in prairie grasslands, coniferous forests, tundra, taiga, and rainforests with a dry season (Campbell 2014). They can live both above and below ground and use dens for shelter.

Least weasels are mostly carnivorous, though they also eat fish, eggs, insects, and scavenge for carrion. They have been known for killing larger prey and storing their remains for later. Mostly, the least weasels eat rodents such as voles, lemmings, and mice but they are opportunistic hunters who can also eat lizards, amphibians and invertebrates (Campbell 2014). Predators for the least weasel includes snakes, foxes, owls, and other birds of prey. They are also preyed on by other mustelids. Only two specimens were identified as least weasels in Subzone IIIa.

***Mephitis mephitis* (Striped Skunk)**

Striped skunks are another widespread mustelid throughout most of North America. They range from southern Canada and most of the United States and are present in the Peace River Region today. They live in woodlands, forests, ravines, and grassy plains, though they can also be found in suburban areas and riparian zones (Kiiskila 2014).

Striped skunks are opportunistic feeders who are omnivorous. Their diets include birds, insects, mammals, carrion and eggs, fish, reptiles and amphibians, arthropods, worms and crustaceans; plant foods include seeds, grains, and nuts (Kiiskila 2014). This species has specialized scent glands that protect them from predation, though there are a few species of birds and predators that prey on them. These species include eagles, cougars and bobcats, coyotes, badgers, and red or gray foxes (Kiiskila 2014).

Canidae

None of the six canid-like specimens were positively identified beyond the Family level. Some specimens may be domestic dogs, coyote, a species of fox, or gray wolves though it is uncertain which classification the remains belong to. Gray wolves live in the majority of the Northern Hemisphere, though their range has decreased as a result of human hunting (Smith 2002). They are one of the widest ranged land animals, living in habitats from arctic tundras to temperate forests, prairies, and arid landscapes (Smith 2002).

Coyotes are another canid that can be found in the region, though historical data shows that they weren't in the region prior to the early 1900s (Levy 2012). This species is highly adaptable opportunists that have allowed them to recently expand their range while other species (such as wolves) have lost much of their range since the 1900s.

Coyotes are opportunistic species that prey on deer, rabbits, mice, and other game and are known to scavenge (Levy 2012).

The domestication of dogs is a topic that is still debated in archaeology, particularly in North America as it is unclear when exactly domestic dogs were brought to the continent. Ancient canid specimens in Siberia are debatably present around 30,000 cal BC (Lee 2015), and one of the oldest domestic dog fossils come from a 9,400-year-old fragment in Texas (Tito et al. 2010). Ancient domestic dog fossils are not common in the IFC region and we are uncertain of the identification of our canid specimens.

***Bison bison* (American Bison)**

Bison were once widespread throughout the western part of North America from Alaska to northern Mexico, but slaughter by humans of wild herds caused the species to nearly go extinct. Now, they are found on protected lands in western United States and Canada in areas such as Yellowstone National Park (Newell and Sorin 2003). They are not as prevalent in the Peace River Region as they were historically.

Generally, bison live in grasslands and open savannas, though they could also be found in boreal forests and semi-desert areas as long as there was enough vegetation to graze on. Bison are gregarious creatures who live in herds; usually a herd will consist of cows and their young and a few older males (Newell and Sorin 2003). They are herbivorous animals, consuming leaves, roots, tubers, stems and woody vegetation. Predators include mountain lions, wolves, and humans (Newell and Sorin 2003). At Tse’K’wa, at least 164 specimens were identified as bison, and they were already studied extensively by Driver and Vallières (2008) (see Chapter 3).

Chapter 5

DATA ANALYSIS

5.1 Taphonomy

An important part of studying faunal remains is understanding how the specimens were deposited and what factors may have influenced preservation thereafter. For studies such as this, understanding how the specimens came to the site can affect the data collected; for example, predator specialization can affect the kinds of prey that appear in an assemblage. A change in predator populations could affect the specimens present in the assemblage and thus influence interpretations. There are many ways a fossil might be moved, altered, or affected after deposition. This chapter begins with a look at taphonomic processes that may have affected the faunal assemblage at Tse’K’wa and then moves on to the analysis and interpretation of past environments.

5.1.1 Carnivore Modifications

One of the most notable works in small mammal taphonomy is by Andrews and Evans (1983). They look at the accumulations of small mammal remains as a result of carnivore activity. The presence of this kind of modification is evident through digestion damage, such as surface rounding and corrosion as a result of the digestive acids. Polishing and abrasion may also suggest digestion, and commonly these bones will be broken and thus are less likely to be fossilized (Andrews and Evans 1983; Fernandez-Jalvo et al. 2014; Madgwick 2014).

Evidence of carnivore gnawing is another indication of carnivore influence on the assemblage. Skeletal elements commonly tend to be a factor in whether or not a specimen is gnawed by carnivores (Haynes 1980). For example, carnivores tend to gnaw on the soft ends of long bones. Splintering, shallow furrows, and fracturing may

also indicate carnivore gnawing (Haynes 1980). Haynes (1983a) investigates the possibility that gnawing damage may indicate carnivore species by looking at the impressions of tooth marks. In some cases, however, no gnawing damage may be present (Haynes 1980, 1983a). In another study, Haynes (1983b) suggests that wolves break long bones, resulting in spiral fractures, while bears gnaw the epiphyses of bones, thus showing that different behaviors result in different modifications. Other methods for identifying tooth marks and the potential to specify carnivore taxa come from measuring pit lengths. Small carnivores are expected to make smaller marks than larger carnivores (Andres et al. 2012; Domínguez-Rodrigo and Piqueras 2003). In addition, tooth marks can be differentiated from percussion marks by the internal crushing caused by carnivore teeth (Blumenschine 1995).

Scavengers are also significant taphonomic agents but they are not always clearly recognized (Casteel 1971). Scavengers often move the bones away from sites and deposit them at another location (Lyman 2008). In addition, the bones that are scavenged are generally not totally destroyed by scavengers, however they can be damaged.

Evidence of carnivore influence in the Tse'K'wa assemblage comes from gnawing and puncture marks. Table 7 shows the number of specimens that show carnivore damage. Most of the carnivore damage can be found on the bison assemblage where 66% of the bison from the Paleoindian layers showed carnivore damage while 27% showed no signs of carnivore damage and 7% were considered inconclusive (Vallières 2004); a muskrat innominate (Figure 14) shows both gnawing and puncture marks. One of the passenger pigeon specimens is particularly interesting; the scapula shows

evidence of a carnivore puncture mark which suggests that this individual may have been brought to the site by carnivores (Figure 15).



Figure 14. Carnivore marks on muskrat innominate. Puncture marks and gnawing present.



Figure 15. Carnivore puncture mark on passenger pigeon right scapula

5.1.2 Avian Pellets

Small mammals are the staple food for many species of owls and are therefore subject to the effects of owl pellet accumulation. Dodson and Wexlar (1979) suggest that owl pellets average around 46% bones and that owl stomach acids tend to be less acidic than hawks, therefore the bones in owl pellets tend to be less corroded than those in hawk pellets. The authors also investigate several species of owls and note that the different bones represent the majority in the pellets of different species (Dodson and Wexlar 1979). Digestive damage was present on the skulls in all species and indicated a feathery appearance (Dodson and Wexlar 1979).

Kusmer (1990) suggests that the frequencies of specimens can distinguish owl pellet assemblages from carnivores because owls tend to be specialists in small mammal hunting. Kusmer also notes that, although digestive damage may be present, there is little surface pitting or corrosion (Kusmer 1990). To distinguish an owl pellet assemblage, she suggests that there should be a high percentage of immature animals of a restricted number of species with a high frequency of femora, radii, mandibles, and humeri. Because the specimens in the bone clusters found at Tse'K'wa were largely intact and contained mostly small rodents such as mice and voles, we determined that the bone clusters were most likely avian in origin.

Post-regurgitated remains of pellets are also subjected to taphonomic processes. Terry (2004) argues that these later conditions often mask the original signatures of owl pellets. While most analysts use distribution of skeletal materials and breakage patterns, post-regurgitation taphonomic processes may skew these signatures, thus complicating pellet identifications.

Ravens also produce pellets; however, they have not been as extensively studied as the owl pellets. One of the major differences between ravens and owls is that ravens tend to be generalist feeders rather than specialized (Laudet and Selva 2005). Laudet and Selva (2005) look at the distribution of small rodent remains in raven pellets and note that these are the majority of the assemblage and the incisors of these species tend to be the most frequent. Ravens were noted at Tse'K'wa (Driver 1999) and tend to be a species that has a wide geographic range, though it may not be possible to distinguish raven from owl pellets.

5.1.3 Human Influence

Human subsistence in the late Pleistocene commonly focuses on big game hunting rather than small mammal hunting, however ethnographic records from the Peace River region show that the Dane-zaa First Nations use smaller mammals, such as hare, as a resource (Riddington 2013). While my thesis does not focus on early human subsistence in the Peace River region, I was mindful that this was a possibility while analyzing the specimens.

Human influence on faunal remains are often noted through burning, breakage/cutmarks, and digestive processes. Burning is not a heavy influence on the small vertebrate assemblage and therefore will not be extensively reviewed here. Still, burning may create fractures and change the color of remains in the vicinity (Asmussen 2009) and will therefore be noted if these kinds of specimens arise.

In terms of small mammals, human modifications may not be as visible as the consumption of big game because small mammals are often processed without tools (Landt 2007). Archaeologically, human consumption of meat may be visible through cooking or digestive damage on the bones. Burning of the small mammal assemblage at Tse'K'wa is not as significant as other taphonomic processes. Speth (2000) notes that lagomorphs may be boiled rather than baked or roasted, and thus would not appear as burned bone. As a result, other lines of evidence may be needed, such as digestive damage. In the case of lagomorphs, Landt (2007) suggests that humans may modify these remains with their teeth, leaving visible marks. In addition, gnawing, polishing and scoring may indicate digestive damage, although it may be difficult to differentiate human consumed or carnivore consumed remains (Landt 2007; Fernandez-Jalvo and Andrews 2011).

Much like the evidence of carnivore gnawing mentioned above, there is little evidence of human modification on the microfauna assemblage. Table 7a. shows that only 4 specimens feature cutmarks in zone IIIa, 7 in IIc/d, and 10 specimens in IIa/b. 80% of these recorded cutmarks are found on the bison assemblage. Table 7b shows the burned bone data and reveals that only three identifiable specimens had evidence of burning while 136 unidentifiable specimens were burned. All identifiable burned specimens occurred in Zone IIIa while 134 of the unidentifiable specimens were in IIIa, 1 specimen in Zone IIc/IIId, and 1 in Zone IIa/IIb. The presence of burned bones does not always suggest human influence; in this case, there is not enough evidence to imply these specimens were burned by people.

Zone	Cutmark	Carnivore	Rodent
IIIa	4	9	0
IIc/d	7	33	2
IIa/b	10	22	0

a

Zone	Burned Identified	Burned Unidentified
IIIa	3	134
IIc/IIId	0	1
IIa/IIb	0	1

b.

Table 7a. & b. NISP modifications of the assemblage. 7b. represents the burned bones that were recorded. Most of the burned bones were considered unidentifiable and does not necessarily suggest human influence.

5.1.4 Weathering

Weathering is one of the major factors affecting bones after they have been deposited at a site. Behrensmeyer's (1978) definitions of weathering patterns have been widely cited because she describes the different stages of weathering. Weathering is described from stages 0-5 with 0 being the beginning stage with no sign of cracking and stage 5 indicating severe weathering, resulting in the bone falling apart (Behrensmeyer 1978). In addition to defining these stages, Behrensmeyer also provides criteria for how to record the stages. Finally, she notes that changes in temperature, moisture, and

whether or not the bones are on the surface will affect the stages of weathering (Beherensmeyer 1978).

Taxa	Zones	Proximal	Distal	Shaft
<i>Lepus</i>	IIIa	37	63	0
	IIc/d	11	78	11
	IIa/b	50	25	25
Sciurid	IIIa	0	0	0
	IIc/d	3	88	9
	IIa/b	20	70	10

Table 8 *Lepus* and *Sciurid* Humeri Epiphysis Preservation percentages.

Most of the assemblage at Tse’K’wa is well preserved with little to no weathering on much of the assemblage. The specimens that could be described as stage 4 or 5 weathering were too degraded to identify a skeletal element and were therefore cataloged as “Unidentified” and not included in the project. That being said, there is good evidence that one or more taphonomic processes are preferentially destroying more vulnerable skeletal elements. This can be demonstrated by considering commonly found skeletal elements in which one end of the bone is less dense than the other. In the following example, the humerus is used because in most mammals the proximal humerus is more susceptible to destruction than the distal end. Table 8 shows that distal epiphyses in *Sciurid* and *Lepus* humeri are generally better preserved than proximal epiphyses. This suggests that weathering or some other taphonomic process is occurring and influencing preservation to some degree.

Table 9 shows the percentage of breakages that were recorded in the entire assemblage for both the proximal and distal ends of the specimens. Most specimens were recorded as being intact; eroded specimens are also present and account for 21-35% of the assemblage except for the distal epiphyses in zones IIa/b where 55% of

them were recorded with erosion. Figure 16 shows an immature *Lepus* ulna that shows mild erosion.

Element Part	Zone	Intact	Eroded	Excavation	Spiral	Transverse
Proximal	IIIa	65	21	2	4	8
	IIc/d	62	30	3	3	2
	IIa/b	67	22	3	3	5
Distal	IIIa	56	24	5	4	11
	IIc/d	55	35	4	3	3
	IIa/b	15	55	9	8	13

Table 9 Percentage of assemblage breakages, including intact specimens, eroded specimens, excavation breaks, and spiral and transverse fractures.

Specimens that displayed stage 5 weathering were labeled “Unidentifiable” and separated from the rest of the analysis. Weathered specimens that could still be identified to skeletal elements and taxa type were included in this research. Some specimens were immature, particularly in the lagomorphs, and therefore had more severe weathering than the mature specimens.



Figure 16. Mild erosion on immature *Lepus* ulna

The Tse’K’wa assemblage has multiple taphonomic processes at play, particularly for the small animal assemblage. Human influences were nonexistent in the microfauna assemblage but present in the bison assemblage. Carnivore and avian influences are

also present, indicating that the Tse'K'wa area was a place where some predators brought prey for consumption or a roosting site for owls. Most of the assemblage appears to have come from the local community, including migratory species, and deposited at the site (see Chapter 3).

5.1.5 Sample Size

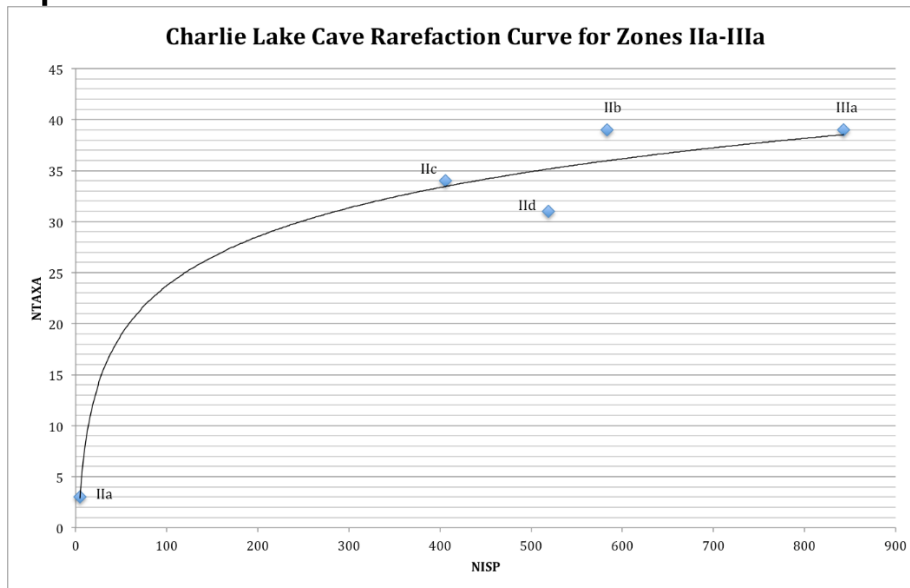


Figure 17. Rarefaction Curve for Zones IIa-IIIa

Another factor that influences faunal analyses is sample size. In general, larger assemblages have a greater variety of taxa than smaller assemblages. Therefore, when comparing assemblages, it is important to be aware of the influence of sample size on the presence or absence of taxa. Few sites in the Peace River Region that are dated to the late Pleistocene have as many well-preserved fossils as Tse'K'wa. Figure 17 shows the Rarefaction Curve for Zones IIa-IIIa to determine if the sample size of the various assemblages was substantial enough for analysis. Zone IIa had the least amount of fauna present with only 3 taxa represented by 5 specimens. Zones IIb-IIIa produced larger assemblages and were more similar in sample size (NISP) and number of taxa (NTAXA). As a result, Zone IIa was either excluded from the analysis or the Zone II

Subzones were amalgamated into pairs (Zones IIa/IIb and IIc/IId) which is also justified by the radiocarbon dates. From this graph, it was determined that the faunal assemblage from the late Pleistocene/early Holocene transition at Tse'K'wa was adequate for analysis, though the issue of sampling is always an issue in archaeological study.

5.2 Methods of Assemblage Analysis

5.2.1 Presence/Absence

Presence and absence data will be used to evaluate environmental conditions and how the assemblage reflects environmental change through time. Presence and absence are used to model species distributions (Warton and Shepherd 2010). In the case of the microfauna at Tse'K'wa, presence and absence of indicator taxa will be significant, because the presence of certain specimens that can only live in certain habitats will indicate the presence of that habitat. Absence on the other hand could indicate that certain habitats are not present if there are no taxa associated with that habitat. Absence can also signify change if previously identified specimens are no longer found, such as the case with the ground squirrels at Charlie Lake that are present in earlier layers but absent from later layers (Driver 2001).

Presence and absence relies on several assumptions. The first is the assumption that species have tolerances to various habitats that affects whether or not they can survive and establish a viable population. Second, it is assumed that the presence of species in an assemblage indicates that they were successfully living in that particular habitat, and the absence indicates that they could not adapt or live in the local environment.

Presence and absence are simple to evaluate; however, this method is not without complications. First, like most methods, this relies on the preservation of the fossil remains (Cutler et al. 1999; Daly 1969; Mitchell 2015). This means that taxa that are not found in the assemblage may still have been part of late Pleistocene to early Holocene environments, but they may not have been deposited at the site nor have been preserved in the assemblage due to taphonomic reasons. Alternately, rare taxa are problematic because it is difficult to determine whether this rarity is a result of poor preservation or a taphonomic anomaly. In addition, “the shifting of habitat boundaries also would tend to decrease differences among environments by mixing assemblages” (Cutler et al. 1999). In a region where the landscapes, climates, and general environments are changing rapidly, it is difficult to understand when and how the environment changed. Visibility of taxa is also complicated by the issues relating to identifications (see below). For example, rare taxa are problematic because it is uncertain if they are actually rare or the product of sampling constraints.

Another complication with presence and absence data is the fact that it only tells us whether or not a taxon was in the region. Taxa represented by a single element are given the same weight as taxa represented by many elements. What this method is unable to calculate is how abundant a taxon is at a given time which is yet another important component of understanding paleoenvironments. Therefore, additional methods are needed to analyze the microfauna at Tse’K’wa.

Other potential drawbacks come from the assumptions that are made in order to evaluate presence/absence. The first assumption that species have specific tolerances to various habitats can be problematic because we do not understand the full range of

species tolerances or the factors that affect tolerances. Competitors, predators, and geographic barriers may exclude a species from a habitat they should be able to thrive in. The second assumption, that presence indicates success, does not account for chance; this is prevalent in the few instances of passenger pigeon in the Tse'K'wa assemblage that may have come to the area after being blown off course during a migration. Redeposition and taphonomic processes may also affect presence data, thus altering our interpretations. These problems also exist in the assumptions made for absence data; some specimens are considered to be rarer than others and it is unclear if this is a result of absence of the species or the sample size of the assemblage.

In addition to considering the presence/absence of individual taxa, one can also consider which taxa co-occur, and compare those co-occurrences with the association of taxa in modern habitats. In the study of late Pleistocene to early Holocene environments, modern analogues are thought to be a useful technique in understanding past environments. Modern analogues look at the taxa that currently exists in modern environments as well as climatic variables that may or may not affect them; this relationship between assemblages and environments are then applied to paleo assemblages to understand past environments (Herbert and Harrison 2016). Although it is helpful to think about this technique, most paleoecological literature suggests that there are no modern analogues for late Pleistocene environments. The question is, is this the case for Tse'K'wa?

There has been a lot of discussion in archaeology in regards to the benefits of analogy in archaeological research. It is uncertain if analogies can be trusted in scientific inquiry because they are often unreliable, limited, and incomplete (Domínguez-

Rodrigo 2008; Hodder 2013). Binford (1967) suggested that analogies should be used to generate more questions for research. In regards to modern analogues in paleoecology, there are often false positives and false negatives that create errors (Jackson and Williams 2004). A false positive suggests that a taxon that was thought to be represented by the fossil assemblage is actually different from the modern and a false negative is where taxa thought to be different are actually similar (Jackson and Williams 2004).

Graham and Mead (1987) suggest that, because there are no modern counterparts for late Pleistocene faunas, they be described as non-analog. This suggests that late Pleistocene fossils do not have modern analogues but therefore represent environmental conditions different from those of today (Stafford et al. 1999). Stafford et al. (1999) suggest that taphonomic agents can create non-analogues and do not imply uniform conditions. In fact, they suggest that their data confirms the argument that late Pleistocene communities are unique. If Tse'K'wa follows this same reasoning and has no modern analog, there are a few predictions we can make.

First, the earliest communities at the site should not resemble modern communities, but the modern communities should begin to appear through time. This means that the specimens found in Zones IIa-IId should contain species that do not coexist together with the rest of the assemblage. In addition, specimens in Zone IIIa and later should have species that do coexist today. Our second prediction is that earlier assemblages should contain species that no longer exist in the region because it is outside their modern range while later assemblages will be consistent.

Table 10 shows the taxa found at Tse'K'wa during this analysis and whether or not

they still exist in the region today. For the bird specimens, presence/absence and modern analogues are difficult to determine since so many of these species are migratory. In the case of the American Golden Plover, for example, we only had a few specimens identified to this category and their modern migration range does not include Tse'K'wa. It is difficult to say whether or not the American Golden Plover samples reflect an actual change in the late Pleistocene/early Holocene bird community or if these specimens are an anomaly.

For specimens such as the collared lemmings and ground squirrels, we see a pattern of non-analog fauna. Neither taxon still exists in the region today and their modern ranges are far apart; collared lemmings are exclusively found in Northern Canada where there are tundra landscapes available while the most ground squirrel species are found from southern Alberta to the southwest United States in warmer grasslands. The fact that these two taxa co-occur supports the idea that Tse'K'wa does not have a modern analog. Because this period is defined by shifting landscapes, higher biodiversity, and dynamic environments, these species would be able to co-occur even with different habitat requirements (Graham et al 1996; Lyons 2003).

The microtine assemblage shows a slightly different picture. With a few exceptions (collared lemmings and southern red-backed voles), the microtine species have overlapping modern distributions; southern red-backed voles (*M. gapperi*) overlap with all species except the taiga voles (*M. xanthognathus*) and collared lemmings (*Dicrostonyx*). It should also be noted that taiga voles and collared lemmings are the only microtine species that do not currently inhabit the Charlie Lake area. Both of these species occur outside the Peace River Region; collared lemmings are currently found in

the northern tundra of Canada, Alaska, and Greenland while taiga voles occur as far south as Alberta and as far north as Alaska.

Alternatively, species like the snowshoe hare (*L. americanus*), muskrat (*Ondatra zibethicus*), meadow voles (*M. pennsylvanicus*), and Southern red-backed voles (*M. gapperi*) are all members of the modern Charlie Lake community. In addition, these specimens begin to appear at the end of the late Pleistocene and continue to increase through the early Holocene.

Taxon	Common Name	Distribution	Modern Presence	Habitat	Ila	Ilb	Ilc	Ild	IIa
Fish	Unidentified Fish	Varies	NA	Aquatic			6	88	317
Amphibians	Frogs	Varies	Y	NA			5	170	7
Reptiles	Snakes	Varies	Y	NA					71
<i>Gaviiformes</i>	Loon	North America	Y	Aquatic					1
<i>Aechmophorus occidentalis</i>	Western Grebe	N. and C. America	Y	Boreal Forests; Aquatic				9	7
<i>Podicipediformes</i>	Grebe	North America	Y	Aquatic		2		20	13
<i>Podiceps auritus</i>	Horned Grebe	Varies	Y	Large Lake and River Biome			1	1	6
<i>Anas sp</i>	Ducks	NA	NA	Aquatic		8	3	13	4
<i>Anas platyrhynchos</i>	Mallard	North America	Y	Aquatic		1			
<i>Oxyura jamaicensis</i>	Ruddy Duck	North America	Y	Aquatic		1			
<i>Teal sp.</i>	Teal	Varies	Y	Aquatic			1		
<i>Anas sp.</i>	Teal Sized	North America	Y	Aquatic (marsh)		1			9
<i>Large Mergus</i>	Ducks	Varies	Y	Aquatic			3		
<i>Bucephala albeola</i>	Bufflehead	North America	Y	Boreal; Taiga; Grassland		13	1		
<i>Tetraonidae</i>	Grouse	Northern Latitudes	Y	Coniferous Forest; Prairie		1	4	1	7
<i>Falconiformes</i>	Falcons	Varies	Y	Forests and Grasslands		1			
<i>Chordeiles minor</i>	Common Nighthawk	North America	Y	Forests and Prairies		1		1	
<i>Fulica americana</i>	American Coot	North America	Y	Boreal Forests; River Biome			2		1
<i>Pluvialis dominica</i>	American Golden Plover	North America	N	Boreal and Grasslands		1	1		2
<i>Calidris sp</i>	Waders	Varies	N	NA			1		
<i>Charadrius vociferus</i>	Killdeer	North America	Y	Taiga and Deciduous Forest		1			
<i>Charadriiformes</i>	Shorebirds	Varies	Y	NA		1			
<i>Columbidae</i>	Pigeon	Varies	Y	Agricultural					1
<i>Ectopistes migratorius</i>	Passenger Pigeon	Extinct	N	Hardwood Forest					2
<i>Small Strigiformes</i>	Small Owl	Varies	Y	Forest and Grassland		1			
<i>Asio flammeus</i>	Short-eared Owl	North America	Y	Open Grasslands		8			
<i>Corvus corax</i>	Raven	Varies	Y	Varies	2	56	1		63
<i>Passerines</i>	Perching Birds	Varies	Y	Forests and Shrubs	2	33	32	11	3
<i>Petrochelidon pyrrhonota</i>	Cliff Swallow	N. and S. America	Y	Cliffs		6	2	1	1
<i>Hirundinidae</i>	Swallow	Varies	Y	Lakes; Orchards		4		2	
<i>Petrochelidon</i>	Cliff Swallow	Varies	Y	Grasslands					1
<i>Turdus Sized Bird</i>	Robin	Varies	Y	Boreal and Grasslands		1			
Large Birds	Large-sized Mallards	NA	NA	NA		1		1	1
Medium Bird	Medium Birds	NA	NA	NA		8	19	20	19
Small Bird	Small Birds	NA	NA	NA		57	26	13	15
<i>Myotis</i>	Bat	North America	Y	River Biome and Caves				1	
<i>Lepus americanus</i>	Snowshoe Hare	North America	Y	Coniferous Forest		33	9	54	105

Taxon	Common Name	Distribution	Modern Presence	Habitat	Ila	Ilb	Ilc	Ild	IIla
<i>Lagomorph</i>	Hare	NA	Y	Forests and Grasslands		6	83	26	62
<i>Marmota monax</i>	Woodchuck	North America	Y	Forests and Fields		2	2		1
<i>Uroditellus</i>	Ground Squirrel	Varies	N	Grasslands		121	59	14	10
<i>Sciuridae</i>	Squirrel	Varies	Y	Forests and Grasslands		21	7		
<i>Eutamias</i>	Chipmunk	North America	Y	Shrub and Boreal					2
<i>Castor canadensis</i>	Beaver	North America	Y	Riparian Zone					6
<i>Peromyscus</i>	Mouse	World Wide	Y	Grasslands		5	2	2	1
<i>Peromyscus maniculatus</i>	Deer Mouse	North America	N	Grasslands		5			
<i>Ondatra zibethicus</i>	Muskrat	North America	Y	Swamps, Marsh, Wetlands		7			8
<i>Neotoma</i>	Pack Rat	North America	NA	Varies		1			
<i>Microtus sp</i>	Vole	NA	NA	NA		12	11	17	17
<i>Microtus xanthognathus</i>	Taiga Vole	North America	N	Boreal and Grasslands		10	2	2	20
<i>Myodes gapperi</i>	Southern Red Backed Vole	Northwest	Y	Boreal and Grasslands		6	10	8	28
<i>Microtus pennsylvanicus</i>	Meadow Vole	North America	Y	Boreal; Grasslands; River Biome;			1	1	1
<i>Microtus longicaudus</i>	Long-tailed Vole	North America	Y	Boreal; Grasslands; River Biome;				1	1
<i>Dicrostonyx</i>	Lemming	Northernmost America	N	Boreal and Tundra		3	3		1
Rodent sp	Rodents	NA	NA	NA		24	12	8	17
Small Mustelidae	Weasel	NA	NA	NA				1	
<i>Mustela nivalis</i>	Least Weasel	Varies	Y	Boreal and Grasslands					2
<i>Mephitis mephitis</i>	Striped Skunk	North America	Y	Forest and Grassland					1
<i>Vulpes</i>	Fox	Varies	Y	Forests and Grasslands		1			
<i>Canidae</i>	Wolf, dog, or other	Canada	Y	Forest and grasslands		1	4	1	
<i>Bison bison</i>	Bison	North America	Y	Temperate Grasslands	1	60	74	3	9
Large Ungulate	Hoofed Animals	NA	NA	NA		1	3	2	9
Large Mammal	large mammal	NA	NA	NA		2			
Medium Mammal	medium mammal	NA	NA	NA			3	2	
Small Mammal	small mammal	NA	NA	NA		66	13	25	

Table 10 Tse'K'wa Fauna NISP, Habitats, and Modern Presence/Absence. The Modern Presence Column refers to whether or not the taxa are still present in the region today; Y means the taxa is still present, N means they are now absent, and NA means there is No Answer because the taxa designation is too vague to determine.

From these examples, it is clear why analogies in archaeology are regarded with uncertainty. Tse’K’wa has a wide range of specimens from small birds and mammals to fish and bison. Collared lemmings, ground squirrels, and a few other species are no longer found in the region and often their modern ranges do not overlap. Bison were present until the 19th Century when they were exterminated and are now extirpated in the region. The fact that many of these taxa do not co-occur in modern environments implies that there are no modern analogs for Tse’K’wa.

5.2.2 Number of Identified Specimens (NISP)

Table 10 shows the NISP of the Tse’K’wa assemblages from Zones II and IIIa. NISP is a fundamental measure for zooarchaeological research (Lyman 2008). It is one of many methods of quantifying and documenting the contribution of each taxa to the assemblage and is therefore useful for understanding the relative abundance of taxa that cannot be understood through presence and absence data. One of the most notable advantages of NISP calculations is that it is relatively simple and time efficient to tally specimens as identifications are made and are therefore easy to update throughout the analysis (Klein and Cruz-Urbe 1984).

NISP calculations are not without notable faults, however. For one, identifications present an issue because of taphonomic influences or inter-observer differences (Driver 2011; Gobalet 2001; Lyman 2008). Fragmentation is also a cause of concern because it means there are more pieces that could potentially be added to the tally, thus causing some taxa to be overrepresented (Cannon 2013; O’Connor 2000). Other potential complications with NISP calculations include the different number of skeletal elements across taxa, the size of the screens used during excavation (especially in the case of

small birds and mammals), as well as taphonomic processes that result in some specimens preserving well while others aren't preserved at all.

Therefore, overrepresentation or underrepresentation of taxa is one of the biggest issues with NISP (Lyman 2008). Interdependence of the specimens refers to the fact that each identified specimen is treated as a discrete item, when multiple specimens may well derive from a single individual animal (Grayson 1979, 1984). In assemblages where fragmentation is prominent, interdependence can skew NISP counts, thus making some specimens appear more abundant than they actually are.

5.2.3 Minimum Number of Individuals (MNI)

MNI refers to the minimum number of individuals that are required to account for the total number of identified specimens of each taxon within an assemblage (Lyman 2008). (NISP is also the maximum number of individuals required to account for the identified specimens. Therefore, the actual number of individuals that contributed to an assemblage must lie between MNI and NISP). MNI is a derived quantitative measure that is meant to counteract some of the issues associated with NISP. One of the most commonly cited advantage of MNI is that it appears to solve the issue of interdependence found in NISP (Lyman 2008). MNI is calculated by finding the most abundant element that must be unique to an individual. For example, if seven left femora, four right humeri, and three atlas vertebrae were present for a certain taxon, the MNI would be seven, because at least seven animals are required to produce this assemblage. Many refinements of MNI have been proposed that tend to increase the MNI counts. For example, consideration of the state of development of the skeletal element could yield more MNI. In the example above, if all of the left femora were from

adults, one of the humeri was a juvenile, and one of the vertebrae from a neonate, then the MNI would be 7 adults plus one juvenile plus one neonate, for a total of nine. One advantage of MNI is the fact that in cases where fragmentation is slight, MNI counts are largely unaffected (Lyman 2008).

However, much like NISP, MNI is not without faults. The first and most obvious fault is that MNI is more difficult to calculate (Bököyni 1970) and needs recalculation with the addition of new data. Size, age, sex, and other characteristics must be determined before MNI can be calculated and intraspecies variation may be problematic for these distinctions (Klein and Cruze-Urbe 1984). MNI is also complicated by variation within the calculations. MNI is a best approximation based on the analyst's choice in how to quantify individuals (Allen and Guy 1984; Grayson 1973).

For Tse'K'wa, MNI may not be appropriate for understanding the abundance of the microfauna. Unlike NISP, MNI's shortcomings cannot be compensated using other analytical means (Lyman 2008); if taxa are underrepresented, we would not have a clear picture of past environments. In addition, NISP and MNI seem to be closely correlated mathematically (e.g. Casteel 1977; Grayson 1978; Klein and Cruze-Urbe 1984). As a result, it stands to reason that if MNI is a derived measure of NISP, then it may not be worth taking extra time to calculate it.

One of the most troubling issues with MNI has to do with the aggregation of the assemblage. Depending on how the assemblage is organized, different MNI values may be calculated even if the elements used in these calculations may be from the same individual and only ended up in different aggregates (Lyman 2008). Aggregates are

chosen by the researcher, and so there is a level of inter-observer variation and bias in MNIs.

MNI will not be calculated for the Tse'K'wa microfauna. I have opted to not use this unit because it takes too much time and may not be suitable for my research questions. NISP will be calculated because it is a fundamental measurement through which derived measures are correlated.

5.3 Analysis

5.3.1 Presence/Absence

Table 11 shows the presence and absence of the Tse'K'wa fauna in Subzones IIb through IIIa and presents a visual display of nestedness at the site. It is set up with the taxa that occur across all four subzones at the top and taxa that only occur in one subzone at the bottom. At the top of the figure, species such as grouse, cliff swallow, snowshoe hare, ground squirrel, bison and a couple species of voles are present in all four subzones. Other species such as killdeer, passenger pigeon, lemming, fox, loon, and others only show up in one of the subzones and are often represented by only one specimen. The data presented in Table 11 not only show when a specimen appears or disappears in the assemblage, but also allows us to measure ubiquity-the number of times a taxon appears in separate assemblages. For example, passenger pigeon, deer mouse, and lemmings only appear in one subzone while snowshoe hare, ground squirrel, and bison appear throughout the selected assemblage.

Tables 12 a., b., and c. are similar to Table 11 but focus on specific habitats. Taxa that were found in wetland/aquatic habitats are featured in Table 12 a., grassland adapted taxa are found in Table 12 b., and forest taxa are included in Table 12 c. A few

species can be found in a wide range of habitats, and were either excluded from Table 12 or included in the habitat where they are most commonly found.

SPECIES	IIb	IIc	IId	IIIa
<i>Tetraoninae</i>	Green	Green	Green	Green
<i>Petrochelidon pyrrhonota</i>	Blue	Blue	Blue	Blue
<i>Lepus americanus</i>	Black	Black	Black	Black
<i>Urocitellus</i>	Green	Green	Green	Green
<i>Microtus xanthognathus</i>	Green	Green	Green	Green
<i>Myodes gapperi</i>	Green	Green	Green	Green
<i>Bison bison</i>	Green	Green	Green	Green
<i>Pluvialis dominica</i>	Blue	Blue	White	Blue
<i>Corvus corax</i>	Green	Green	White	Green
<i>Marmota monax</i>	Black	Black	White	Black
<i>Canid sp.</i>	Green	Green	White	White
<i>Dicrostonyx</i>	Green	Green	White	Green
Fish	White	Blue	Blue	Blue
Frogs	White	Blue	Blue	Blue
<i>Microtus pennsylvanicus</i>	White	Green	Green	Green
<i>Bucephala albeola</i>	Blue	Blue	White	White
<i>Anas sp.</i>	Blue	White	White	Blue
<i>Ondatra zibethicus</i>	Blue	White	White	White
<i>Chordeiles minor</i>	White	Black	Black	White
<i>Fulica americana</i>	White	Blue	White	Blue
<i>Microtus longicaudus</i>	White	White	Green	Green
Snakes	White	White	Green	Green
<i>Aechmophorus occidentalis</i>	White	White	Blue	Blue
<i>Podiceps auritus</i>	White	White	Blue	Blue
<i>Anas platyrhynchos</i>	Blue	White	White	White
<i>Oxyura jamaicensis</i>	Blue	White	White	White
<i>Falconiformes</i>	Green	White	White	White
<i>Charadrius vociferus</i>	Blue	White	White	White
<i>Strigiformes</i>	Green	White	White	White
<i>Asio flammeus</i>	Green	White	White	White
<i>Peromyscus sp.</i>	Green	White	White	White
<i>Neotoma</i>	Black	White	White	White
<i>Vulpes</i>	Green	White	White	White
<i>Teal sp.</i>	White	Blue	White	White
<i>Myoti</i>	White	White	Green	White
<i>Gaviiformes</i>	White	White	White	Blue
<i>Ectopistes migratorius</i>	White	White	White	Black
<i>Castor canadensis</i>	White	White	White	Blue
<i>Eutamias.</i>	White	White	White	Black
<i>Mustela nivalis</i>	White	White	White	Black
<i>Mephitis mephitis</i>	White	White	White	Black

Table 11 Tse'K'wa Presence/Absence and Nestedness. Green spaces represent grassland species; Blue represents wetland species, and Black represent forest species. Blank spaces represent an absence of the taxa in that zone.

a.

SPECIES	IIb	IIc	IId	IIIa
<i>Petrochelidon pyrrhonota</i>	■	■	■	■
Fish	■	■	■	■
Frogs	■	■	■	■
<i>Pluvialis dominica</i>	■	■	■	■
<i>Aechmophorus occidentalis</i>	■	■	■	■
<i>Podiceps auritus</i>	■	■	■	■
<i>Bucephala albeola</i>	■	■	■	■
<i>Anas</i> sp.	■	■	■	■
<i>Fulica americana</i>	■	■	■	■
<i>Ondatra zibethicus</i>	■	■	■	■
Gaviiformes	■	■	■	■
Teal sp.	■	■	■	■
<i>Anas platyrhynchos</i>	■	■	■	■
<i>Oxyura jamaicensis</i>	■	■	■	■
<i>Charadrius vociferus</i>	■	■	■	■
<i>Castor canadensis</i>	■	■	■	■

b.

SPECIES	IIb	IIc	IId	IIIa
<i>Tetraoninae</i>	■	■	■	■
<i>Urocitellus</i>	■	■	■	■
<i>Microtus xanthognathus</i>	■	■	■	■
<i>Myodes gapperi</i>	■	■	■	■
<i>Bison bison</i>	■	■	■	■
<i>Corvus corax</i>	■	■	■	■
<i>Microtus pennsylvanicus</i>	■	■	■	■
<i>Canid</i> sp.	■	■	■	■
<i>Dicrostonyx</i>	■	■	■	■
<i>Microtus longicaudus</i>	■	■	■	■
Snakes	■	■	■	■
Falconiformes	■	■	■	■
Strigiformes	■	■	■	■
<i>Asio flammeus</i>	■	■	■	■
<i>Myoti</i>	■	■	■	■
<i>Peromyscus</i> sp.	■	■	■	■
<i>Vulpes</i>	■	■	■	■

c.

SPECIES	IIb	IIc	IId	IIIa
<i>Lepus americanus</i>	■	■	■	■
<i>Marmota monax</i>	■	■	■	■
<i>Microtus pennsylvanicus</i>	■	■	■	■
<i>Aechmophorus occidentalis</i>	■	■	■	■
Chordeilinae	■	■	■	■
<i>Ectopistes migratorius</i>	■	■	■	■
<i>Tamias</i> sp.	■	■	■	■
<i>Neotoma</i>	■	■	■	■
<i>Mephitis mephitis</i>	■	■	■	■
<i>Vulpes</i>	■	■	■	■

Table 12 a. (wetlands), b. (grasslands), and c. (forests) presence/absence of habitats.

From the presence/absence data, we see that some taxa are more common in the assemblages than others and persist throughout all four subzones. This suggests that they were still present near the end of the late Pleistocene/early Holocene Transition. The persistence of these taxa such as the taiga vole, snowshoe hare, cliff swallows,

bison, and ground squirrels suggests that the environment had not completely shifted from grassland to forest and was still in transition. It is hard to say why some taxa are only represented occasionally. In addition to being a real reflection of their presence/absence in the local environment, we must also bear in mind other factors such as birds being blown off course during a migration, the relatively low numbers of carnivores in relation to herbivores, and the processes that brought specimens to the site.

5.3.2 Changes in Relative Abundance of Taxa

In the Peace River Region, pollen records show a trend of postglacial environments moving rapidly from open grassland landscapes to boreal forests (Pedersen et al. 2016). If this is accurate, we should see a similar trend in the faunal remains. In order to test this prediction, we should see more open habitat and grassland specimens in lower levels of the Tse'K'wa site that should be replaced by boreal habitat specimens over time. In addition, the percentage of open habitat specimens should decline through time.

After identifying the species present in the assemblage, I determined the habitats generally associated with each species and found what percent of the NISP each habitat type (Grassland, Wetland, or Forest) represented. For example, meadow voles (*M. pennsylvanicus*) are often found in boreal regions while taiga voles (*M. xanthognathus*) are often found in tundras and Southern red-backed voles (*M. gapperi*) are found in grasslands. In the following analyses, I use %NISP to examine changing habitats through time.

Figure 18 shows the changes in Tse'K'wa's habitats through faunal associations. Separating species into habitats is not without complications. While I was researching the kinds of habitats the identified species lived in, I found that several species lived in multiple kinds of habitats (several species of voles lived in both forest and grassland habitats); this makes it difficult to infer which habitat is more dominant and may change depending on how the specimen is tallied. In these instances, specimens were not counted twice but included in the habitat group where they are more commonly found. As expected, grassland species dominate the lower layers (IIb and IIc) and these decrease through time in relative abundance because of an increase in relative proportions of forest and wetland taxa.

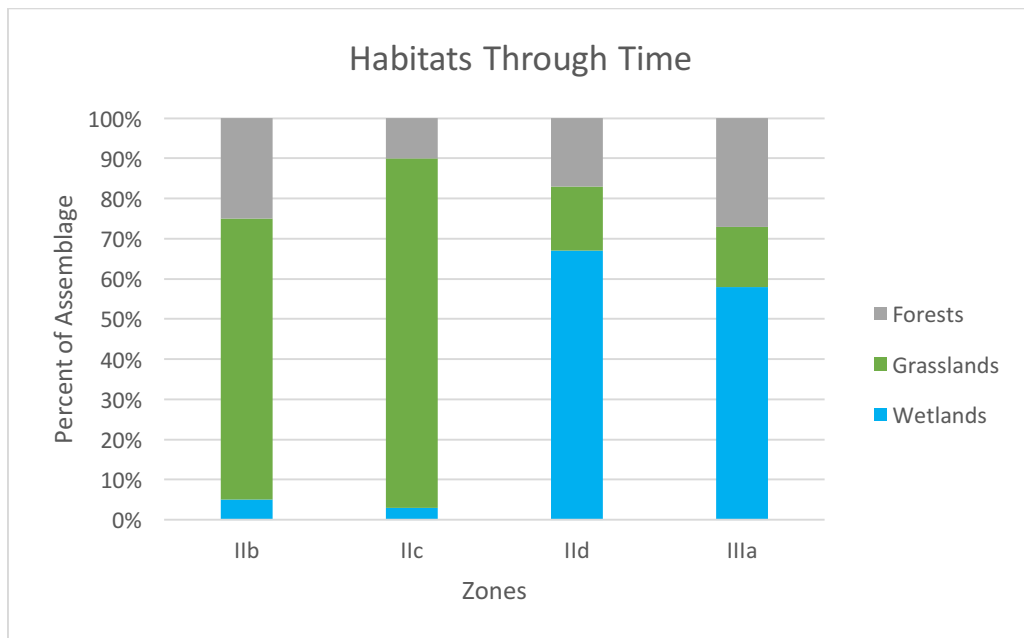


Figure 18. Tse'K'wa habitats through time, represented by wetlands, grasslands, and forests

Based on previous work in the region, the transition from grasslands to forest was expected. However, another interesting trend in the assemblage analysis was the increase in aquatic taxa. The fact that fish become more common over time shows a clear transition towards a more aquatic habitat. Zone IIb has no fish present and only

about 5% of other aquatic species (including water fowl and mammals adapted to wetland habitats). By Zones IId and IIIa, this percentage increases to over half of the assemblage being represented by wetland-adapted taxa as the lake habitat became established.

Forest species aren't as clearly represented unless the aquatic habitat species are removed (Figure 18). When only terrestrial habitats are considered, in Zone IIb, forest species represent approximately 26% of the assemblage and this decreases to 10% in Zone IIc. After Zone IIc, the percentage of forest species increases again to 61% in Zone IId and 64% in Zone IIIa. In Figure 19, it is much easier to see that the fauna at Tse'K'wa follows a similar trend as the regional pollen core data in that there is a transition from grassland to forest habitats.

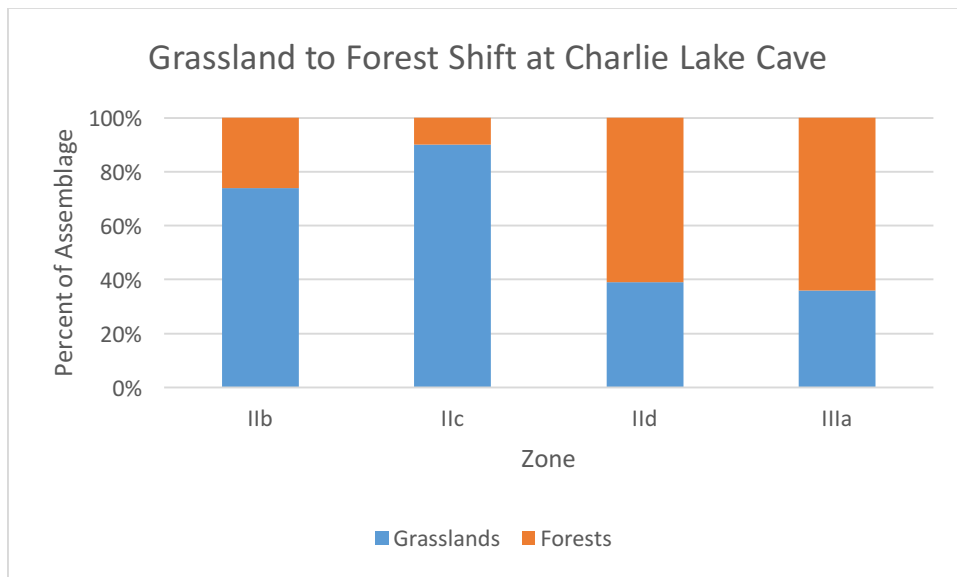


Figure 19. Faunal associations without aquatic species

If the assemblage is broken down, not into habitat types, but two common species, we see a different picture. Snowshoe hares (*Lepus americanus*) and Ground Squirrels (*Sciuridae*) show a pattern that more closely resembles the pollen cores. These two

species were chosen as a way to simplify the analysis and show environmental changes through two similarly sized specimens with clearly defined habitat differences. Snowshoe hare live in forest habitats, particularly boreal and coniferous forests, while ground squirrels are more commonly known as prairie species. In addition, their similar sizes also serve to control taphonomic issues since they are less likely to be affected by differences in predator selections and other taphonomic factors.

In Figure 20, *Lepus americanus* are represented by the green line which increases through time while *Sciuridae* species are represented by blue and decrease through time. Given what we know from the pollen record, this relationship between ground squirrels and snowshoe hare was expected. The boreal species (the hare) increases in time while the grassland species (the ground squirrel) decreases, much like the transition from grassland pollen to boreal forest pollen.

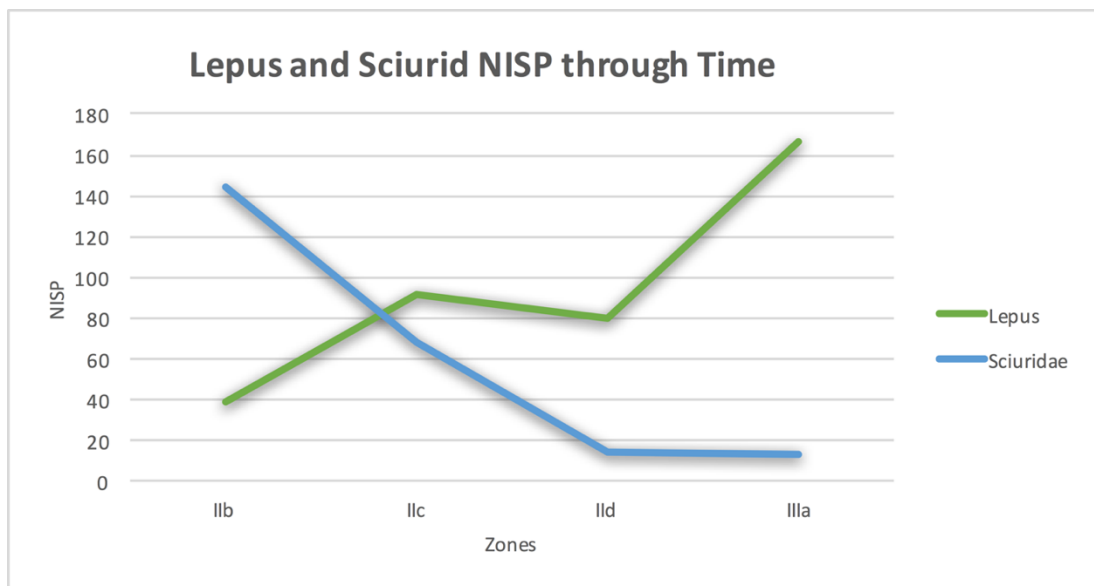


Figure 20. Changes in the *Lepus americanus* and *Sciurid* NISP in Zones IIb through IIIa

After looking at just the hare and ground squirrels, I looked at the changes in microtine species through the zones (Figure 21). We identified four microtine species

and one genus (*Dicrostonyx*). That is associated with a specific habitat type. Of the identified species, we found meadow voles (*Microtus pennsylvanicus*), taiga voles (*Microtus xanthognathus*), Southern red-backed voles (*Myodes gapperi*), and long-tailed voles (*Microtus longicadus*).

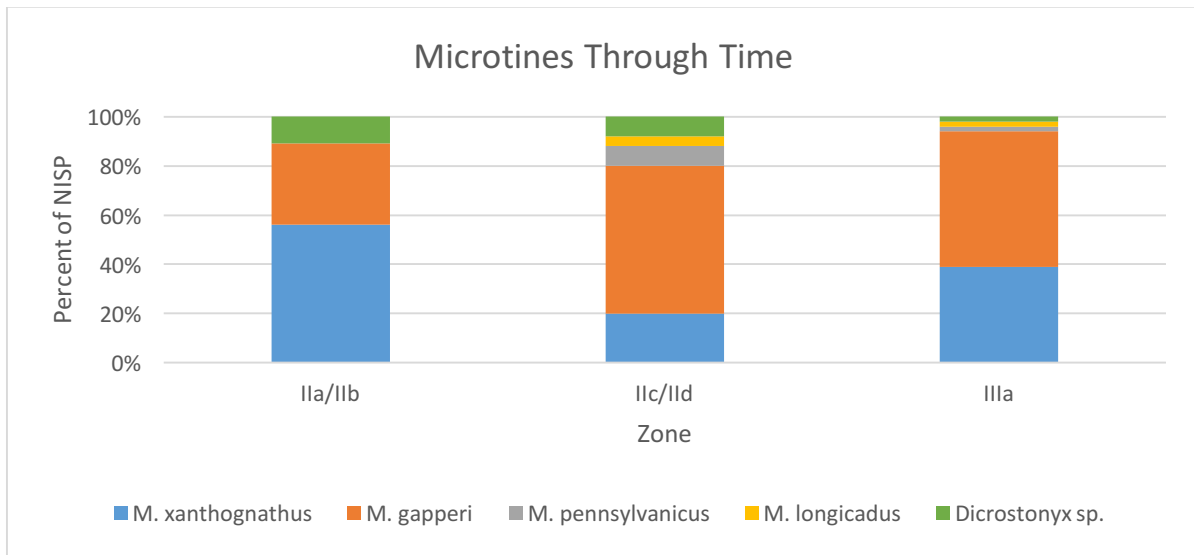


Figure 21. Microtine percentages in Zones IIb through IIIa

In Zones IIa/IIb, species such as the taiga vole, Southern red-backed voles, and collard lemmings are present with taiga vole being most abundant. These species have grassland and taiga habitats in common, though Southern red-backed voles can be found in both grassland and boreal habitats. In Zones IIc/IId and IIIa, taiga voles and collared lemmings decrease while Southern red-backed voles increase. Meadow voles and long-tailed voles also appear in Zones IIc/IId and also represent boreal habitats.

5.3.3 Pollen, environmental DNA and the Tse’K’wa Assemblage

Pedersen et al. (2016) took the most recent cores from Charlie Lake as well as cores from Spring Lake (approximately 630 kilometers southeast from Charlie Lake). The ages of these cores span the entire late Pleistocene/early Holocene Transition at Charlie Lake and later for Spring Lake. In addition to the pollen record and radiocarbon

dates, the researchers also found traces of environmental DNA (eDNA) that they also analyzed. Considering the proximity to the archaeological site, we should see similarities in the range of animal species and the same species should appear and disappear around the same time. The core data corroborates the data found at Tse’K’wa but also fill in gaps that the faunal assemblage may have. Alternatively, the eDNA data gaps can be supplemented by the faunal assemblage at Tse’K’wa.

Species	Common Name	I	II	III
<i>Esox</i>	Pike			
<i>Bison</i>	Bison			
<i>Mammuthus</i>	Mammoth			
<i>Microtus</i>	Voles			
<i>Alces</i>	Moose			
<i>Haliaeetus</i>	Eagle			
<i>Leporidae</i>	Rabbits/Hare			
<i>Lepus</i>	Hare			
<i>Perciformes</i>	Perch			
<i>Culaea</i>	Sticklebacks			
<i>Gasterosteus</i>	Sticklebacks			
<i>Castor</i>	Beaver			
<i>Eptesicus</i>	Bats			
<i>Cervus</i>	Elk			

Table 13 Pedersen et al. (2016) Charlie Lake pollen core presence/absence based on eDNA. Pollen Zones differ from Tse/K/wa Zones; Pollen Zone I dates between 11,000 to 10,600 cal BC, Pollen Zone II is dated 10,600 to 9,600 cal BC, and Pollen Zone III is dated 9,600 to 9,000 cal BC.

Table 13 shows the presence/absence of the Charlie Lake core. Bison is a common species at Tse’K’wa, appearing in Zones IIb through IIIa; unsurprisingly, bison also has a presence in the core data and appears in all three Pollen Zones. The bison eDNA shows a similar timeline to Tse’K’wa. Bison in the pollen cores appear around 11,000 cal BC and continue through 9,000 cal BC (Pedersen et al. 2016). In addition to

bison, large fauna such as moose, elk, and mammoth were also identified in the pollen cores but were not identified in the faunal assemblage. Eagles were also present in the core, but were not identified in the Tse'K'wa assemblage.

Smaller species such as hare, voles, beaver, and brown bat are also present in both analyses. Pedersen et al. (2016) identified the *Lepus* species in their pollen cores as jackrabbit, though do not specify the species. It is possible that some of the eDNA belonged to *Lepus americanus*, but the authors did not give specific identifications beyond the Genus level. In the Charlie Lake assemblage, snowshoe hare (*Lepus americanus*) was identified but the larger *Lepus* species could not be identified by zooarchaeological methods. In the Charlie Lake and Spring Lake pollen cores, *Lepus* was recorded at 10,400 cal BC and 9,500 cal BC, while Tse'K'wa has hare present throughout the transition into the Holocene.

There were only six specimens identified as beaver in Subzones IIb through IIIa at Tse'K'wa. In the cores, beaver was present around 9,000 cal BC (Pedersen et al. 2016). Only one specimen was identified as bat in Zone II d, but could not be identified to the species level because the mandible was without teeth and other distinctive markers. Pedersen et al. (2016) identified brown bat in the Spring Lake core between 8,000-7000 cal BC, though they don't provide much detail on the finding and its implication. Microtines were also found in the eDNA record at 10,400 cal BC to 9,700 cal BC, but were not identified to species so it is difficult to compare these results.

One of the major differences between the Tse'K'wa faunal record and the Charlie Lake core is the lack of water fowl in the eDNA data. Water fowl make up approximately 5% of the entire Zone IIb-IIIa assemblage and include various species of

duck, grebes, American coot, loons, and Charadriiformes such as the American golden plover (*Pluvialis dominica*) and killdeer (*Charadrius vociferus*). Figure 22 shows the identified water fowl and their percentages. In Zones IIb and IIc, ducks dominate the water fowl assemblage; these include bufflehead (*Bucephala albeola*), mallards, teals, and others. In Zones IIId and IIIa, grebes such as the Western grebe (*Aechmophorus occidentalis*) and the horned grebe (*Podiceps auritus*) begin to dominate. It is unclear why ducks dominate in Zones IIb and IIc, but not IIId and IIIa. This may be the result of predator preferences, feeding habit differences (only some ducks are divers while grebes primarily feed by diving for fish), or other taphonomic processes, or it may be because we can only analyze a sample of past environments.

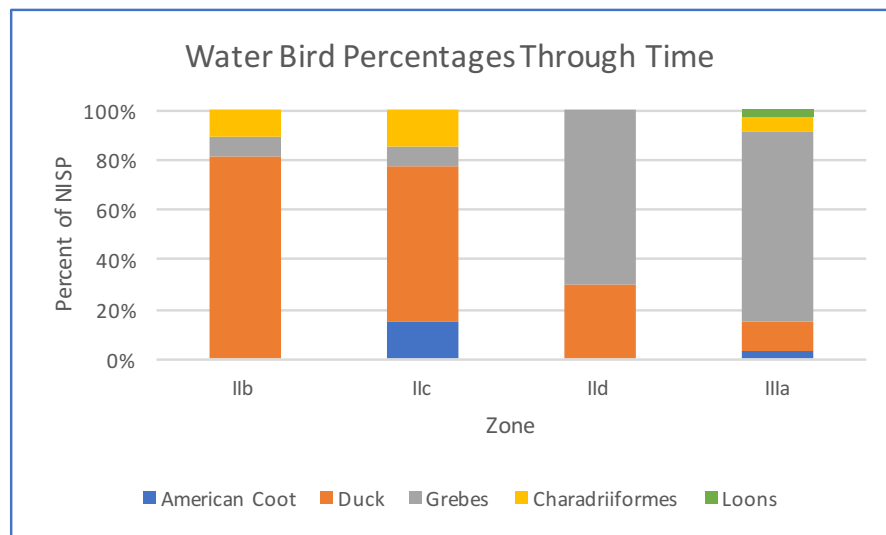


Figure 22. Water Fowl species at Tse'K'wa

The cores from Charlie Lake and Spring Lake confirm the transition from grasslands/steppe habitats to boreal forests (Pedersen et al. 2016). The data shows and influx of grasses and sedges around 11,000 to 10,600 cal BC. Until 9,600 cal BC, steppe vegetation and fauna remain present and include *Artemisia*, *Asteraceae*, *Rosaceae*, *Betula*, and *Salix* species in both lakes (Pedersen et al. 2016). This steppe

habitat supported bison, *Lepus*, and *Microtus* populations by 10,500-10,400 cal BC. After this time, *Populus* trees became more dominant. After 9,500 cal BC, the pollen and eDNA data suggests a decline in pollen influx in favor of green algae (*Botryococcus*), but later transitions to modern Boreal Forests after 9,000 cal BC.

Although there are a few gaps in data for both the faunal assemblage and the core eDNA, these analyses are complementary. The cores found taxa that were not preserved in the faunal assemblage, giving us a better idea of past ecological communities. In addition, the core corroborates the radiocarbon dates and the presence of some species at Tse'K'wa. When the corridor first opened, vegetation spread gradually through the region until a steppe and woodland habitat was present. This habitat featured bison and other large ungulates, microtines and lagomorphs, as well as eagles, and mammoths, and other species. By approximately 10,000 to 9,000 cal BC, a fish community was established, an aspen parkland habitat was also present, followed by a boreal forest. Bison and mammoth and other steppe species disappear from the cores once the forests are established, much like in the Tse'K'wa faunal record.

While the cores can corroborate the timing of environmental changes and the presence of some communities, the eDNA data provided aren't as specific as the faunal assemblage. Using microtine teeth, we were able to identify several species of voles and collared lemmings while the eDNA just shows the presence of "Voles." In addition, the hare that was reported does not specify whether or not snowshoe hare is present and does not clarify what species of larger hare is present.

Most studies agree on a transition from grasslands to forests at the end of the late Pleistocene in the Peace River Region (Arnold 2006; Burns 1996; MacDonald and

McLeod 1996; White 1983; White and Mathewes 1986). Pielou (2008) looked at current deglaciation processes in Glacier Bay, Alaska as a modern analogue to late Pleistocene/early Holocene deglaciation. She observed that nitrogen fixer plants would be the first to colonize, followed by patches of growth. This cannot be seen in the Tse'K'wa faunal assemblages, but Pedersen et al. (2016) noted the presence of *Shepherdia canadensis* (buffaloberry) which is a nitrogen-fixing plant. Hickin (2013) determined that stabilization of the regions' dunes occurred between 12,000 cal BC and 10,000 cal BC and coincides with boreal parklands. The data here suggests that boreal habitats occur much later towards the end of the late Pleistocene/early Holocene transition.

Megafauna such as bison have also been recorded as indicators of steppe habitats around 11,400 cal BC (Burns 2010). Shapiro et al. (2004) and Heintzman et al. (2016) also note the presence of bison early in the chronology. Steppe fauna found at Wally's Beach Site in southern Alberta were dated to 11,200 cal BC (Kooyman et al. 2001); these dates differ from those at Tse'K'wa but support the findings of an open steppe-like habitat at the end of the Pleistocene as deglaciation progresses. Later, vegetation indicative of boreal forests such as *Picea*, *Pinus*, and *Betula* colonize the region (Driver 1988; MacDonald 1987a; Pedersen et al. 2016; White 1983; Wilson 1996b); the increasing presence of boreal species is also supported by this analysis.

5.4 Conclusion

Tse'K'wa is a unique site in the Peace River Region because of its excellent preservation and a large sample size. These factors make Tse'K'wa unique and provides insight to late Pleistocene/early Holocene environments. The fauna at Tse'K'wa were deposited throughout the history of the site and shows minimal

weathering on identifiable specimens in Zone II and IIIa. There are a few instances of carnivore influence and avian pellets, but little human impact on the small birds and mammals.

The data at Tse'K'wa can be used in many different ways to understand past environments. With presence/absence methods and an understanding of habitat requirements for the specimens found, the data shows a transition from an icy landscape to an increasingly more aquatic habitat. In addition, the data supports other conclusions of a transition from grassland habitats to forested habitats.

Recent pollen core studies have provided (when paired with the faunal assemblage) a clearer picture of past faunal communities in the Peace River Region. The cores found animal DNA from taxa that had not been identified in the faunal assemblage but the DNA analysis did not include many of the taxa that were identified in the faunal record.

Chapter 6

CONCLUSIONS

The purpose of this study was to understand local paleoenvironments in the Peace River Region during the late Pleistocene/early Holocene transition, with a focus on the assemblage of smaller fauna at Tse'K'wa. The microfauna, consisting of rodents, other small mammals, and small birds, were abundant and well preserved throughout the late Pleistocene and early Holocene and helped to provide a unique insight to past environments. Using zooarchaeological identification methods, presence/absence data and calculations of relative abundance based on NISP, this research was able to add to our understanding of the late Pleistocene/early Holocene transition in the study area.

Tse'K'wa is the only site in the Peace River Region that has well preserved fauna in well-dated stratigraphic zones that spans from at least 10,500 cal BC to the present. The site was divided into four Zones, each with numerous Subzones. Only Zones IIa-IIIa were considered for this research since Zone I lacked the faunal remains needed and Zones IIIb-IV are younger than the late Pleistocene/early Holocene Transition. Zone II is defined by a silty sediment with larger specimens of quartz, quartzite, chert and other materials. It is dated from 10,500-9,500 cal BC based on the series of radiocarbon ages on animal bones from the site (see Chapter 3). Zone IIIa, around 9,500 to 9,000 cal BC, is the only Subzone in Zone III to be included in this analysis since it is still early enough to be part of the transition. It is distinguished from Zone II by its medium fine sand and higher organic content.

Tse'K'wa is also known for its cultural components. Although these were not integral to the environmental analysis, the cultural components show human

involvement at the site. Ten cultural components were identified by Handly (1993); these categories were based on the stratigraphy and only three are relevant to the Paleoindian layers. Component 1 features butchered bison and a projectile point, though it also contains a bead, some flakes, and core tools. Component 2, however, had a smaller assemblage with no distinctive artifacts. Finally, Component 3 contained a microblade core in direct association with a raven skeleton.

A popular hypothesis for environmental changes in the Peace River Region are that the region transitioned from a grassland habitat to a forest habitat. This thesis supports that hypothesis and, in addition, it shows an increasing aquatic influence in the local area. The data that support this transition can be seen in the habitat requirements for the taxa found as well as the changing relative abundances of NISP values for taxa with definable habitats. This is particularly clearly seen in the differences in abundance between *Lepus* and *Sciuridae* species. As Sciurids (such as ground squirrels) decrease through time, *Lepus* species (such as the snowshoe hare) increase; because the former are indicative of grassland habitats and the latter indicates forests, it is suggested that this reflects the transition.

Lake core data reported by Pedersen et al. (2016) also shows this trend. The pollen data indicates a tundra/steppe with poplar around 10,600 cal BC to 9,600 cal BC that shifts to an aspen parkland and later a boreal forest after 9,000 cal BC. In terms of the eDNA data from the core samples, the analysis in this thesis explored whether or not the microfauna assemblage from Tse'K'wa supported the findings of Pedersen et al. (2016)'s analysis from Charlie Lake and Spring Lake. Species such as hare, voles beaver and brown bat were present in both analyses. However, the voles were not

identified to the species level on the basis of eDNA and the cores did not seem to indicate the presence of waterfowl in the eDNA data. The waterfowl in the Tse'K'wa assemblage is reviewed to expand on this lack of data.

The microfauna from Tse'K'wa adds to the evidence for a changing environment. In Zone IIa, few faunal specimens were found, so few conclusions can be made. Zone IIb (10,500-10,000 cal BC) features a larger assemblage that seems to come from a terrestrial grassland habitat. Zones IIc and IId (10,000-9500 cal BC) are where the environment begins to change. Zone IIc is still dominated by grasslands while IId is dominated by forests. Species such as meadow voles and long tailed voles appear in this time and represent the boreal habitats. Another difference between IIc and IId is the large percentage of ducks in the former and grebes in the latter; it is unclear what the cause of this shift is but for the other fauna in these Zones, changes in habitat may explain why some species appeared and increased in population while others slowly faded out. Zone IIIa featured the least amount of Sciurids and the most *Lepus* specimens. By this time, the faunal assemblage is over 60% forest dominated; it is not yet a completely boreal habitat but it is clear that the grasslands are beginning to shift towards forests and the transition is still ongoing.

The Peace River has had extensive paleoenvironmental research conducted to understand the deglaciation and repopulation of the region. Most of these studies agree that the glacial ice had retreated from the region approximately 15,000 cal BC to 14,000 cal BC (Bobrowsky and Rutter 1992; Catto et al. 1996; Dyke et al. 2002; Ives et al. 2013; Hickin 2016) and Glacial Lake Peace drained around 11,600 cal BC (Hickin 2013; Hickin et al. 2015; Munvikawa et al. 2016; White 1983), although the exact nature of

these events is still debated and the timing of the rehabilitation processes is still uncertain. At Tse'K'wa, there are ages as far back as 10,500 cal BC that confirm that Glacial Lake Peace had drained by this time if not earlier.

Revegetation in the region has also been extensively studied by several researchers. The chronology of revegetation is uncertain and often seen as a slow process (Pielou 2008). Some studies suggest that revegetation in the Peace River Region was continuous from the draining of GLP throughout most of the Holocene. Though it is uncertain when exactly the region became habitable and vegetation was established, it is widely agreed that there was a transition from steppe and tundra habitats that became warmer forest habitats over time (Arnold 2006; Burns 1996; Burns 2010; Heintzman et al. 2016; Hickin 2013; MacDonald and McLeod 1996; Pedersen et al. 2016; White 1983; White and Mathews 1986). This thesis did not analyze any pollen from the local area of Charlie Lake, but the microfauna assemblage appears to depict a similar pattern. Steppe habitats appeared in the local area around 10,500 cal BC but, by 9,000 cal BC, the area was dominated by boreal forests.

One of the changes to the local environment that differs from the general regional environment is the fact that the site is located near Charlie Lake, and so there is the added influence of an aquatic habitat. Although there are several other lakes in the region, Charlie Lake is unique in the preservation of the faunal assemblages nearby, so the aquatic and terrestrial aspects of the site could be analyzed. Cores from the lakes have provided eDNA samples to add evidence to changing environments, but as this study shows, these samples are not all inclusive. One issue with the eDNA samples from Charlie Lake and Spring Lake was the fact that waterfowl DNA was not found in

the cores. With the faunal assemblage present at Tse'K'wa, the fossil record was able to fill in the gaps found in the cores and vice versa.

The aquatic influence at Charlie Lake is a direct result of deglaciation and the retreat of Glacial Lake Peace. That being said, while there was a lake present and used by animals throughout the sequence, fish species do not appear until the end of the Paleoindian layers where they appear in large numbers. Waterfowl such as ducks, shorebirds, and grebes are present throughout all of the Paleoindian layers, though the percentages differ from zone to zone. It is difficult to compare the presence of waterfowl and other aquatic species from the rest of the region because few sites have an assemblage adequate for comparisons.

One of the most investigated questions of North American archaeology is understanding when and how early humans first occupied the Americas. For a long time, the IFC hypothesis was the widely-accepted explanation, though this has since been reevaluated; the dates for human occupation and the viability of the Peace River Region do not line up in a way that makes it possible for the corridor to be the route for first occupation. The question, then, is not if the corridor was the location for the first entry into the Americas, but when the region was viable for later occupations and what conditions these early groups would have lived in.

Tse'K'wa has been central to understanding environmental conditions in the region as well as the archaeological implications of its location since its discovery. The site is the only one in the region that provides well-dated faunal assemblages throughout the late Pleistocene/early Holocene transition when the corridor would have been viable for occupation. It also features evidence of human occupation that is equally dated.

However, it is unclear what interactions may have occurred with these early humans and the microfauna of Charlie Lake since there was no evidence of human influence on the specimens other than a few burned bones; ethnographic histories, however, discuss hunting of species of hare and fish which were abundant in the region at the end of the Pleistocene and therefore could have been hunted.

Despite the lack of evidence for a direct connection between human occupations and microfauna, we can still speculate on what these data mean for human occupation. When Paleoindian groups first moved into the region, they would have found a steppe habitat suitable for the bison they've been known to hunt. The region would have been more open, allowing the groups to move through the region around 10,500 cal BC. Over time, this would have shifted towards a warmer forest habitat that these groups would have adapted to as they moved through and settled throughout the Peace River Region around 9,000 cal BC and later.

Although the analysis of small mammals and birds at the site has expanded upon and supported other studies, it is not without problems. There were many specimens, particularly the small birds and some of the mammals that could not be identified by the skeletal remains alone. Most of the small birds were labeled passerine but were not distinctive enough to identify a species and the same issue was found in regards to the *Lepus* species that were not snowshoe hare. The ground squirrels could not be identified through zooarchaeological methods, but aDNA conducted by the SFU Lab confirmed the species was Richardson Ground Squirrel. Further studies could use aDNA to get definitive identifications to supplement the findings here.

The small fauna assemblage at Tse'K'wa has potential for several future studies. Firstly, studies could continue to focus on the fauna at Tse'K'wa. For example, although this study acknowledged the presence of potential avian pellets, they were not analyzed to the full extent. Analyzing the bone clusters can not only contribute more understanding to the ecological community at Charlie Lake during the transition, but may also contribute to the zooarchaeological study of avian pellets and bone clusters which have not been extensively studied.

Another study could focus on predators and predation at Tse'K'wa. Although there wasn't a large sample of predators to work with, one could use the small mammal and birds to infer changing site use by predators through time. Other studies could focus on the migratory patterns of birds in the late Pleistocene/early Holocene; some of the identifiable birds are known migratory species and others, like the passenger pigeon, were not known to have been in the region until they were found at Tse'K'wa. The movement of species in a post glacial environment is another point of interest; studies on the bison remains of the Peace River Region explored the northern and southern movement of bison through the deglaciated landscape. Another study could focus on whether or not such movements can be seen through the microfaunal remains.

There is always the possibility for more archaeological sites in the Peace River Region to be found to have similarities to Tse'K'wa with well dated stratigraphy and adequate faunal samples throughout the sequence. Should this happen, comparative studies could be done to further explore late Pleistocene/early Holocene environments and ecological communities. Until then, Tse'K'wa remains a unique site that can

provide insight to environmental conditions that Paleo-Indians would have experienced as they moved through the area.

While other studies focus on large mammals such as bison as well as pollen data, the microfauna from Charlie Lake has also added another line of evidence for this transition and provides more detail in regards to the presence and absences of certain species. No other site has the preservation and abundance of small mammals throughout the entire transition, making the microfauna at Charlie Lake a unique study.

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