PULLING APART THE PILE: ANALYZING THE CHRONOLOGY AND ZOOARCHAEOLOGY OF HEAD-SMASHED-IN BUFFALO JUMP

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Abstract

Head-Smashed-In Buffalo Jump (Estipah-skikikini-kots), located in southwestern Alberta, Canada, is the oldest confirmed, best preserved, and the longest used bison jump in the Great Plains. It was excavated by several researchers in the 20th century, and the earliest deposits at the site are currently being investigated by a joint University of Lethbridge (ULeth) and Royal Alberta Museum (RAM) research team. This thesis project focuses on the re-investigation of chronological and zooarchaeological aspects of Head-Smashed-In Buffalo Jump (HSIBJ) using artifacts and documents from previous excavations now curated at the Royal Alberta Museum. There are three main components of this research. The first is an investigation of the chronology of the site, conducted by collating decades of projectile point data, submitting new ^{14}C dates, and reanalyzing the stratigraphy from the original kill site excavation notes. The second component is a taxonomic study of the bison species that were hunted during the first use of the site, *Bison antiquus occidentalis* or *Bison bison*. The third component is a comparative study of the zooarchaeological data from HSIBJ and other large bison kills on the Northwestern Great Plains. Through this research, we now have a better understanding of site use during the mid-Middle Precontact period. Key outcomes include the discovery that there is likely no cultural gap between 3 100 and 900 BCE as previously hypothesised and that the makers of the Oxbow point used the jump. It is also likely that the earliest hunters drove herds of *Bison antiquus occidentalis* over the cliff. As with other jumps and pounds in the Middle Precontact Period, the hunters who used HSIBJ wasted little, and while no skull monuments have been found at the site, discarded horn sheaths and the absence of horn cores in kill site deposits may well

reflect ceremonial activities. This project highlights the value of working with long held museum collections to answer new questions and re-investigate even well-researched archaeological sites. Its contribution is timely given the ongoing ULeth-RAM project at HSIBJ.

Acknowledgments

Indigenous Acknowledgement

The site that is the core of this thesis, Head-Smashed-In Buffalo Jump, and the University of Lethbridge are located in the homeland of the Siksikaitsitapi, the people of the Blackfoot Confederacy. It has been a profound privilege to contribute to our understanding of this important place and the northwestern Great Plains region. The Blackfoot name for Head-Smashed-In Buffalo Jump is Estipah-skikikini-kots, Piskun are buffalo jumps, and Iinnii are the buffalo. The stories tied to Head-Smashed-In Buffalo Jump and the cultural connections to the site and the buffalo are living relations shared by the Blackfoot people.

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Chapter 1: Introduction

The value of museum collections to new research projects has been well documented across numerous disciplines (i.e., Suarez & Tsutsui, 2004). Within archaeology, returning to re-examine old collections has yielded excellent results, even on topics often considered over-studied rather than under-studied (see Frieman & Janz, 2018 for examples). After decades, and in some cases, centuries of collecting, there are hundreds of millions of artifacts in museum collections around the world. These collections have been accumulated by numerous academic excavation projects, through acquiring older antiquarian collections, by receiving private donations, and, more recently, via legally mandated cultural resource management (CRM) projects. Storing and curating these collections is seen as an ethical imperative to human heritage and for the benefit of the general public. It is also necessary for the scientific validity of archaeology because it allows other researchers to do replication studies (Bawaya, 2007: 1026).

It has been said that “the future of archaeology is in excavating [museum] collections” (Childs quoted in Bawaya, 2007: 1026). This is due to the immense amount of archaeological material housed by museums, how infrequently it is studied, and the potential for new technologies and techniques to enable researchers to extract new information from the artifacts. In recent years, the investigative potential of using new technologies on old collections has been realized quite dramatically (Nishimura, 2020: 3). Examples of these technologies include isotopic analysis, residue analysis, AMS radiocarbon dating, X-ray fluorescence, and mass spectrometry. Using some of these tools, the sources of the materials that a given assemblage of artifacts is made from

was revealed, allowing researchers to reconstruct ancient trade routes and production chains. New discoveries about the symbolic and ideological lives of ancient people have also been made by applying advanced technologies to museum collections. A non-destructive form of ZooMS (Zooarchaeology by Mass Spectrometry) has been used to determine the species from which bone projectile points from Quebec, Canada were made from (Mcgrath et al., 2019: 2). Prior to this technology, it was impossible to identify the species used because the carving method obliterated any taxonomic identifiable features on the bones. McGrath and colleagues determined that the points were made of black bear (*Ursus americanus*) and human (*Homo sapiens sapiens*) long bones. These results were combined with existing ethnographic knowledge, supporting the interpretation that the makers of these points were symbolically harnessing the power of bears or their human ancestors into their weapons (McGrath et al., 2019: 6).

There are challenges to working with old museum collections, however. One common issue is establishing the context of the artifacts. This issue can be due to poor record keeping, the separation of the artifacts from the field notes, or poor collecting practices at the time of excavation (Frieman & Janz, 2018: 5). Given that an artifact's context is of paramount importance to how archaeologists understand the past, this issue is seen as insurmountable by some researchers, though Frieman & Janz (2018: 5) argue that this problem can be mitigated by a well thought out research design or by working to reconstruct the context, a process that itself can be a productive way to generate new archaeological knowledge (Voss, 2012:146). Even if the context of a legacy museum collection can only be reconstructed to the level of site, culture, or region, studying the collection can still yield significant results. This is because the

collection functions as a dataset that can then be linked with the data being generated by more recent research projects from the same site, culture, or region (Nishimura, 2020: 2). Together, such research approaches form a powerful tool for investigating the past. Even with minimal contextual information, archaeologists have still found productive ways to analyze artifacts (Nishimura, 2020: 3). Some examples include use-wear studies, determining the chaîne opératoire of artifacts, and performing stylistic analyses.

Another major issue with the examination of legacy collections is the variation and evolution of the typological classification systems used to identify and catalogue the artifacts (Frieman & Janz, 2018: 5). Typological classification systems vary across regions and decades, leading to a lack of standardisation in what artifacts are named in the records and in how the records and collections are organized. Moreover, classifications of artifacts in museum records are rarely being updated to the modern typological consensus. This issue is not due to a lack of understanding or will, but chronic underfunding. Museum staff's time is taken up processing incoming collections from both new research excavations and CRM survey and mitigation projects (Frieman & Janz, 2018: 5). It is important to note that typological classification systems, whether original or updated, can conceal the variation within and between museum collections (Frieman & Janz, 2018: 5), thus requiring researchers to spend time physically exploring and handing collections to properly understand them. These visits to do research on the collections can be used by the museum to justify the need for funding and hopefully help to mitigate the underfunding problems (Frieman & Janz, 2018: 8). In addition, researchers working with the collection can, over the course of completing their project,

assist the museum staff in ameliorating the state of the collection by improving, correcting, or expanding records and finding misplaced artifacts.

This thesis research project is a re-investigation of Head-Smashed-In Buffalo Jump (HSIBJ) principally using archaeological material collected between 1965 and 2021, which is curated at the Royal Alberta Museum (RAM). This study is timely because the University of Lethbridge and the RAM have begun a multi-year excavation project at the site. The results from this thesis research can be used to inform the current excavations, in addition to expanding the interpretive results of previous research at the site.

Background on Head-Smashed-In Buffalo Jump

Head-Smashed-In Buffalo Jump (DkPj-1) was first investigated by Junius Bird and Boyd Wettlaufer in the first half of the 20th century (see Giering 2009 for an overview of their work). Following these projects, there was extensive work at the kill site by Brian Reeves in the 1960s and 1970s. Jack Brink's team excavated in the processing area in the 1980s and 1990, and Brian Kooyman's work at the kill site ran from 1990 to 1995. In the 21st century, Bob Dawe et al. (2023) carried out a targeted project to extract a roasting pit from the processing area for a museum exhibit in 2016 and the University of Lethbridge has run three field schools in the HSIBJ campsite in 2021, 2022, and 2024 (Bubel et al., 2023).

Head-Smashed-In Buffalo Jump (HSIBJ) is a UNESCO World Heritage Site in southern Alberta, Canada. It was known as the best buffalo jump by the local Indigenous people (Brink, 2008: 289). The oldest date retrieved from the site thus far

indicates that it was first used as a bison jump at about 6 581 years ago (Brink, 2016: 16). Its final use was at the end of the 1800s, making HSIBJ the oldest and longest used bison jump in the world (Brink, 2016: 16). Bonfire shelter has been proposed as a much earlier and more southerly buffalo jump but there are numerous issues with this assessment, such as the absence of drive lanes and a problematic taphonomic situation, that prevents its acceptance as such (Kilby et al., 2020). While HSIBJ is the oldest confirmed bison jump, it is not the oldest site known for large scale hunting practices. In North America, the oldest communal kills are Clovis arroyo bison hunts found in the Southwest US (Speth, 2017: 532). The oldest human built communal hunting structure in North America are the caribou drive lanes found at Alpena-Amberley Ridge under Lake Huron dated to 8 900 BP (O'Shea et al., 2013), although the validity of this site is in question (White, 2021). This is due to the very small size of the site and because it has more similarities to known elk hunting structures, with elk being more common at that time and place than caribou.

The archaeological timeframe in which Indigenous people started using HSIBJ is called the Middle Precontact period, formally called the Middle Prehistoric period. The Middle Precontact period tends to be defined as beginning with the adoption of atlatl technology and ending with the adoption of archery (Peck, 2011). The Middle Precontact period in the Northwestern Great Plains thus dates to between approximately 7 500 and 1 350 BP (Bubel et al., 2012: 13). There is strong evidence of the atlatl being in widespread use with the earliest people in North America (Hutchings, 2015); thus, the start of the Middle Precontact is better defined by the transition from lanceolate to notched points.

Background on Communal Bison Hunting

Communal bison hunting in North America dates back approximately 13 000 years, starting with the Folsom era arroyo traps on the Southern Plains (Speth, 2017: 534; Carlson & Bement, 2013: 93). Arroyo traps were a short-lived technique and after their disappearance from the archaeological record there is a few thousand-year interval before communal bison hunting, which was carried out at Head-Smashed-In Buffalo Jump, re-enters the archaeological record. After several thousand years, communal bison hunting becomes common on the Northern Plains in the form of jumps and pounds (Brink, 2016: 18).

Why communal bison hunting occurred is a topic of much debate. There are three main theories, although it is very possible all are true in at least some if not most instances (Brink, 2008). Communal bison hunts were carried out for winter provisioning or trade, and were a result of social complexity. One major issue hampering the testing of these theories is that we do not know how often these sites were used or how often communal hunting occurred (Speth, 2017: 536). Attempts to determine site usage frequency geochemically have failed (Dormaar & Beaudoin, 1991: 97) and the only heavily used site where the stratigraphy is sufficiently distinct is the Late Precontact Vore site in Wyoming, used millennia later. The kill events at the Vore site are spaced 14 to 41 years apart (Crago, 2003: 60). Furthermore, groups would have had multiple viable hunting locations in their territory, though many of these sites are less archaeologically visible than communal pounds and large-scale ambushes as well as jumps. Thus, communal bison hunting could still be an annual activity that rotates through several locations and methods.

The first theory as to why this large-scale communal bison hunting occurred is the original winter provisioning model developed in the late twentieth century (Speth, 2017: 536). The premise is that large communal bison hunts would occur in or near the fall season to stock up on fat rich food and warm hides for the winter (Brink, 2008: 224). In addition, fall is when the bison would be in peak condition and thus most worth the substantial effort involved. Evidence has since emerged that many such hunts took place at other points of the year prompting other theories (Speth, 2017: 536).

The second theory centres on long-distance trade. Specifically, the goal was to produce a surplus of hides and pemmican to be used as trade goods in order to acquire goods not available on the Northwestern Plains (Brink & Dawe, 1989: 298; Brink, 2008: xiv; Oetelaar, 2021: 21). Examples of imported goods include maize (*Zea mays mays*) and beans (*Phaseolus vulgaris*) from the eastern plains and woodlands regions to diversify their diet (Lints, 2012: 234), native copper from the Great Lakes region for tools (Peck, 2011: 194), marine shells such as *Dentalium* and *Olivella* from the west coast for jewelry (i.e.: Brink et al., 1985: 210; Fedirchuk, 1991: 37; Peck, 2011: 281), extremely powerful recurved bows made of bighorn sheep (*Ovis canadensis*) horns (Henery et al., 1897: 278), and, most importantly, high quality lithic raw material for stone tool making. There is very little high quality lithic raw material available in deposits in Southern Alberta so Indigenous people traded for Knife River Flint from the Dakotas (Bubel et al., 2012: 24), Swan River Chert from Manitoba and Saskatchewan (Bubel et al., 2012: 24), Kootenay Argillite from British Columbia (Bubel et al., 2012: 26), and obsidian from Yellowstone, Oregon, and Idaho (Bubel et al., 2012: 23) among others.

Preparing pemmican and other elements of the bison, such as hides, for trade certainly occurred in later time periods but there is limited evidence to support this practice in earlier phases. The first evidence of maize and beans being imported to the Canadian Plains appears at CE 660 and 710 respectively (Lints, 2012: ii). Bows were not adopted on the Northwestern Great Plains until 1 350 BP (Bubel et al., 2012: 13) even though they may have been available in some form 1 500 years prior to that (Walde, 2013: 140). Yet, the oldest confirmed use of HSIBJ is in the Mummy Cave Complex around 6 600 years ago. Artifact assemblages from those kill deposits at HSIBJ are dominated by quartzite (Reeves, 1978), an abundant local lithic raw material (Bubel et al., 2012: 22). Imported raw materials are far more common in Alberta, and at HSIBJ, during later times. Thus, the economic theory may correlate with the increased frequency of large-scale communal hunting in the later half of the Middle Precontact and the Late Precontact periods.

The third social/political model has received the most attention in recent literature (Speth, 2017: 537). This theory posits that the primary purpose of communal bison hunting was to bring together people belonging to the same society but living in different bands to reinforce social and political ties through cooperation, exchange, sharing of the spoils, as well as information and ceremonies (Carlson & Bement, 2013: 93). It would have also given people a sense of ownership and home on the landscape (Smith, 2013). Proponents of this theory argue that large scale communal bison hunting like the jumps evidence of the development of substantial social complexity on the Northern Plains (Zedeño et al., 2014: 42).

How or why communal bison hunting was developed is hard to answer but researchers agree that those people must have had a deep understanding of both the land and the target species' behaviour, knowledge acquired over many generations of observation, experimentation, and practice (Brink, 2008: 97; Smith, 2013). Barsh & Marlor (2014) assert that it was not just observations of bison and experiments that enabled people to drive bison but that they were mimicking wolf behaviours and in effect becoming wolves, who are excellent bison hunters. Evidence of this knowledge comes from Blackfoot oral history, linguistics, stories, and mythologies in addition to European accounts of buffalo runners dressed as wolves.

Background on the Operation of HSIBJ

There are three main components to Head-Smashed-In Buffalo Jump (Figure 1). The first is the gathering basin, which is a natural depression of approximately 40 km² located behind the cliff (Brink, 2008: 73). Within it lies the longest and most elaborate system of drive lanes of any buffalo jump in the world. The drive lanes are made of several hundred small cairns of stones stretching for kilometers westward from the cliff edge. Based on ethnographic and historic studies, the cairns would have been built up with bison dung or branches prior to operating the jump (Verbickey-Todd, 1984: 60). The purpose of these features was to help the hunters funnel a stampeding bison herd towards the cliff edge. Within the gathering basin are some petroglyphs that are associated with the site (Brink et al., 1986: 327).

The second is the cliff and massive bone deposit beneath it known as the kill site (Brink, 2008). Reeves (1978: 167) reports on the excavations here. The maximum

depth achieved by the excavators was 30 ft (~9 m). Excavations here revealed an informative sequence of projectile points, various other tools, and a vast quantity of bison bones. It is this component of the site from which the overall history of the site was developed based on projectile point sequences and radiocarbon dates. The projectile point classification and identification has been revised as our understanding of these artifacts has improved (Peck, 2011; Peck, 2019).

The third component is known as the campsite or processing area. It was extensively excavated in the 1980s (Brink, 2008: 24). It sits a few dozen metres east of the cliff and is approximately 1 000 m by 300 m (Reeves, 1978: 154). Here is where the people who used the site assembled together, prepared for the hunt, and then processed the bison carcasses (Brink, 2008: 24). The deposits of artifacts and ecofacts here are very dense and often cannot be distinguished stratigraphically. In addition to an enormous number of fire-broken rocks, bison bone fragments and artifacts of all sorts, boiling pits, roasting pits, and hearths are extremely common. There is a spring channel that flowed through the campsite. The users of HSIBJ retrieved water from it to fill their boiling pits. It stopped flowing in the mid-20th century.

Operating a bison jump was a substantial effort that required preparation and planning (Brink, 2008: 98). Long before the site was intended to be used, a controlled burn was conducted in the gathering basin to promote the growth of nutritious fescue grass that would have attracted the bison (Oetelaar, 2014: 17; Roos et al., 2018: 8147). Once people assembled, they would have had to retrieve boiling stones (Brink & Dawe, 2003), select and repair the drive lanes, gather fuel for fires, dig the boiling and roasting pits, and conduct ceremonies (Brink, 2008: 107), all before the hunt took place.

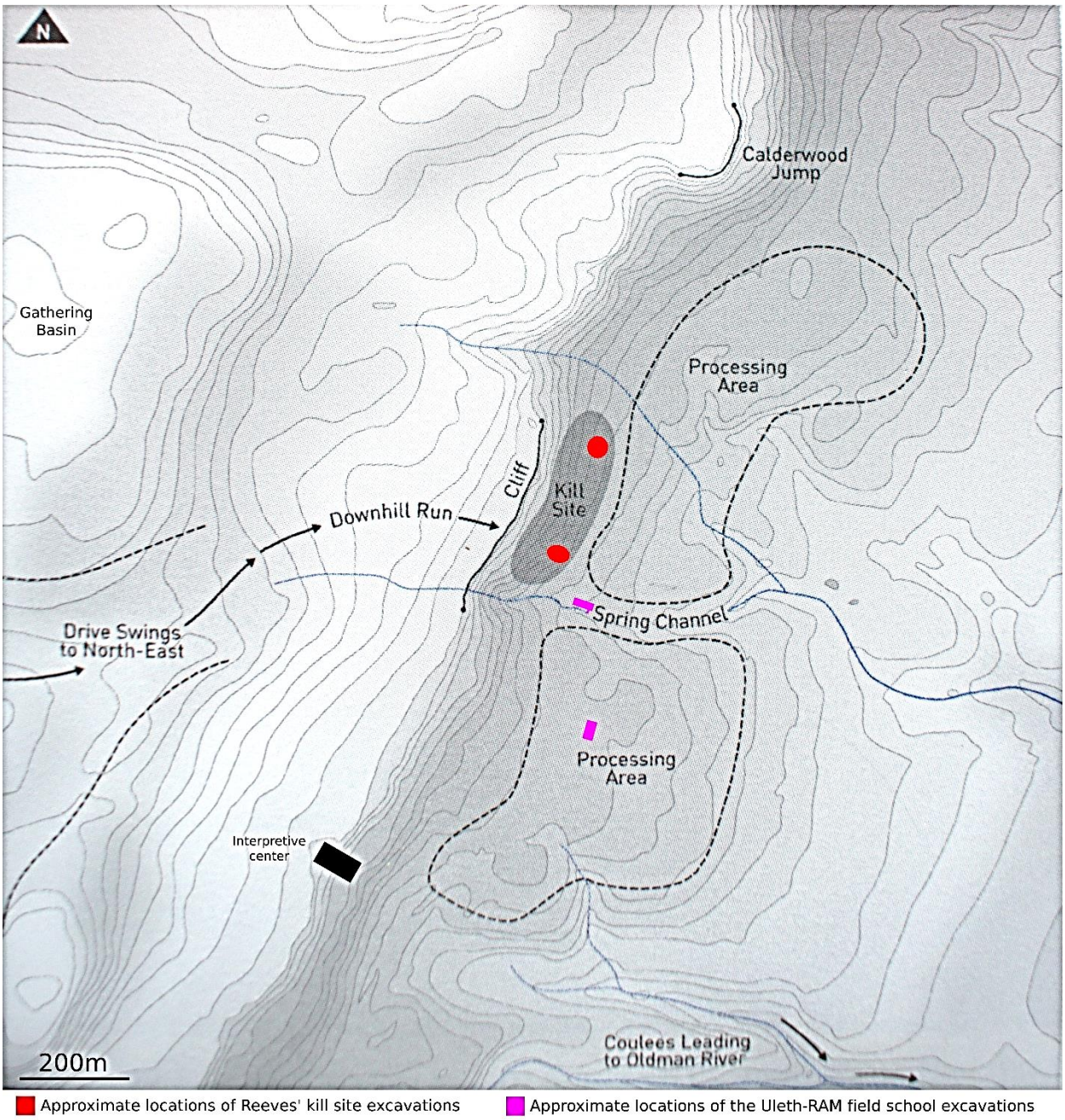

Figure 1: Map of HSIBJ with the approximate location of Reeves' and the ULeth-RAM excavations. Brink's and other excavations are not shown. The full extant of the gathering basin, drive lanes, and the Calderwood Jump campsite are not shown. (Image adapted from Brink, 2008:146).

The next step was to deploy the buffalo runners. These highly trained individuals would be dressed as wolves, pronghorns, or bison calves. Their task was to find and manipulate a herd of roughly 200 bison into the drive lanes, a process that might take days. They did this by perfectly mimicking the behaviour of their chosen disguise to either lure or harass the bison herd. Once the bison herd entered the drive lanes, they would be accelerated to a stampede as people manning the cairns waved hides to help funnel the bison over the cliff. With the hunt complete, the processing began with removing the hides. Preferred portions of meat were roasted or stewed while the rest was dried for pemmican. In addition, bones were smashed open to remove the marrow and then boiled for the grease, a critical pemmican ingredient.

Thesis Research Objectives

The research objectives of this thesis research are presented in three main components that targeted different questions. The main component (Chapter 2) focuses on the reanalysis of the chronology and stratigraphy of HSIBJ using original field notes and collections, acquiring new AMS radiocarbon dates, and bringing together decades of research subsequent to the defining work by Reeves (1978). The second research component (Chapter 3) of this thesis explores the possibility that different species of bison were hunted at HSIBJ. This involved the analysis of faunal remains in the collection that were taxonomically analyzed for the first time to determine whether there is evidence of the extinct taxon *Bison antiquus occidentalis* at HSIBJ. The third component (Chapter 4) investigates various aspects of the zooarchaeological record at the kill site component of HSIBJ to better understand butchering practices and waste,

the non-bison remains, and the use of bison skulls. The results of this research were then compared to other major bison kills sites on the Northwestern Great Plains to better contextualize the activities carried out at HSIBJ (Chapter 4).

Chapter 2: Chronology of Head-Smashed-In Buffalo Jump Established through Typological Analyses, Stratigraphic Interpretation, and Radiocarbon Dating

Introduction

The core of our understanding of the chronology of HSIBJ is derived from Reeves' fieldwork in 1965, 1966, and 1972 (1978: 152). His team excavated several units in the kill site, where he unearthed and documented multiple occupation levels. Reeves' fieldwork was much more extensive than what was done by Junius Bird in 1938, Wettlaufer in 1949, and Kooyman from 1989-1993. In addition, the campsite of HSIBJ has been extensively excavated by Brink from 1983-1991. These projects contributed to, but did not significantly change, the understanding of the site's chronological framework as presented by Reeves (1978: 167), though the current ULeth-RAM excavation project carried out in 2021, 2022, and 2024 is expanding the temporal sequence (Bubel et al., 2023)

It has been more than fifty years since Reeves presented his chronological framework. Since that time, many more diagnostic artifacts have been excavated from HSIBJ and the projectile point sequences within the northwestern Great Plains have been refined, more stratigraphic sections have been drawn and mapped across the site, and radiocarbon dating has advanced significantly. There is much more chronologically related information now available, thus, one of the main research goals of this project was to collate these data and use them to evaluate Reeves' chronological framework. Is it still applicable or are changes needed?

There are three types of evidence these researchers used to put together the chronology of HSIBJ. First are the diagnostic artifacts, items that were crafted in either a particular region or time period, or both, which have been used to build a seriation sequence. Information about these diagnostic artifacts, which are predominantly projectile points, is found in numerous excavation reports, books, and articles written over the last several decades. These data have been collated and are presented here.

The chronological framework used at HSIBJ is based on Reeves' work, therefore, this thesis research included a thorough review of his field notes accessioned at the RAM. The field notes were retyped at some point after the completion of the project; the original hand-written material is not present. Unfortunately, the notes at the RAM are incomplete with the most notable missing material being the stratigraphic sections drawn in the field. Since Reeves' notes are unpublished, relevant sections to this thesis research are included in Appendix 1. This information was used to assess the stratigraphy of HSIBJ, namely, to evaluate the chronology, though matrix connections and contexts are also reported in this thesis where spatial ties could be made. It is important to note that the stratigraphy is entwined with the typological sequence, as is the case for any archaeological site, so special attention was paid to records of diagnostic artifacts within excavation or stratigraphic levels. This important connection is also why these data are discussed together within this chapter.

Archaeologists routinely document and interpret the different matrices they encounter when excavating. Most deposits follow the Law of Superposition meaning that the older levels/deposits are below the more recent ones. Thus, an older cultural occupation level will be buried underneath a younger one. Stratigraphic layering can be

altered or complicated by natural and cultural formation process, but when intact, the stratigraphic levels can denote a temporal sequence that can be confirmed and qualified when combined with typological assessments and radiometric dates.

The stratigraphy of HSIBJ includes both natural stratigraphy, made up of varying layers of matrix, and cultural stratigraphy, made up of layers of cultural remains evidencing numerous occupations of the site. The stratigraphic sequence of HSIBJ is best preserved in the kill site where there are separable natural and cultural layers from the surface to a depth of at minimum 27 feet or 8.2 meters noted in Reeves (1978: 167) as 34 feet (10.4 meters), an issue that will be returned to. The kill site stratigraphy is well documented in Reeves' unpublished notes (see Appendix 1) and they provide more information than his 1978 publication, which only shows his correlated interpretation of the stratigraphic sequence, not the actual stratigraphic profile from an excavation unit.

The stratigraphy of the HSIBJ campsite is quite well-documented by Brink. Diagrams of both the natural and cultural stratigraphy are included in his site reports (i.e.: Brink & Dawe, 1989: 22, 205, 212, and 220). In the campsite area of the site, the last approximately 2 000 years of site use is represented by a rich deposit from surface to a depth of only 50 cm (Brink & Dawe, 1989: 180). This is likely due to greater compression and less deposition of material compared to the kill site. Until the recent excavations, evidence of the earliest uses of HSIBJ were restricted to a few early forms of projectile points, typologically dated to between 9 600 and 7 500 BP, often found in secondary contexts. The ULeth-RAM excavation project in the campsite area has yielded some cultural material to a depth of over 150 cm below surface (Bubel et al., 2023: 4) but the quantity is limited. Hopefully further work will yield more material. Thus,

at this point the kill site remains the most stratigraphically informative part of the site from between 6 600 and 250 BP, and thus, is the focus of this thesis.

The third line of evidence used to establish the chronology of HSIBJ is radiocarbon dating. Numerous samples have been submitted to different labs over the last fifty years from both the kill site and campsite. Samples tested during the 20th century have much larger date ranges and were more prone to errors than samples submitted since the advent of Accelerated Mass Spectrometry (AMS) radiocarbon dating technology. Radiocarbon dates from Reeves (1978: 162) and Brink & Dawe (1989: 27) have date ranges of 100 years or more, while modern AMS dates typically have ranges of 20 years (see below) and are, therefore, considered more reliable.

Though there are a few more recent radiometric dates acquired on specimens excavated from HSIBJ, there are periods within the chronological sequence that have no associated date. This is especially problematic for time periods with few diagnostic artifacts or none at all. Thus, acquiring more radiocarbon dates was needed to evaluate the chronological framework used at HSIBJ. Determining how many samples and which excavation contexts to date was based on Reeves' notes, the artifacts recovered, their stratigraphic contexts, and available funding. Radiocarbon dates must be evaluated within their stratigraphic context and tied to typological assignments; therefore, these results are included within this chapter, together the diagnostic artifacts and stratigraphic assessment. For confidence and clarity, only published and newly submitted AMS radiocarbon dates were used in this thesis research.

The key goals of this component of the thesis were to collate decades of previous scholarship and to combine it with some new analyses to formulate a revised

understanding of the chronology of HSIBJ. This process relied on the original field notes from Reeves' kill site excavations, new radiocarbon dates, and previously published research.

Diagnostic Artifacts of Head-Smashed-In Buffalo Jump

The following is an overview of all the projectile point types, ceramic styles, and other diagnostic artifacts identified at HSIBJ. This work involved the collation of all the diagnostic artifact data for HSIBJ, which is spread across numerous publications spanning six decades. This is the first time a comprehensive overview of the HSIBJ projectile point data has been presented and this framework was needed to address questions about the chronology of the site. The point styles are discussed in chronological order and according to their location, whether in the kill site or campsite, (see Table 1 for a summary of these data). The original typological classifications and attribute data was noted as such. It was beyond the scope of this project to reanalyze the diagnostic artifacts of HSIBJ, but it is noteworthy that some classifications are in dispute (see Brink et al., 1986: 117 for examples).

Projectile point types are defined based principally on their morphology (Bubel et al., 2012: 31). Some researchers propose that in certain cases, projectile point types can be indicative of the cultural or ethnic affinity of the people who made them (Boser, 2022: 71). Instances of such claims were only included in this study in cases where there is significant evidence to support the possible cultural affinity or relationships. Associated radiocarbon dates taken from the literature are uncalibrated unless otherwise stated, as is convention.

Cody Complex Points

There are four diagnostic artifacts assigned to the late Paleoindian Period, Cody Complex: the Alberta point, the Scottsbluff point, the Eden point, and the Cody knife. The Alberta point is older than the others and is characterized by a broad stem ~1/3 the total length of the point with wide shoulders and convex blades (Bubel et al., 2012: 42). Scottsbluff points have small, angular shoulders and relatively short, square stems. Eden points have a diamond shaped cross section with a long, narrow body and small stem with very subtle shoulders. In Alberta, Alberta points date to between 9 600 BP and 9 000 BP while Scottsbluff and Eden points date to between 9 000 BP and 8 600 BP (Bubel et al., 2012: 44).

In 1949, Wettlaufer found seven artifacts typologically dated to the late Paleoindian period on the farmer's dugout in the spring channel part of the campsite (Giering, 2009: 28). Two are Scottsbluff points (Figure 2: C), two are large point fragments that display a knapping technique consistent with Cody Complex technologies, one is possibly the stem of an Alberta point, one is a large point fragment that has enough of patina to likely date to Paleoindian times, and an obsidian biface that appears to be Paleoindian in age given its size and knapping technique (Giering, 2009: 29). Furthermore, Dawe (2013: 151) contends that that one of the lithic artifacts from this collection is likely an Eden point (Figure 2: E).

In addition to Wettlaufer's collection, staff at the RAM have recently become aware of a private collection from the HSIBJ spring channel area that contains two complete Cody Complex points that Dawe is now analyzing (Dawe, *pers. comm.*). The only *in situ* Cody Complex artifact found at the site is the base of an Alberta point

(Figure 2: A), unearthed in 2021 by the joint ULeth-RAM team in the campsite (Bubel et al., 2023: 6). No Cody Knives have been found at HSIBJ, and no Cody Complex material has been found in the kill site, though Reeves only reached deposits dated to 6 581 BP (Brink, 2016: 16).

Transitional/Boss Hill Points

The transitional period between the Early and Middle Precontact is poorly understood due to the lack of sites in the northwestern Great Plains. It was originally called transitional because researchers thought this period marked the adoption of the atlatl. Research by Hutchings (2015) showed that the atlatl was in use in North America with the earliest inhabitants on the continent. Now, instead, the transitional period marks the creation of side-notched points. One point was found in the campsite that Bubel et al. (2023: 6) state closely resembles artifacts 5 and 6 from Occupation Level 7 of the Boss Hill site in Alberta (Figure 2: G, H, and I respectively), which Peck (2011: 116) termed the Boss Hill corner-notched point. This style has associated dates from the Boss Hill site which date to 7750 ± 105 BP and 7875 ± 130 BP which calibrate to 8 737 BP and 8 571 BP respectively (Bubel et al., 2023: 6). This point is characterized by large corner notches and an expanding stem. Boss Hill corner-notched points are considered part of the Lusk complex, which dates to 8 300-7 500 BP uncalibrated (Peck, 2011: 108, 116). No transitional points were found in the kill site, though, again, Reeves only reached deposits dated to 6 581 BP (Brink, 2016: 16). The campsite of HSIBJ does have two published ^{14}C dates from the transitional period, 7 573 cal yr BP and 7 872 cal yr BP (Bubel et al., 2023: 4).

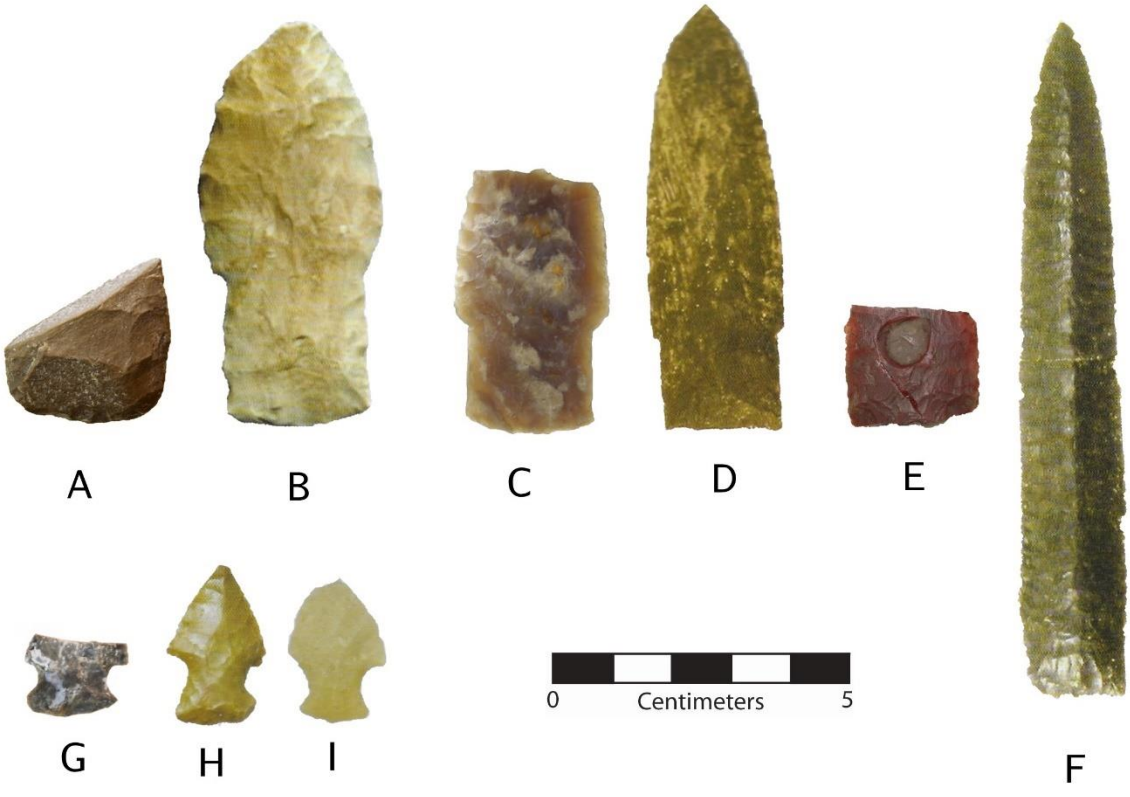

Figure 2: Cody Complex and Transitional dart points found at HSIBJ with reference images for identification comparisons. A. Alberta point base, HSIBJ campsite (Bubel et al., 2023: 6); B. Alberta point reference image (Bubel et al., 2012: 43); C. Scottsbluff point, HSIBJ campsite (Giering, 2023: 17); D. Scottsbluff point reference image (Bubel et al., 2012: 45); E. Possible Eden point body fragment, HSIBJ campsite (Dawe, 2013; Giering, 2023: 18); F. Eden point reference image (Bubel et al., 2012: 47); G. Boss Hill point base, HSIBJ campsite (Bubel et al., 2023: 6); H. Boss Hill point, reference image (Bubel et al., 2012: 51); I. Boss Hill point, reference image (Bubel et al., 2012: 51).

Mummy Cave Points, including Bitterroot, Maple Leaf, Gowen, and Calderwood Points

The Mummy Cave timeframe is traditionally described as spanning from 7 500 BP to 4 500 BP (Bubel et al., 2012: 52) and includes numerous subtypes. Peck (2018:

18) redefined it to be from 7 300 BP to 6 700 BP and considers it effectively synonymous with Bitterroot points. This subtype has deep side notches with sharp shoulders, typically square basal edges and a straight base (Bubel et al., 2012: 52). Figure 3: A and B are examples found at HSIBJ.

Reeves (1978: 171) found multiple Mummy Cave points, most of which he identified as Bitterroot (Figure 3: A) and Salmon River styles. He also called some “Pelican Lake style”, which makes his designation unclear. The most likely explanation for this typological assignment is that he used this description to refer to the corner-notched points he unearthed in the Mummy Cave levels, such as numbers 5 and 6 in Figure 17-21 of his (1978: 167) publication. Three Mummy Cave points have been found *in situ* in the campsite, two Bitterroot points (Figure 3: B) found in the 1980s (Brink & Dawe, 1989: 218), and one point base of an unspecified Mummy Cave type found in 2021 (Bubel et al., 2023: 5). The Mummy Cave point base found by Bubel et al. (2023: 5) is very similar to one found by collector John Viens on the surface that is now on display at the HSIBJ interpretative center (Dawe, *pers. comm*.; Figure 3: D). Both specimens have a straight base and side-notches. Additional Mummy Cave points recovered from HSIBJ are known from private collections.

Peck (2011: 151) prefers to use the term “Salmon River Fish Tail” for Salmon River points given the differences in morphology between points found in Alberta that are called Salmon River and the original Idaho Salmon River points. Peck (2011: 150) reclassified the Salmon River points from Reeves’ (1978: 171) kill site excavation as Maple Leaf Complex points (see Figure 3: E for an example). There are no points identified as belonging to the Maple Leaf complex from the campsite. Peck (2011: 151)

states that this complex lasts from 6 300 BP to 5 200 BP. These points have shallow side notches that typically remove the corner of the point and a concave base. Both large and small varieties exist.

Gowen points are dart points with a concave base and side-notches that are wide and shallow (Boser, 2022: 114). This type is traditionally understood as part of the Mummy Cave complex and evolved into the Oxbow type (Cole, 2015: 76). Walker (1992: 141) redesignated some of the Mummy Cave points from Reeves' kill site excavations as Gowen points. He does not specify which specific points or how many he redesignated as Gowen. At least one of the points pictured in Reeves' publication (1978: 171) matches the reference example in Boser (2022: 114) very closely (Figure 3: I and J respectively). There have been no reports of Gowen points from the HSIBJ campsite. Walker (1992: 141) estimated the timespan of Gowen points to be between 6 000 BP and 5 500 BP while Peck (2011: 163) and Boser (2022: 114) give a timespan of 5 900 BP to 5 200 BP. Cole (2015: 75) claims Gowen is dated to between 6 100 BP to 4 700 BP based on recent discoveries and better dating technology.

Peck (2011: 157) reclassified most of the Bitterroot and the "Pelican Lake style" points from Reeves' (1978: 171) kill site excavation as Calderwood points (see Figure 3: G and H for examples). There are no points identified as Calderwood points from the campsite. Peck (2011: 142) states that this complex lasts from 5 200 BP to 4 700 BP. The Calderwood Complex as defined by Peck (2011: 152) lacks any defining projectile point style and is instead made up of several dissimilar points morphologies with no established relationship between them and often significant variety among them. The

morphologies include near corner-notched, Oxbow-like, concave-based with near barbs, and an elongate form with broad, round notches and a straight base.

Oxbow Points

Oxbow dart points have wide, shallow side notches and a deep concave base to form proximal margin ears (Bubel et al., 2012: 54). There are many published timespans for Oxbow points. Alberta sources have traditionally placed them between 4 500 BP and 4 100 BP (Bubel et al., 2012: 54). Taylor (2006: 319) puts their temporal range to 5 000 BP to 3 500 BP. In Saskatchewan, Boser (2022: 116) claims their timespan to be 4 700 BP to 3 800 BP. Cole (2015: 75) assigned Oxbow to 5 200 BP to 3 800 BP based on recent discoveries. Reeves (1978: 161) did not report any Oxbow points from the kill site. Two definite (Figure 3: K and L) and one probable Oxbow point were recovered from the campsite (Brink & Dawe, 1989: 218). Another was found at the Dersch locality (DkPj-35), a southern extension of HSIBJ (Peck, 2011: 300).

Hanna Points and the McKean Complex/Series

Hanna dart points have convex blades, sharp shoulders, a flared stem, and a concave base (Bubel et al., 2012: 60). In Alberta, Hanna points date to between 3 900 BP and 3 500 BP (Bubel et al., 2012: 60). They are part of the McKean complex, named for the earlier McKean dart point. The McKean point is relatively short and lanceolate in morphology, with a deep concave base and straight side. McKean points were used in Alberta between 4 200 BP and 3 500 BP (Bubel et al., 2012: 56).

Reeves (1978: 172) found several Hanna points in the kill site (Figure 3: O and P). Three Hanna points (Figure 3: Q) were found in the campsite (Brink et al., 1985: 124). The only evidence for the rest of the McKean complex, namely McKean and Duncan points, at the site is a base of a McKean point found in the campsite (Dawe & Brink, 1991: 149); no Duncan points have been found. On the Canadian Plains, Hanna points are very rarely found in association with McKean points; clear stratigraphic and temporal separation is the norm (Webster, 2004: 117). Furthermore, once Hanna and Duncan points appear, McKean points become uncommon, thus it is likely that this one McKean point represents a separate occupation from the Hanna phase use of the jump. However, one should consider the possibility that this artifact is an Oxbow preform like the one identified at the Castor Creek site (Peck, 2011: 118).

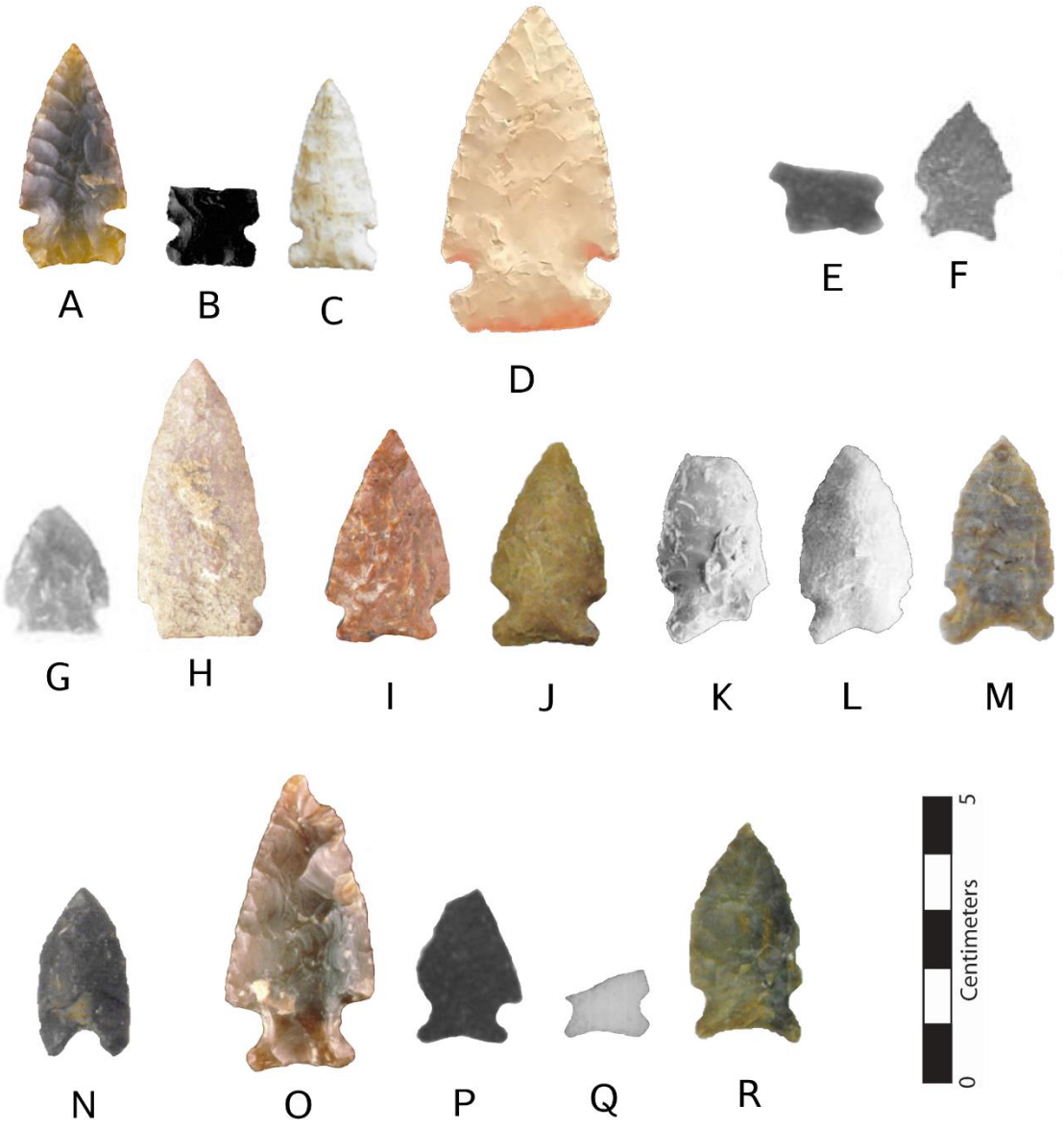

Figure 3: Mummy Cave, Oxbow, Hanna, and McKean dart points found at HSIBJ with reference images for identification comparisons. A. Mummy Cave Bitterroot point, HSIBJ kill site (Reeves, 1978: 171, photograph provided by the RAM); B. Mummy Cave Bitterroot point, HSIBJ campsite (Brink & Dawe, 1989: 203); C. Mummy Cave Bitterroot point, reference image (Boser, 2022: 113); D. Mummy Cave point, surface find by John Viens (McGeough, *pers comm*.); E. Maple Leaf point, HSIBJ kill site (Peck, 2011: 144; Reeves, 1978: 171); F. Maple Leaf point, reference image (Peck, 2011: 144); G. Calderwood point, HSIBJ kill site (Peck, 2011: 155) used as a reference in Peck (2011: 155); H. Calderwood point, HSIBJ kill site (photograph provided by the RAM) used as a reference in Peck (2011: 155); I. Gowen point, HSIBJ kill site (Walker, 1992: 141) (Reeves, 1978: 171, photograph provided by the RAM); J. Gowen point, reference image (Boser, 2022: 114); K. Oxbow point (one ear and tip missing), HSIBJ campsite

(Brink & Dawe, 1989: 203); L. Oxbow point (one ear missing), HSIBJ campsite (Brink & Dawe, 1989: 55); M. Oxbow point, reference image (Bubel et al., 2012: 55); N. McKean point reference image (Bubel et al., 2012: 57); O. Hanna point, HSIBJ kill site (Reeves, 1978: 172, photograph provided by the RAM); P. Hanna point, HSIBJ kill site (Reeves, 1978: 172); Q. Hanna point, HSIBJ campsite (Brink et al. 1985: 130); R. Hanna point, reference image (Boser, 2022: 123).

Pelican Lake and Bracken Points

Pelican Lake dart points have a narrow neck, triangular body, straight blades, and corner notches that form barbs (Bubel, et al., 2012: 62). In contrast, Bracken points have reduced or absent barbs and far wider necks. They also occurred later with some temporal overlap. The currently agreed upon dates for this series is approximately 3 600 BP to 2 800 BP for Pelican Lake and 2 800 BP to 2 000 BP for Bracken (Kevinsen, 2013; Peck, 2011: 256). It is hypothesized that the transition from Pelican Lake and Bracken points is indicative of the serious beginning of large-scale communal bison hunting.

Several of the points that were found in the kill site by Reeves (1978: 172) were identified as Pelican Lake (Figure 4: C, D, and E). Peck (2011: 260) reassigned these as Bracken points. Points identified as Pelican Lake have been found in the campsite (Figure 4: A and B) (Brink & Dawe, 1989: 217; Brink et al., 1986: 124; Dawe & Brink, 1991: 149; Giering, 2023: 16). No researchers have reanalyzed the points from the campsite to see if any of them are Bracken points as Peck did with the kill site points. Peck (2011: 234) does confirm that the narrow-necked points from the Calderwood Jump (DkPj-27) are Pelican Lake points. This site is less than 1 km north of HSIBJ and

shares the same gathering basin and drive lane complex as HSIBJ (Brink et al., 1987; Marshall & Brink, 1986) making the Calderwood Jump effectively a component of HSIBJ. Thus, it remains clear that both Pelican Lake and Bracken point types were used at HSIBJ.

Outlook, Besant, Sonota, and Samantha Points

The Besant Phase includes multiple distinct point styles dated between 2 500 BP and 1 350 BP (Bubel et al., 2012: 65), namely Outlook, Besant, Samantha, Sonota, and Sandy Creek. Four of these have been recovered from HSIBJ; Sandy Creek points have not been reported. Outlook points date to 2 500 BP, Besant points themselves date to between 2 100 BP and 1 500 BP, and Sonota points date to between 1 500 BP and 1 350 BP (Peck, 2011: 3). Outlook points are typically long, with broad, shallow side notches (Bubel et al., 2012: 66). Besant points are relatively short and broad with side notches and a mildly concave base. Samantha points are defined as small Besant or Sonota points and have been interpreted as early arrowheads (Bubel et al., 2012: 68; Reeves, 1983: 63), although other researchers consider them dart points (Bubel et al., 2012: 68). Sonota points are very similar in morphology to Besant points but are typically longer, with convex blades and low side notches. Sonota is also differentiated from the other point forms by its association with pottery and burial mounds as well as the fact they are most often made of Knife River Flint. The groups of people using all of these point styles are thought to be migrants from the Dakotas (Peck, 2011: 453).

Reeves (1978: 172) found multiple Besant points in the kill site (Figure 4: J and K). He described three of these Besant points as unusual and Peck (2011: 246)

redesignated those specimens as Outlook points (Figure 4: H and I). These three points were found within a Pelican Lake/Bracken level in the North Area of the kill site, so this reassignment matches their stratigraphic context. Peck (2011: 320) also suggests that some of the Besant points (Figure 4: J and K) from the kill site are likely Sonota points but he also states that the lack of clear provenience hinders this assignment and more detailed analysis of the specific points is needed to confirm this hypothesis. Reeves (1983: 102) identified four Samantha points from the kill site in the late Avonlea levels but did not publish images of them.

Several Besant points (Figure 4: L and M) were found in the campsite (Brink et al., 1985: 113; Brink & Dawe, 1989: 215). Brink & Dawe (1989: 215) split these into Type 1 and Type 2. The difference is that Type 2 “have a convex base and broad, parabolic notches that meet the base at rounded, acutely angled, [and] laterally projecting junctures”. One possible Sonota point (Figure 4: Q) has been found in the campsite (Bubel et al., 2023: 8). Brink et al. (1985: 121) Brink et al. (1986: 117) listed numerous artifacts as “small notched” (Figure 4: R and S) to encompass projectile points that they were unable to determine whether they are Samantha points, Prairie Side-notched points, or some other point type.

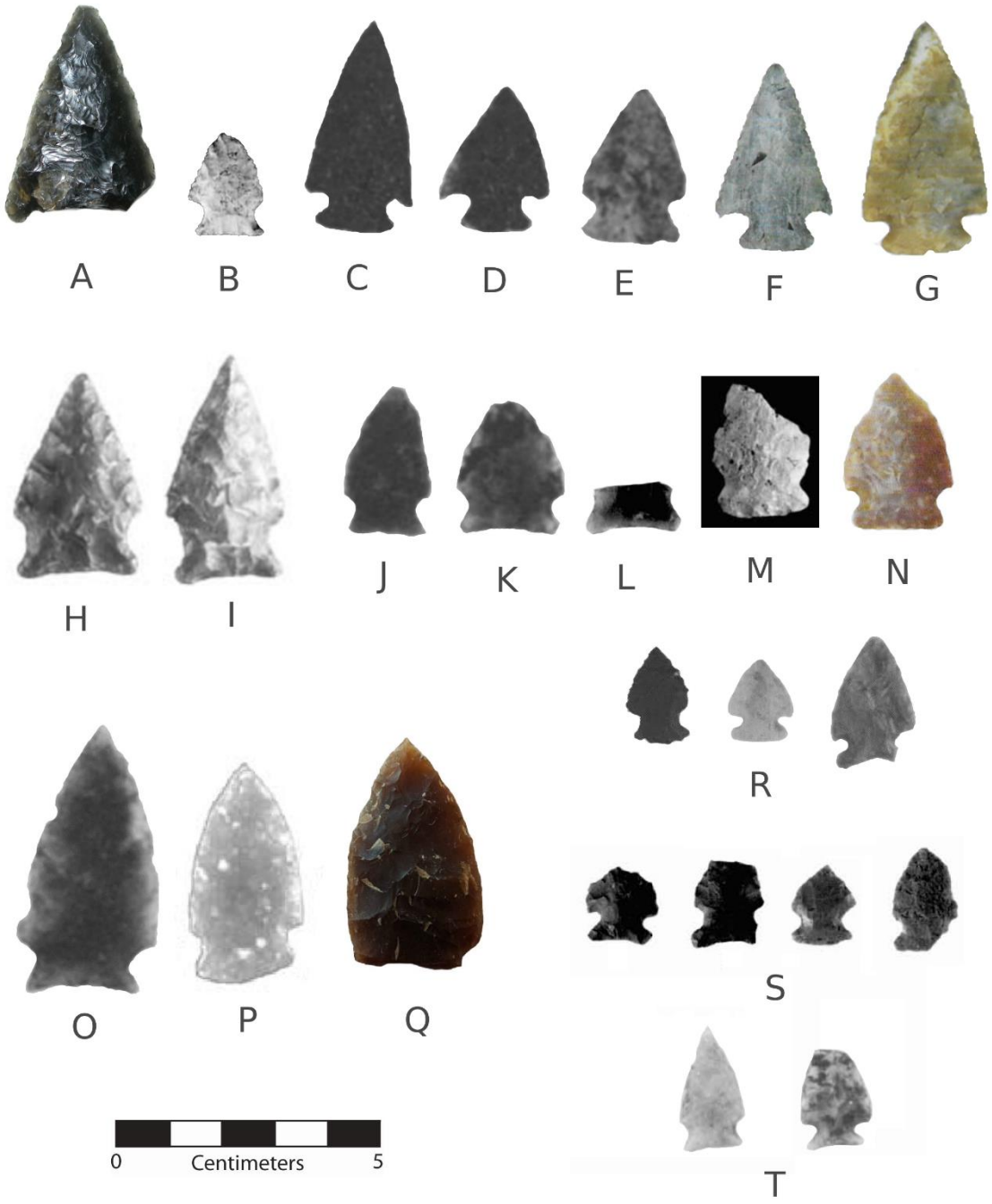

Figure 4: Pelican Lake, Bracken, Outlook, Besant, Sonota, Samantha, and unidentified small, notched points found at HSIBJ, with reference images for identification comparisons. A. Pelican Lake point, base missing, HSIBJ campsite (Giering, 2023: 16); B. Pelican Lake point, HSIBJ campsite (Brink et al., 1986: 115); C. Pelican Lake/Bracken point, HSIBJ kill site (Reeves, 1978: 172); D. Pelican Lake/Bracken point, HSIBJ kill site (Reeves, 1978: 172); E. Pelican Lake/Bracken point, HSIBJ kill site (Reeves, 1978: 172); F. Pelican Lake point reference image (Boser, 2022: 125); G. Bracken point reference image (Boser, 2022: 126); H. Outlook point, HSIBJ kill site

(Peck, 2011: 243), used as a reference image in Peck (2011: 243); I. Outlook point, HSIBJ kill site (Peck, 2011: 243), used as a reference image in Peck (2011: 243); J. Besant point, HSIBJ kill site (Reeves, 1978: 172); K. Besant point, HSIBJ kill site (Reeves, 1978: 172); L. Besant point, HSIBJ campsite (Brink & Dawe, 1989: 202); M. Besant point, HSIBJ campsite (Brink & Dawe, 1989: 203); N. Besant point, reference image (Bubel et al., 2012: 67); O. Sonota point, HSIBJ kill site (Reeves, 1978: 172); P. Sonota point, HSIBJ kill site (Peck, 2011: 313); Q. Sonota point, base missing, HSIBJ campsite (Westerhound, *pers. comm*.); R. Small notched points, (Brink et al., 1985: 129, 131); S. Small notched points, (Brink et al., 1986: 114); T. Samantha point reference images (Reeves, 1983: 341).

Head-Smashed-In Corner-notched Points

Arrow points mark the beginning of the Late Precontact period in the Great Plains region 1 350 BP. Head-Smashed-In Corner-notched arrowhead points were first identified at HSIBJ by Reeves and are described as very similar to the Avonlea point (see below) but exhibit corner-notches instead of side-notches (Bubel et al., 2012: 69). They have been found in the kill site by Reeves (1978: 173; 1983: 336) as well as in the campsite by Brink & Dawe (1989: 211) (Figure 5: A and B respectively) and Brink et al. (1986: 122) who call them Avonlea Type 2. Reeves (1983: 62) indicated that eight of the Head-Smashed-In Corner-notched points kill site specimens are serrated. While previous researchers (i.e., Brink et al., 1986: 122; Reeves, 1978: 173; Reeves, 1983: 61) have interpreted these as part of the Avonlea Phase, Peck (2011: 356) argues that since they were only found in the lowest Avonlea level, they should be interpreted as Sonota arrowheads rather than a unique projectile point type or part of the Avonlea Phase. In contrast, Reeves (1983: 164) argues that these points are descended from the Pelican Lake phase points.

Avonlea Points

Avonlea points are the earliest undisputed arrowheads found in Alberta and represent the first time there are groups on the Canadian Plains using the bow exclusively. They are thin triangular side-notched points that are very finely made (Figure 5: C and D). In Alberta, Avonlea points date to between 1 350 BP and 1 100 BP (Bubel et al., 2012: 69) although they appear slightly earlier in Saskatchewan (Walde, 2013). The masterful craftsmanship and consistency in style and quality of Avonlea points has led researchers to suggest that their manufacture was socially restricted. For instance, Walde (2013) hypothesizes that special Avonlea arrowhead knapping societies formed among local groups in Alberta and Saskatchewan, and that the societies existed to maintain secrecy regarding the techniques to manufacture these points. Walde (2013) bases this on the craftmanship needed to create these points as well as the suggestion that these groups were adopting archery specifically for military use against groups using Besant/Sonota points who were crowding them out of the bison rich regions in the Canadian Plains. Whether this was the case or not, Avonlea artifacts are very common in both the kill site and campsite of HSIBJ (Brink & Dawe, 1989: 199; Dawe & Brink, 1991: 149; Brink et al., 1987; Brink et al., 1986: 120; Brink et al., 1985: 111; Giering, 2023: 16; Kooyman, 1990: 13; Reeves, 1978: 173).

Stemmed Arrow Points

Brink et al. (1985: 121) found two small unidentified similar arrow points in the campsite (Figure 5: H and I) they describe as “very small arrowheads with approximately rectangular stems and ovate serrated blades”. One of them is made of

obsidian and was found *in situ* in a pit feature. The charcoal in the pit feature was radiocarbon dated to 1 300 ± 70 BP. Brink et al. (1986: 114) also found two stemmed points in the campsite they describe as “very small arrowheads with approximately square stems and triangular blades.” Brink & Dawe (1989: 214) unearthed two small, stemmed points in the campsite one of which was similar to those found by Brink et al. (1986: 114) and the other, smaller one, they considered a probable toy.

In the kill site, Reeves (1983: 166) found stemmed arrowheads associated with Avonlea points. These are very different from the campsite artifacts. They are approximately three times the size and appear to have corner-notches. In addition, two of them are barbed and one is serrated (Figure 5: F and G). Reeves (1983: 166) thinks that these stemmed and serrated points are evidence of cultural contact between the users of Avonlea points and groups in British Columbia. The serrated point (Figure 5: F) strongly resembles a type found in Wyoming but not previously identified in Alberta called the Foothill Corner-notch point, which dates to 1 800-600 BP (Taylor, 2006: 372-374). The only other reference of stemmed arrowheads from the Late Precontact period of Alberta is from EgPn-656 and EgPn-661 near the Elbow River that date to 950 BP and have been interpreted as being made by ancestors of the Stoney/Nakota people (Peck, 2011: 403).

Old Women’s Phase Points

There are two types of Old Women’s Phase arrowheads, Prairie Side-notched and Plains Side-notched (Figure 5: N and O respectively). Prairie Side-notched points have converging to triangular blades and low side notches, whereas Plains Side-

notched points typically have their notches higher up to form larger, squared-off bases (Bubel et al., 2012: 72). They date to between 1 100 BP and 250 BP. Peck (2011: 367) assigned these points to the Cayley Series to better represent the gradual transition between the two types. He also argues that Cayley Series points are indicative of the Precontact Blackfoot people (Peck, 2011: 403). Old Women's points (Figure 5: J-M) are commonly found in both the campsite and the undisturbed parts of the kill site (Brink & Dawe, 1989: 199; Brink et al., 1986: 113; Brink et al., 1985: 107; Brink et al., 1987: 11 Dawe & Brink, 1991: 149; Giering, 2023: 15; Kooyman, 1990: 13; Reeves, 1978: 173). This is in spite of the fact that the Old Women's levels of the kill site were heavily looted during the 20th century (Reeves, 1978: 152).

Highwood Points

Highwood points are associated with a poorly understood phase best documented in Montana that some scholars have attributed to an Indigenous group called the Snake, who were likely part of the Shoshone. They came from the mountains in the US and pushed north, fighting an ultimately unsuccessful war with the Blackfoot and their Cree allies in the early Protocontact period (Peck, 2011: 413). Highwood points resemble Plains Side-notch points with basal notches or spurs on the ear. Peck (2011: 408) identifies five points from Reeves' kill site excavations as Highwood points (Figure 5: P and Q). In addition, Wettlaufer collected two obsidian tri-notched points from the surface of the campsite (Giering, 2023: 16) that match the description of Highwood points (Figure 5: R). Peck (2011: 408) dates the Highwood phase to between 500 BP and 300 BP.

Plains Triangular Preforms/Points

Plains Triangular points are small knapped triangular artifacts thought to be related to the Old Women's Phase (Bubel et al., 2012: 72). They lack notches and typically have a straight to slightly concave base. They may be preforms rather than finished projectile points (Dawe, 1987). Two were found at the kill site (Reeves, 1978: 173) and several in the campsite (Brink et al., 1985: 117; Brink et al., 1986: 124; Brink & Dawe, 1989: 212). Figure 5: U is an example from the campsite and Figure 5: V is from the kill site.

Toy Arrowheads and similar Artifacts

Dawe (1997) used ethnographic and archaeological knowledge to define toy arrowheads. His criteria for identifying these special artifacts is largely derived from the functional properties of arrowheads in relation to manufacturing, hafting, effect on target, and the physics with the bow. Dawe (1997: 310) and Brink & Dawe (1989: 208) identified numerous toy arrowheads from the campsite (see Figure 5: S and T respectively for examples). A small number of the kill site arrowheads also fit these criteria (Dawe, 1997: 309). Moreover, an extremely small endscraper, decorated rim sherd, and shaft smoother were found at the HSIBJ campsite, which were also interpreted as toys (Dawe, 1997: 311). The shaft smoother is the correct size to make arrow shafts that fit the necks of the smallest points. These artifacts are diagnostic of the Late Precontact period.

Protohistoric and Post-contact Artifacts

There are two types of metal arrowheads, those made by Euro-Canadian blacksmiths, and those made by Indigenous people from reworking other metal objects (Taylor, 2006: 390). Both types are typically stemmed while the shape of the body can vary substantially, especially among the Indigenous-produced ones (see Figure 5: X and Y for examples). The easiest way to tell them apart is that Indigenous-produced points tend to have linear scratch marks running a short distance up the body, roughly parallel to the stem (see Figure 5: X). Reeves (1978: 166) found multiple metal points in the kill site in an area that experienced minimal looting compared to the rest of the site. Collectors have claimed to have gathered musket balls from the kill site (Dawe, *pers. comm*.). In the campsite, metal points, glass beads, metal scraps, a brass knife. and an iron buckle have been found (Brink & Dawe, 1989: 284; Brink et al., 1986: 102).

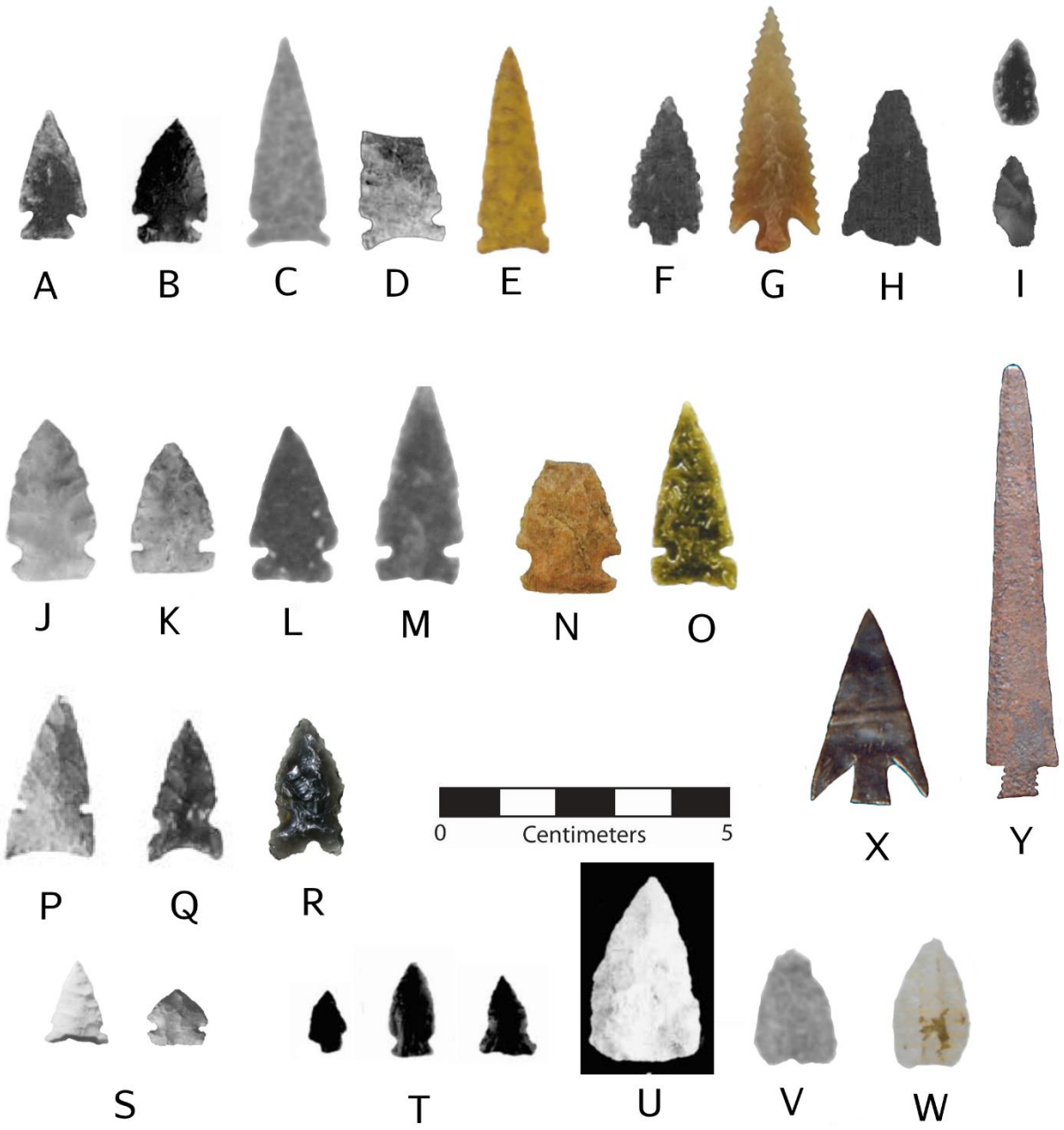

Figure 5: Arrowheads found at HSIBJ, with reference images for identification comparisons. A. HSI Corner-notched point, HSIBJ kill site (Reeves, 1983: 337); B. HSI Corner-notched point, HSIBJ campsite (Brink & Dawe, 1989: 200); C. Avonlea point, HSIBJ kill site (Reeves, 1978: 173); D. Avonlea point, HSIBJ campsite (Brink & Dawe, 1989: 202); E. Avonlea point, reference image (Bubel et al., 2012: 71); F. Serrated stemmed arrowhead, HSIBJ kill site (Reeves, 1983: 337); G. Foothill Corner-notch point reference image (Taylor, 2006: 374); H. Stemmed arrowhead, HSIBJ kill site (Reeves, 1983: 337); I. Stemmed arrowheads, HSIBJ campsite (Brink et al., 1985: 130, 131); J. Old Women's point, HSIBJ kill site (Reeves, 1978: 173); K. Old Women's point, HSIBJ kill site (Reeves, 1978: 173); L. Old Women's point, HSIBJ campsite (Brink & Dawe,

1989: 199); M. Old Women's point, HSIBJ campsite (Brink & Dawe, 1989: 199); N. Old Women's point, Prairie Side-notched, reference image (Boser, 2022: 137); O. Old Women's point, Plains Side-notched, reference image (Bubel et al., 2012: 73); P. Highwood point, HSIBJ kill site (Peck, 2011: 409), used as a reference image in Peck (2011); Q. Highwood point, HSIBJ kill site (Peck, 2011), used as a reference image in Peck (2011: 409); R. Highwood point, HSIBJ campsite (Giering, 2023: 16); S. Toy arrowheads, HSIBJ campsite (Dawe, 1997: 310); T. Toy arrowheads, HSIBJ campsite (Brink & Dawe, 1989: 201); U. Plains Triangular/Preform point, HSIBJ campsite (Brink & Dawe, 1989: 203); V. Plains Triangular/Preform point, HSIBJ kill site (Reeves, 1978: 173); W. Plains Triangular/Preform point, reference image (Bubel et al., 2012: 73); X. Indigenous produced metal point from HSIBJ (photograph provided by the RAM); Y. Euro-Canadian manufactured trade point from HSIBJ with some corrosion (photograph provided by the RAM).

Ceramics and other Diagnostic Artifacts

Ceramic artifacts are commonly found at the HSIBJ campsite but like most Precontact pottery from Alberta, these sherds are typically in too poor of condition to thoroughly analyze. Brink and Dawe (1989: 283) did find sherds that they could identify as Avonlea and Old Women's ceramic styles. These sherds were associated with the expected projectile point types. So far, there has not been any Sonota style pottery identified at HSIBJ.

Iniskim are sacred buffalo calling stones crafted from Ammonoid fossils that are common in Alberta, typically the genus *Baculites* (Peck, 2002: 149). They remain important to the Blackfoot people. In archaeological contexts, Iniskim are associated with the Old Women's phase. This has, in part, led to researchers to tie the Old Women's phase to the Precontact Blackfoot people (Peck, 2002: 148; Peck, 2011: 404). One probable Iniskim was recovered from the campsite (Bubel et al., 2023: 9).

Unidentified and Exotic Projectile Points

Numerous unidentified projectile points have been recovered from HSIBJ. Many are fragments of a point that can only be assigned to a general temporal window, being Early, Middle, or Late Precontact, or Postcontact periods. Some specimens are broken but have enough diagnostic attributes for them to be described and hopefully identified in the future. In some cases, their stratigraphic context and associations with other artifacts do not provide enough information to typologically define these artifacts. It is also possible, as Boser (2022: 147) posits for one-off point styles found in Saskatchewan, that some points may be the result of experimentation by individual knappers. In addition, two projectile point bases, discussed below, are from points not otherwise found in Alberta or the Northwestern Great Plains region. These artifacts and others of note have been included because future research may render them diagnostic.

Brink et al. (1986: 115) found two artifacts that they describe as Narrow Ovate dart points (Figure 6: G and H). These points have convex blades and a straight base. They were found in different levels of different units, both with stratigraphic issues.

Brink et al. (1986: 115) unearthed eight broken artifacts that they classified as dart points based on their size (see Figure 6: J, R, and S for the most intact examples). They all appear to be either side-notched or stemmed and rather squat in morphology. Their stratigraphic context provided no clues as to their age or cultural affiliation.

That same season, Brink et al. (1986: 115) found four artifacts that they described as concave based dart points (Figure 6: N). One of these was recovered from a pit feature with a date of 2 710 ± 150 ^{14}C years BP and was speculated to be the base

of a McKean point. Brink et al. (1985: 123) found two points they describe as lanceolate concave-based. The smaller one (Figure 6: T) seems similar to the artifacts found by Brink et al. (1986: 115). Brink & Dawe (1989: 203) also found unnotched lanceolate projectile points, the smallest of which appears similar the ones discussed above. Brink et al. (1985: 124) observed that the larger of the lanceolate concave-based points (Figure 6: L) is similar to point types from the Early Precontact period, specifically the Plainview point or Meserve point. Brink & Dawe (1989: 219) also found a second large lanceolate concave-based point (Figure 6: F) and indicated that it appeared to be similar to Early Precontact points, in this case the Meserve point. Plainview points are a common Southern and Central Plains unfluted lanceolate style that dates to between 9 000 and 10 000 BP (Boszhardt, 2003). They are morphologically very similar to the thousand-year older Goshen points found on the Northern Plains. Goshen points have been found in Alberta, but are very rare (Peck, 2011: 37). Meserve points are also from the Central Plains and are debated to either be reworked Plainview points or reworked Dalton points rather than a unique type (Myers & Lambert, 1983). Brink & Dawe (1989: 220) suggest that a more reasonable interpretation is that they are preforms of dart points. Brink & Dawe (1989: 220) observe that the larger Bitterroot point they found the same year is the identical width and thickness, although slightly shorter.

Brink et al. (1985: 131) found two artifacts they describe as notchless eared projectile points (Figure 6: K). The ears are large, rounded tabs that extend horizontally from the base of the artifact. The points are sharp. Brink et al. (1985: 127) do not offer any speculation as to whether these are dart or arrow points.

Brink et al. (1985: 130) unearthed an artifact they described as broad V-shaped side notched point (Figure 6: U). It is complete and has a squat appearance with shallow but wide V-shaped side-notches and a convex base. The width of its neck implies use as a dart point.

Brink et al. (1986: 126) found two corner-notched projectile points on the surface that they did not typologically assign to Pelican Lake, Bracken, or Head-Smashed-In Corner-Notched (Figure 6: O and P). They have straight blades and barbed shoulders. One is significantly wider than the other. No explanation is given for why they were not assigned to a specific type.

Brink et al. (1985: 130) discovered a small side-notched projectile point with an additional notch on each blade (Figure 6: Q). The side-notches on the base form a narrow-stemmed morphology with a concave base. The notches on the blade are approximately halfway up the body. Given that the neck is less than a centimetre wide, it is more likely an arrow point. The only other reference to a projectile point from Alberta with four notches is the Pincher Creek double side-notched dart point found at the Pincher Creek Buffalo Jump (DjPl-1) by Ball (1987: 26), though it has all of its notches on the base rather than a pair on the blade.

A side-notched dart point was excavated during the well-head excavation (Figure 6: I) by Brink and Dawe (1989: 221). The shoulders are square and notches are small and extremely close to the base. Brink and Dawe (1989: 221) do not offer any speculation as to its typology. It appears similar to Mummy Cave point number 14 on Figure 17.21 in Reeves (1978: 171).

Brink and Dawe (1989: 220) found the proximal portion of a well-made lanceolate projectile point with very shallow notches (Figure 6: M). It has a symmetrical, biconvex cross-section with horizontal, parallel flake scars. The notches form what Brink and Dawe (1989: 220) refer to as an “incipient stem”. It was found below the sterile sand horizon, nearly 40 cm below surface.

Northern Side-notched/Northern-San Rafael-Sudden Side-notched Series Points

One point base identified as a Northern Side-Notched or Northern-San Rafael-Sudden Side Notched series point (Figure 6: A) was found in the campsite (Brink et al., 1985: 117). This series of points is unknown in Alberta and is typically found in the Great Basin region and the mountains of Idaho and Montana (Des Planques, 2001). Brink et al. (1985: 118) report that the specimens they compared this artifact to are known to date between 7 000 BP and 4 600 BP. Des Planques (2001) reports that the Northern Side-Notched points date to between 8 000 BP and 6 000 BP, while the Sudden Side-Notched points occur from 6 500 BP to 5 000 BP, and the San Rafael points date to between 5 500 BP to 3 000 BP. Unfortunately, without knowing its precise type it is impossible to know which of these date ranges it falls into. Nothing comparable was found in the kill site.

Pinto/Elko Points

One point base (Figure 6: C) identified as either Pinto Barbed (Figure 6: D) or Elko Eared (Figure 6: E) was found in the campsite (Brink & Dawe, 1989: 217). These

point styles are most common in the Great Basin but do occur in neighbouring regions (Des Planques, 2001: 12, 16; O'Connell, 1967: 130). Pinto, Elko Eared, and Elko Corner Notch have been found at bison jumps in Idaho (Agenbroad, 1978: 219). There are no other artifacts identified as either Pinto or Elko point variations from anywhere else in Alberta or in the HSIBJ kill site. There was a proposed Elko Eared point from the Alberta foothills, but it was redesignated as a Burmis Barbed point based on its morphology, age, and the geographic area in which it was found (Peck, 2011: 127). The specimens that Brink & Dawe (1989: 218) used for comparison to identify this artifact were dated to between 3 300 BP and 1 400 BP in 1970. Without narrowing down the specific subtype an AMS-based date cannot be reported. Knowing the subtype is key because these points have an extremely wide temporal range. Pinto points have been reported from 7 000 BP to 3 500 BP while Elko corner notched points, which may include Elko Eared, span from 8 000 BP to 2 000 BP (Des Planques, 2001). The HSIBJ artifact came from a layer Brink & Dawe (1989: 218) dated to 800 BP.

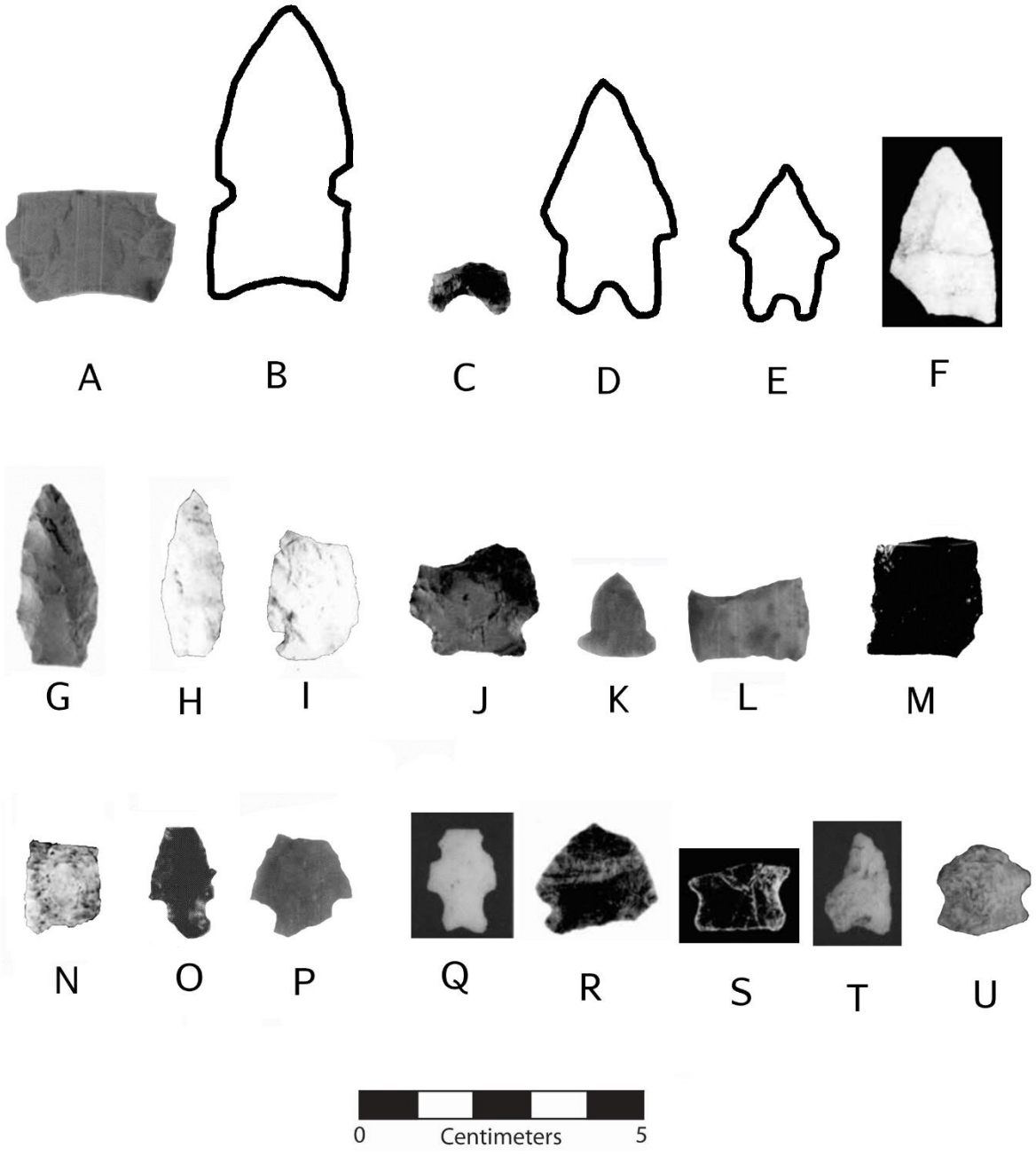

Figure 6: Exotic and unidentified projectile points of HSIBJ with reference images for identification comparisons. A. Northern Side-Notched/Northern-San Rafael-Sudden Side Notched point base, HSIBJ campsite (Brink et al., 1985: 118); B. Sudden side-notched point reference outline; C. Pinto barbed/Elko eared point base, HSIBJ campsite (Brink & Dawe, 1989: 217); D. Pinto barbed point outline image; E. Elko eared point outline image; F. Lanceolate Concave-Based point, HSIBJ campsite (Brink & Dawe, 1989: 203); G. Narrow ovate dart point, HSIBJ campsite (Brink et al., 1986: : 115); H. Narrow ovate dart point, HSIBJ campsite (Brink et al., 1986: 115); I. Non-classified dart point, HSIBJ campsite (Brink & Dawe, 1989: 202); J. Non-classified dart point, HSIBJ

campsite (Brink et al., 1986: 115); K. Notchless eared point, HSIBJ campsite (Brink et al. 1985: 131); L. Lanceolate concave base point, HSIBJ campsite (Brink et al., 1985: 130); M. Shallow notched lanceolate dart point, HSIBJ campsite (Brink & Dawe, 1989: 202); N. Concave base dart point, HSIBJ campsite (Brink et al., 1986: 115); O. Unidentified Corner-notched point, HSIBJ campsite (Brink et al. 1985: 131); P. Unidentified corner-notched point, HSIBJ campsite (Brink et al. 1985: 131); Q. Side and blade notched point, HSIBJ campsite (Brink et al., 1985: 130); R. Non-classified dart point, HSIBJ campsite (Brink et al., 1986: 115); S. Non-classified dart point, HSIBJ campsite (Brink et al. 1986: 115); T. Lanceolate concave-based point, HSIBJ campsite (Brink et al., 1985: 133); U. Broad V-shaped side-notched point, HSIBJ campsite (Brink et al., 1985: 130).

In summary, nearly every projectile point type well established in Alberta has been found at HSIBJ (Table 1), except for the earliest Paleoindian points (Clovis, Folsom, Goshen, Agate Basin, and Hell Gap). In addition, a few rare and exotic projectile point types have been found at the site. There are several important research outcomes from this overview. The first is that, based on the artifacts found in the campsite area, HSIBJ was visited continuously from over 9 500 years ago until the 1800s (Figure 7). This is not to say that people camped at the site every year, but that all archaeological time periods from the Cody Complex to European contact are reflected in the lithic assemblages. We do not know with certainty that all of these visits were to use the cliff for jumping bison but regardless, HSIBJ was clearly among the most frequented places in the region for the last nine millennia. There are very few sites on the northwestern Great Plains that experienced this volume of visitation throughout the millennia. Possibly the only comparable site in Alberta is the Stampede site in the Cypress hills, a campsite which was used fairly regularly for approximately 8 000 years (Peck, 2011: 137).

Table 1: Summary of the projectile point types found at HSIBJ with ages and references.

Projectile point type	Kill site	Campsite	Age in Alberta	Kill site reference	Campsite reference	Age reference
Metal points	Yes	Yes	250-100 BP	Reeves, 1978	Brink & Dawe, 1989	Bubel et al, 2012
Toy arrowheads	Yes	Yes	Late precontact	Dawe, 1997	Dawe, 1997	Dawe, 1997
Highwood	Yes	Yes	500-300 BP	Peck, 2011	Giering, 2023	Peck, 2011
Plains Triangular/preforms	Yes	Yes	1 100-250 BP	Reeves, 1978	Brink & Dawe, 1989	Bubel et al, 2012
Old Women's	Yes	Yes	1 100-250 BP	Reeves, 1978	Brink & Dawe, 1989	Bubel et al, 2012
Stemmed arrowheads	Yes	Yes	1 300 BP	Reeves, 1983	Brink et al, 1985	Brink et al, 1985
Avonlea	Yes	Yes	1 350-1 100 BP	Reeves, 1978	Brink & Dawe, 1989	Bubel et al, 2012
HSIBJ Corner-notched	Yes	Yes	Early Avonlea	Reeves, 1978	Brink & Dawe, 1989	Reeves, 1978
Foothill corner-notch	Yes	No	1 800-600 BP	-	Reeves, 1983	Taylor, 2006
Samantha	Yes	Maybe	Late Besant/Sonota	Reeves, 1983	Brink et al, 1985	Bubel et al, 2012
Sonota	Yes	Yes	1 500-1 350 BP	Peck, 2011	Bubel et al, 2023	Peck, 2011
Besant	Yes	Yes	2 100-1 500 BP	Reeves, 1978	Brink & Dawe, 1989	Peck, 2011
Outlook	Yes	No	2 500 BP	Peck, 2011	-	Peck, 2011
Pinto/Elko	No	Yes	unknown	-	Brink & Dawe, 1989	-
Bracken	Yes	?	2 800-2 000 BP	Peck, 2011	-	Peck, 2011
Pelican Lake	Yes	Yes	3 600-2 800 BP	Reeves, 1978	Brink & Dawe, 1989	Peck, 2011
Hanna	Yes	Yes	3 900-3 200 BP	Reeves, 1978	Brink et al, 1985	Webster, 2004
McKean	No	Yes	4 200-3 500 BP	-	Dawe & Brink, 1991	Bubel et al, 2012
Oxbow	No	Yes	5 200-3 800 BP	-	Brink & Dawe, 1989	Cole, 2015
Calderwood	Yes	No	5 200-4 700 BP	Peck, 2011	-	Peck, 2011
Gowen	Yes	No	6 100-4 700 BP	Walker, 1992	-	Cole, 2015
Maple Leaf	Yes	No	6 300-5 200 BP	Peck, 2011	-	Peck, 2011
Salmon River	Yes	No	6 300-5 200 BP	Reeves, 1978	-	Peck, 2011
Bitterroot	Yes	Yes	7 300-6 700 BP	Reeves, 1978	Brink & Dawe, 1989	Peck, 2019
Various Mummy Cave	Yes	Yes	7 500-4 500 BP	Reeves, 1978	Bubel et al, 2023	Bubel et al, 2012
Northern Side-Notched/Northern-San Rafael/Sudden Side Notched series	No	Yes	unknown	-	Brink et al, 1985	-
Boss Hill corner-notched	No	Yes	7 875-7 750 BP	-	Bubel et al, 2023	Bubel et al, 2023
Lusk Complex	No	Yes	8 300-7 500 BP	-	Bubel et al, 2023	Peck, 2011
Eden	No	Probable	9 000-8 600 BP	-	Dawe, 2013	Bubel et al, 2012
Scottsbluff	No	Yes	9 000-8 600 BP	-	Giering, 2009	Bubel et al, 2012
Alberta	No	Yes	9 600-9 000 BP	-	Bubel et al, 2023	Bubel et al, 2012

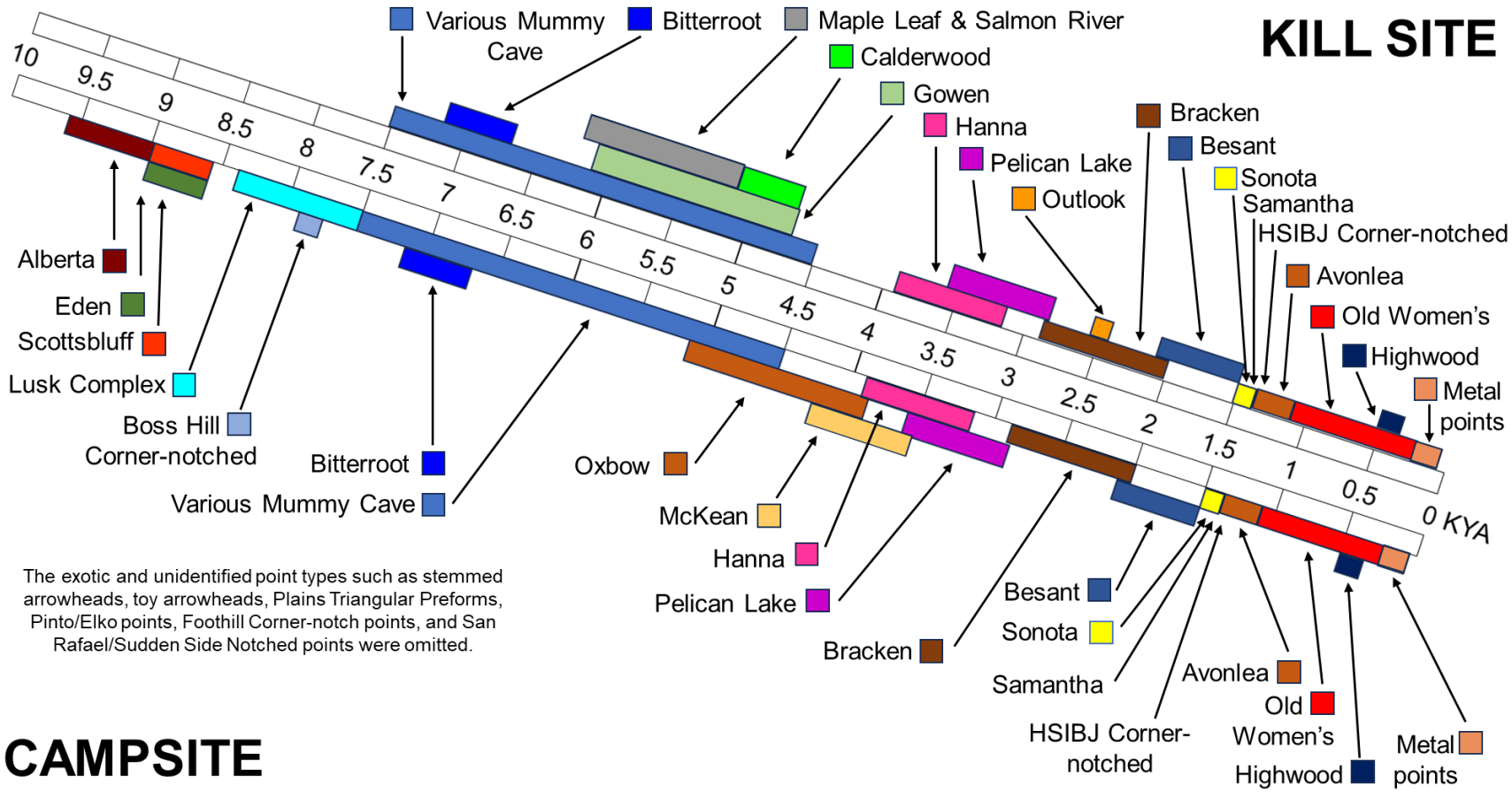

Figure 7: Timeline of projectile points from HSIBJ with the campsite and kill site shown separately. Exotic and unidentifiable projectile point styles have been omitted.

This research also calls into question the proposed 2 000-year “gap” in site use proposed by Reeves (1978: 171). Based on these collated data, the site was used throughout the Hypsithermal, though perhaps not as frequently as later periods. This new interpretation will be discussed further, which was done as part of the stratigraphic re-examination discussed in the following section.

The second major outcome of this typological overview relates to HSIBJ’s central function in the region through time. Many of these projectile point types have not been found at other jumps, making HSIBJ unique in the Great Plains. The typological chronology present at HSIBJ can be used as a framework upon which archaeological phases and cultures can be understood. Issues surrounding the Gowen-Oxbow point series, for example, may be explored using this chronological scaffolding and framework. Initial results from the joint ULeth-RAM project look promising and may help to resolve the classification of the earliest projectile point types from the site, especially the Cody Complex material. Furthermore, other bison jumps and kills sites can be better interpreted in relation to HSIBJ, both at the site level to confirm temporal use periods, and at the regional level to build cultural links between sites. This typological overview can inform archaeological research being carried out at Precontact in Alberta and across the northwestern Great Plains. The projectile points found at the site that are either exotic to Alberta or not part of any named projectile point type or archaeological phase or complex can be a starting point to explore broader cultural connections.

This research also highlighted the ongoing development of, and remaining lack of consensus in, the classification of projectile points. As more points were discovered in the province, some of Reeves’ typological classifications were modified. Much of this

work was done by Peck (2011) but Brink and colleagues (Brink et al., 1985; Brink et al., 1986; Brink & Dawe, 1989) also worked to refine the typological classifications of the points found at HSIBJ, among others. Some chronological issues were resolved thanks to their work. Typological inconsistencies or a lack of consensus on the type of point is mainly due to poor contexts or incomplete specimens. It does remain challenging, however, to differentiate between the Mummy Cave point varieties and Samantha points, as well as the lanceolate points with a concave base, such as McKean and Plainview or Meserve points. These cases are not simply the echoing of a lumper or splitter debate (see Whittaker et al., 1998 for further discussion), though this issue also plays a role in the typological assignments of HSIBJ points and others across North America.

There is still much work to be done in Alberta and the Northwestern Great Plains on projectile point typology and seriation and this research can be used for such studies. Ideally, the artifacts recovered from HSIBJ should be re-examined to confirm or update their typological assignments and harmonize the various classifications of these artifacts that have been proposed over the decades. This research project established the framework to do so.

The Stratigraphy of the Kill Site

Reeves (1978) conducted the most extensive excavations of the HSIBJ kill site to date. In 1965 Units A and B in the South Area of the kill site were excavated and then connected by a shallow trench (Reeves, 1978: 156). Unit A was excavated to understand the stratigraphy and depth of the site whereas Unit B was excavated to sample one of the few areas undisturbed by looting. In 1966, Units X, Y, and Z were excavated in the South Area adjacent to a dragline trench dug by the Geological Survey of Canada. The purpose of the dragline trench was to investigate the bedrock and slumping of the cliff face. Also in 1966, there were excavations in the North Area of the kill site. In 1972, Unit C was excavated in the South Area to better understand the Late Precontact Period. The North Area was also excavated with the intent of finding the earliest deposits, leading Reeves (1978: 156) to dig intentionally in the most heavily looted sections to avoid unnecessarily further disturbing the more recent deposits.

The only published stratigraphic diagram of Reeves' work at the kill site is his synthesis of his excavations (Reeves, 1978: 167). He merged the south excavation units into one column and did the same with the north excavations which he then correlated (Figure 8). The main goal of this part of the thesis research was to create a stratigraphic diagram for each of Reeves' excavation units/areas and then correlate these to determine how they connect (or do not) across the whole site (Figure 9). By creating and presenting these stratigraphic profiles in this thesis, using Reeves' original notes, future researchers have easier access to vital contextual information needed for cultural interpretation, a valuable output in itself.

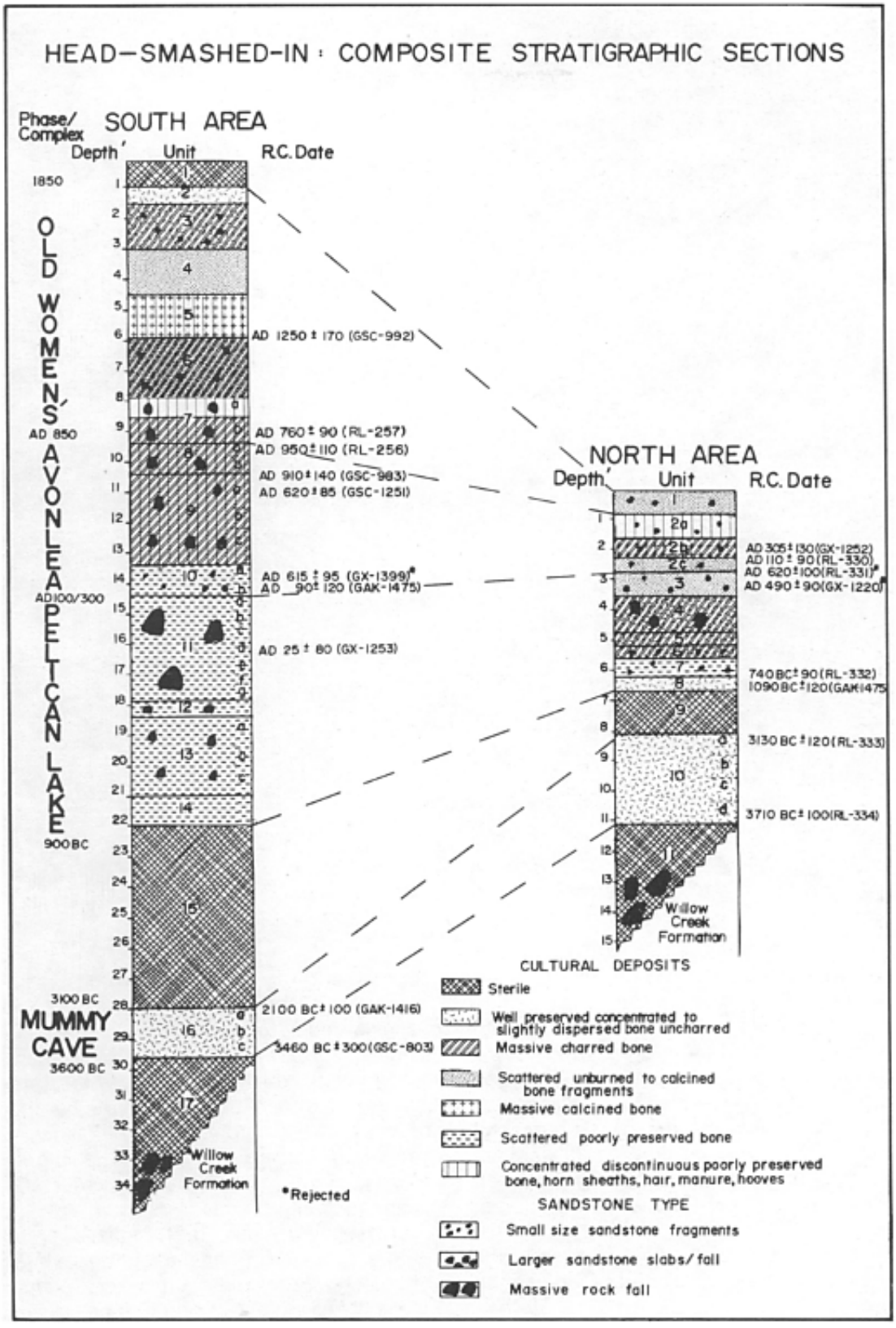

Figure 8: Stratigraphic diagram of the HSIBJ kill site from Reeves (1978: 167).

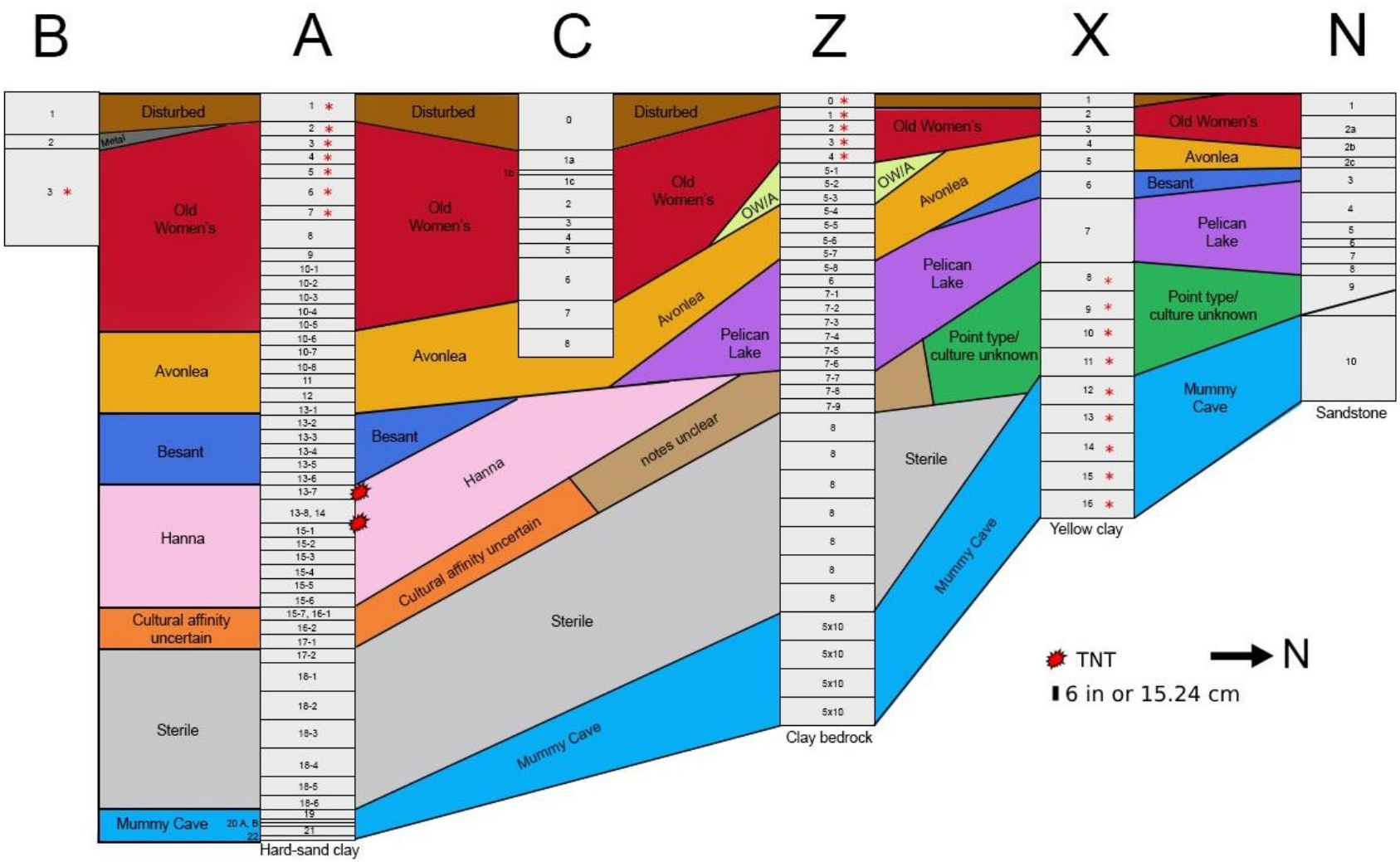

Figure 9: Units and levels of Reeves' excavations of the HSIBJ kill site. The stratigraphic columns of the units are correlated to one another. The red asterisks indicate levels where the notes are unclear as to how thick the level is.

The bulk of the data used to create Figure 9 is based on the portions of Reeves's original field notes that are currently accessioned at the RAM. Locating and reviewing these notes proved to be lesson in archival research and it quickly became clear that a new digital document was needed. It often took a significant amount of time to understand what was written in the notes, sometimes because of poor handwriting or paper quality, sometimes because of recording errors or typing mistakes. Thus, this component of the thesis research began with a close reading of the field notes. A digital summary document of the field notes applicable to this study was created (Appendix 1). Records of particular significance were transcribed as accurately as possible with qualifying notes added where appropriate. Errors are noted along with corrections.

Stratigraphic correlations were made based on artifact type as described within the field notes, though descriptions of the matrix in the notes were considered where possible. In most cases, matrix descriptions lack the detail needed to assess formation processes and stratigraphic connections. In the South Area, excavation Unit Y was excluded because it was a shallow excavation meant only to confirm the stratigraphy of Unit Z and there is very little artifact information available for it.

Individual unit notes for the North Area excavation units are not at the RAM, and it is unclear if they still exist. Thus, the North Area is shown as one excavation unit based on the sets of North Area correlated descriptions found in Reeves' notes. Doing so should not significantly hamper interpretation since there is a photograph showing that in at least one of the excavation units, all of the levels Reeves discussed as part of the North Area stratigraphy are present (Figure 10).

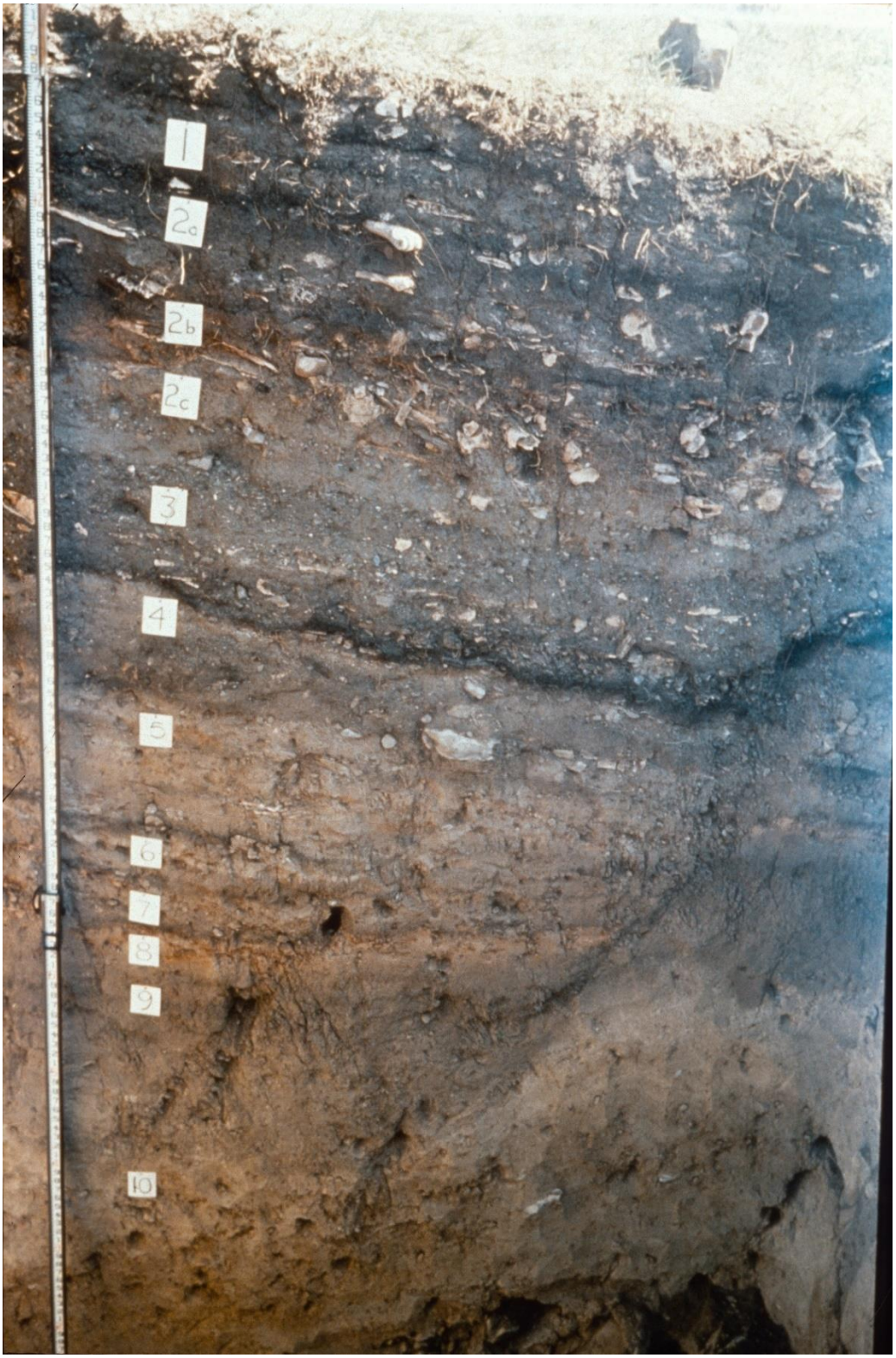

Figure 10: Profile photograph of an unknown unit in Reeves' North Area excavation.

The horizontal layout in Figure 9 above is based on Reeves' (1978: 158, 161) maps of the site. While the level thicknesses and unit depths are to scale (see below for caveats), it is important to remember that the strata of the site underwent significant compression over the millennia of use (Reeves, 1978: 169), therefore, the lower levels are not as thick as they were when they were first deposited in antiquity.

Specific thickness information for every level or sublevel of every excavation unit was not always included in the notes. These cases have been marked with a red asterisk. Reeves describes the excavation levels in Unit X as arbitrary rather than natural levels but because both 1-foot and 6-inch arbitrary levels exist elsewhere in the project, it was not clear how deep they were dug. One foot was chosen because the deeper levels of Unit Z are arbitrary 1-foot levels. The levels in Units A and Z of unknown thickness have no information in the notes as to their depths so they were assigned 6-inch values because that is the typical thickness of the arbitrary levels for the upper levels. In addition, it was unclear from the notes if the sandstone blocks dynamited in Unit A should be considered distinct levels, unnumbered levels, or as part of existing levels, so they were left out and their position marked with a symbol. Lastly, there is significant confusion in the notes about Unit B (see Appendix 1). In Figure 9, Unit B is depicted according to Reeves' own description of its stratigraphy after he re-excavated it rather than the original excavator's description. Some levels or sublevels vary in thickness and in these cases the maximum stated thickness was used except for North Area Level 9 where both the maximum and minimum thickness are shown.

If a level or sublevel lacked information but they were between two levels bearing the same projectile point type, they were depicted as that type. For example, the notes

for Unit Z Level 5 Sublevel 8 have a description of the points being barbed but no mention of the type. This level was assigned to Pelican Lake as this is the barbed point type that fits within the sequence and subsequent levels contain Pelican Lake points. In the notes of Unit A, the section is labelled “cultural affinity uncertain” due to the fact that these levels contain bone fragments and evidence of burning but no projectile points were mentioned in the notes. However, there is a photograph of a point *in situ* from that within that section (Figure 11). The photograph quality and angle make it difficult to identify. It appears to be a stemmed point with some similarities to Hanna points, which the notes mention were found in the levels directly above. Since it does not clearly match any of the Hanna points with available photographs from Reeves excavations, this section remains labelled “cultural affinity uncertain”.

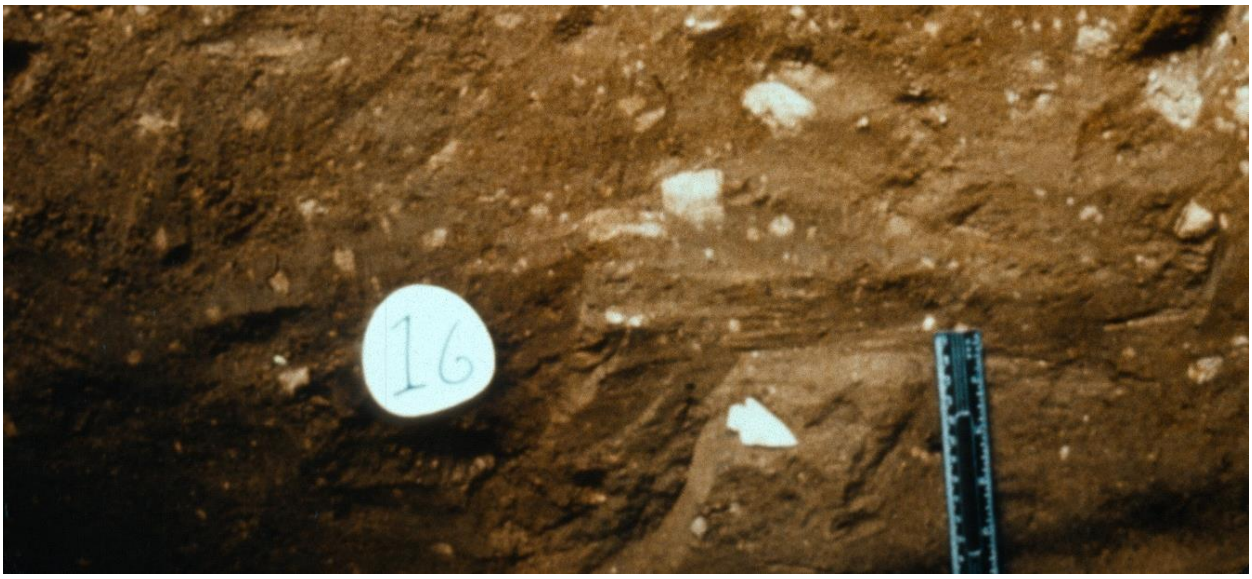

Figure 11: Projectile point from Unit A Level 16 of the kill site. It appears to be a stemmed point similar to Hanna, but it cannot be confidently identified using only the photograph.

The bottom of Level 7 of Unit Z is labeled “notes unclear” due to particularities in the description of the unit in the notes (see Appendix 1). The section on those sublevels is left blank. Based on the text within the notes, it could mean that the levels were also assigned Pelican Lake or that the description in the following summary applies to them. There are comments in the notes stating that the level has several buried Ah horizons [paleosols], bone fragments, and plenty of charcoal. The author of the notes hypothesizes that the level is similar enough to correlate it with Level 9 in Unit X and Level 9 in the North Area, but this is uncertain.

Level 9 of the North Area is labelled as “culture unknown” rather than sterile as Reeves (1978: 167) stated because his original notes list it as containing bone fragments, charcoal, and a paleosol (see Appendix 1). This does not meet the typical criteria to be described as sterile and this level is unlike the sterile levels in Units Z and A. Levels 8-11 in Unit X are labeled as “culture unknown” because they have many clearly butchered bones (see Figure 12 for examples) but lack diagnostic artifacts. Also, it was described the “unknown” component in Smith’s (1980: 60) zooarchaeological analysis of Reeves’ finds (see below).

Perhaps the most striking result from doing this work, which is revealed in Figure 9, is how patchy the distributions of projectile point styles between Mummy Cave and Avonlea are throughout the site. This indicates a spatially uneven use of the site that has not been recognized before. Importantly, this spatial distribution impacts our understanding of how the jump was used. For instance, Hanna and metal projectile points would not be part of our understanding of the kill site chronology had Reeves chosen to dig one fewer unit or had dug a different part of the kill site. As this is the only

known bison jump to have a Hanna component, it is very fortunate that Reeves encountered it. Furthermore, the substantial thickness of the Hanna component of the site implies that HSIBJ saw significant use during this period.

The value of the large scale of Reeves' project cannot be overstated. However, we are left to wonder, as Brink and Dawe (1989: 254) have, if given the enormity of the site, Reeves' excavations still missed some cultural components. Finally, the patchiness likely explains the large sterile levels in Units A and Z. Knowing that the cultural remains at the HSIBJ kill site were not deposited evenly, these sterile blocks could represent the space in-between frequently used portions of the kill site that were filled in by loess accumulating in the topographic lows.

It is also clear that the site saw heavier use in the Late Precontact Period than in the Middle Precontact Period even with compression of the sediment being considered. This is consistent with the general understanding of communal bison hunting and patterns of bison jump usage in the literature (Brink, 2016: 18). The widespread use of the site during the Mummy Cave timeframe is quite interesting, especially because HSIBJ is the only Mummy Cave bison jump currently known. The radiocarbon dates from Unit X and the North Area (Figure 16) confirm substantial use of the site during this period, with seemingly regular use from approximately 6 600 cal BP to the end of what is traditionally considered the Mummy Cave era (~4 500 BP). The projectile point sequence of HSIBJ also bears this out, with multiple types within the traditional Mummy Cave umbrella identified (see Table 1). Now that some researchers are subdividing Mummy Cave into several discrete types (see Peck, 2011 and Peck, 2018 for

examples), it is worth remembering that bison hunting techniques persisted through these technological changes.

There is a feature of the natural stratigraphy that is worthy of additional consideration. All three of the deep excavations Reeves' (1978) conducted in the South Area of the kill site (Figure 13) are floored by a hard clay (Figure 9). While the notes do not describe it the same way every time, the overall characterization is very similar. This is significant as any one of these descriptions could very accurately characterize the matrix the joint ULeth-RAM field school project dug through to reach Mummy Cave, Boss Hill, and Alberta point levels in the campsite area (Bubel et al., 2023: 4). This strongly implies that Reeves did not dig deep enough to reach the earlier deposits and oldest uses of HSIBJ, which Reeves (1978: 173) himself noted. It is strongly recommended that a future excavation project of the HSIBJ kill site target the South Area and dig through this material in hopes of confirming a Boss hill and Cody complex use of the kill site.

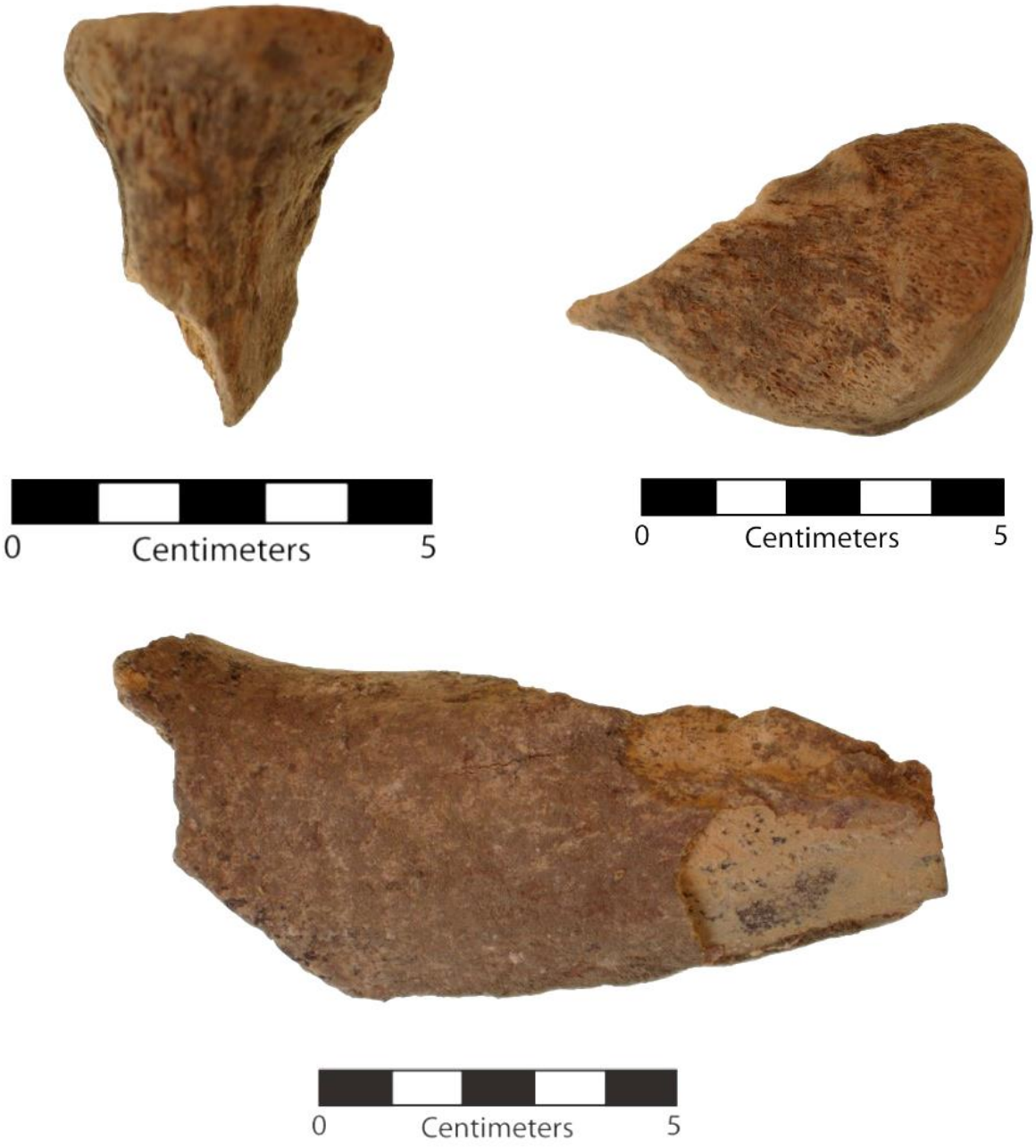

Figure 12: Butchered bones from Unit X Level 8.

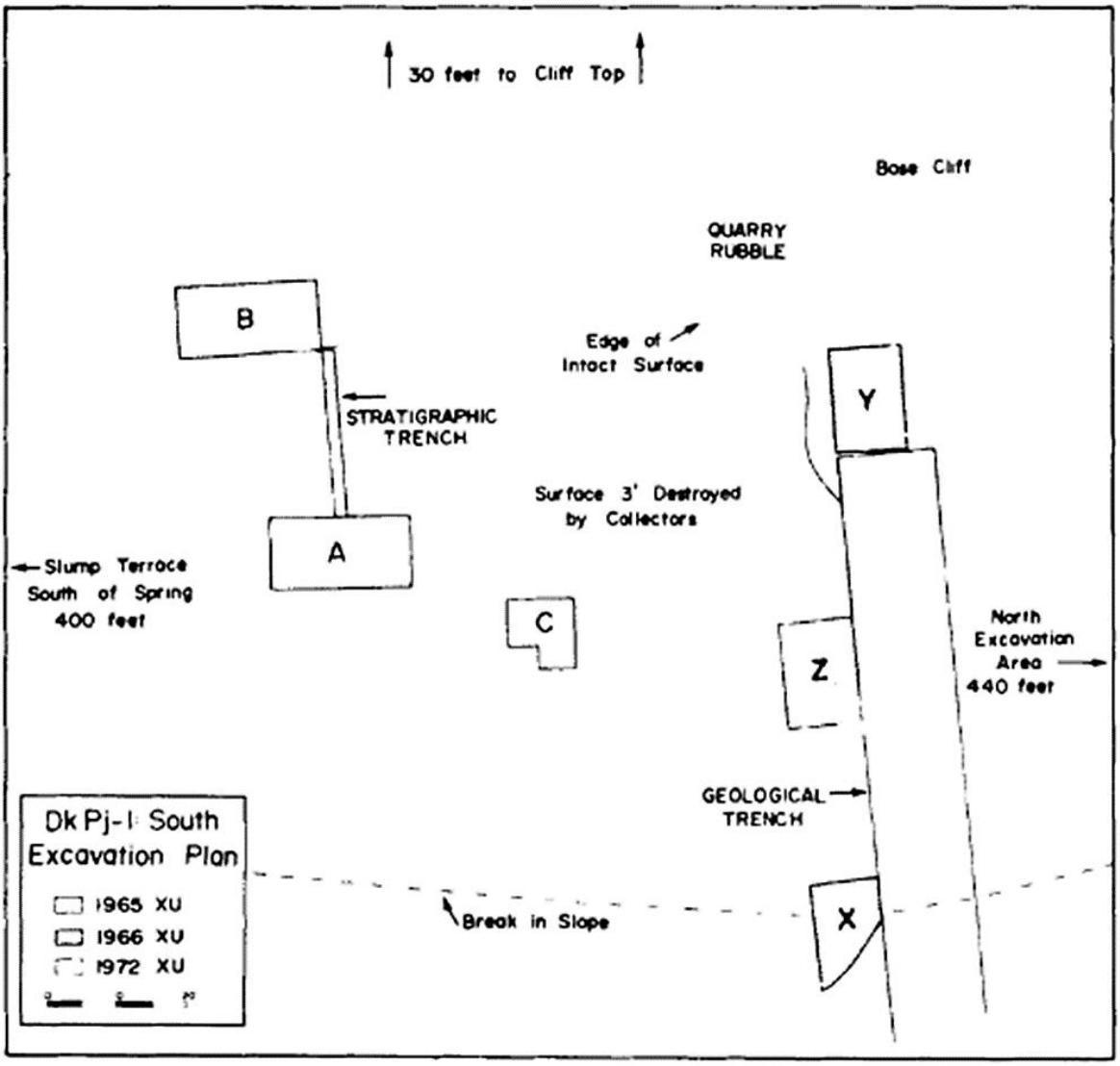

Figure 13: South excavation area map from Reeves (1978: 158).

Testing "The Gap Hypothesis"

The "gap" is a proposed hiatus in the use of HSIBJ between the Mummy Cave and Hanna components (Reeves, 1978: 167). This proposition is based on the large sterile layers Reeves identified in the kill site and by a gap in the projectile point sequence. Reeves (1978: 167) dated the sterile layer to between 3 100 and 900 BCE

with three radiocarbon dates and illustrated it in his North Area and South Area profile drawings (Figure 8). Based of these dates, there appears to be a break radiocarbon dating sequence. Brink (2016: 17) stressed the need for new dates to define the edges of the “gap” due to the lack of clarity regarding its length. Only a small number of dates were obtained by Reeves (1978: 162), and these dates were taken before much more accurate and precise AMS radiocarbon dating was available.

Moreover, why there is an apparent break in cultural activity is unclear. Reeves (1978: 172) hypothesized that the people who used McKean projectile point styles arrived in the area from elsewhere and did not know how to drive bison. He rejected the possibility that climatic factors made the jump unusable. Further research in the subsequent years confirmed that the plains were populated during this time and that the climate was suitable (Walker, 1992: 143; Robertson, 2011; Meyer et al., 2016). Therefore, the “gap” at HSIBJ cannot be simply be explained by a lack of people or poor climatic conditions, concurring with Reeves.

Peck’s (2011: 202) summary of the state of research on the McKean complex indicates that scholarly consensus, especially in Canada, is that McKean emerged from the mountains in the western United States and spread across the Northern Plains. The causes of this spread are unknown but are hypothesized to relate to the end of the Hypsithermal (Peck, 2011: 202), a period that was warmer and drier. Reeves (1978: 172) claimed that McKean points occur in the area around HSIBJ based on surface finds but did not elaborate. One assumption based on his view of the origins of the McKean complex is that the people making those points migrated into the region but did not know how to use the jump to hunt bison. Reeves’ (1978: 172) hypothesis is

problematic, however, because he found Hanna points at the kill site, which are considered to be a part of the McKean complex according to more recent interpretations (Peck, 2011: 202). Instead, Reeves considers Hanna points to be a direct precursor to Pelican Lake (Peck, 2011: 226), so his reasoning was consistent regardless of the fact this interpretation is now outdated. Another issue with Reeves' hypothesis is that the oldest known bison pound is the Scoggin site, which is an early McKean site dated to approximately 5 200 cal BP (Brink, 2016: 18). This site shows that the users of McKean points had sophisticated communal bison hunting techniques prior to reaching the Canadian Plains.

One of the goals of this research project was to date the start and end of the "gap". To do so, excavation units that temporally fell within it, just before, and just after needed to be identified using the information in Reeves' field notes. It became clear that the excavation units in the South Area of the kill site could not be used in this analysis. There are three excavation units in the South Area that were deep enough to reach the Mummy Cave deposits and thus, should contain the sterile layers depicted in Reeves' (1978: 167) composite stratigraphic diagram. These are Units A, X, and Z (Figure 9). However, only in Units A and Z actually contain such a layer; Unit X does not (see Appendix 1). The layer in the North Area of the kill site that Reeves (1978: 167) tied to the "gap" is problematic and is discussed below.

Unit A as it Relates to the "Gap"

It is not possible to date the start and end of the "gap" in this excavation unit. Based on the field notes, the level directly above the "gap" is Level 17 but after

searching through all of the material stored at the Royal Alberta Museum from Reeves' excavations it was determined that the RAM did not receive any bones or charcoal from this level. Level 17 had no projectile points and thus, its cultural affiliation is undeterminable. This is unfortunate because it is below the Hanna component, which is the oldest post-Mummy Cave projectile point style identified by Reeves (1978: 172). There is no indication that bones from the Hanna levels were sent to the RAM despite the fact that bones are recorded as being present in the notes for those levels. If bones from the Hanna timespan were available, they would have been submitted for radiocarbon dating in lieu of or ideally in addition to the Level 17 bones.

Level 18 is sterile and thus represents the stratigraphic hiatus Reeves identified. Level 19 has a flake, probable paleosols and several bones but none of the bones were found in the RAM collections. It is unknown if they were collected in the field. Level 20 Stratum A of Unit A is described as a bone bed-like layer and depicted as such in the stratigraphic drawing from the field but only two small bone fragments are in the RAM's collections. These are the only two bones remaining from the Mummy cave levels of this unit, and they are in too poor of condition to radiocarbon date. Another reason not to attempt to radiocarbon date the bones from Level 20 Stratum A of Unit A is that there were two attempts to date bones from Level 13 of Unit A that failed despite the specimens being in marginally better condition.

Unit Z as it Relates to the "Gap"

It is not possible to date the start and end of the "gap" in this excavation unit. Having gone through all of the material stored at the RAM from Reeves' excavations, it

appears that they stopped collecting bones shortly after the first arbitrary 6-inch sublevel of Level 7, or did not submit these specimens to the RAM. However, the field notes still report bones at least as low as the third 6-inch sublevel of Level 7 and the authors imply the recovery of artifacts down to the sixth 6-inch sublevel. Level 8 is the large sterile layer for Unit Z that Reeves used to propose the “gap” of use at the site. There are no bones reported from below Level 8 where quartzite artifacts presumed to be of Mummy Cave age were recovered and none were found in the RAM’s collection. One would suspect the presence of artifacts without any bones would be unexpected enough in a bison kill site to warrant mention. Since the notes are typically very scant when discussing bones, it is possible that they did encounter bones associated with the quartzite artifacts but simply did not make their presence. This was the case in other levels from which bone was recovered and is at the RAM, but was not mentioned in the field notes.

Unit X as it Relates to the “Gap”

Based on Reeves’ notes, there are no sterile levels in Unit X. In one section of his notes, Reeves describes how he determined the correlations for the figure in his 1978 paper. The deepest part of Unit X that is mentioned is the second 6-inch sublevel of Level 7. This he assigned to part of Level 14 in his published stratigraphic diagram. He did so even though Level 7 has five sublevels, and that Unit X has 16 levels in total. Moreover, Level 7 was assigned to the Pelican Lake culture in Reeves’ notes for the unit. Reeves indicates that the archaeological culture of Level 8 is undeterminable, presumably due to a lack of projectile points. It is not sterile; there is a significant

quantity of butchered bone that was collected, and it seems to contain a paleosol based on the notes. Unfortunately, the thickness is not given for Level 8 of Unit X.

Level 9 does not have a specified thickness either but appears to be the start of a series of arbitrary levels that go to Level 16. These would either be 6 or 12 inches thick based on the thicknesses of arbitrary levels throughout the rest of Reeves' project. Unfortunately, there are clarity issues within the notes in this regard, so these levels were reconstructed in part using the labels on the bone boxes at the RAM and Smith's report (1980), the faunal analysis conducted under Reeves' supervision. Level 9 is described in the notes as similar to Level 8.

Unfortunately, the box labels indicate that the Level 9 bones are mixed with the Level 7 bones of unknown sublevel. Since Level 7 is 2.3 feet thick, it would be unrealistic to assume that whatever bone we date is from immediately below Level 8 rather than elsewhere in Level 7. There are butchered bones from Levels 10, 11, 12, 14, 15, and 16 in the RAM collections. In addition, Smith (1980: 60) identifies Levels 8-11 of Unit X as making up an "unknown" component of the site that is part of the correlated Level 15 in Reeves' (1978: 167) publication and its stratigraphic diagram (Figure 8). Smith (1980: 60) does confirm that Levels 12 through 16 are interpreted as Mummy Cave although Reeves' notes only mention that stone choppers and quartzite flakes were found, not projectile points.

In sum, there seem to be no sterile levels in Unit X and thus no stratigraphic hiatus the top and bottom of. It is also important to state that Reeves did not identify any erosional contacts between stratigraphic deposits in this unit, so it is unlikely that a

sterile “gap” deposit was eroded from this area of the site due to natural formation processes.

North Area as it Relates to the “Gap”

The North Area is made up of several excavation units and trenches. The disconnect between the notes and Reeves’ (1978: 161) publication make it difficult to properly understand the layout due to the lack of labels on the maps (Figure 14). The numbered Units N1, N2, N3, N4, and N5 appear to form the main excavation of the North Area based on the notes and box labels, but individual notes for any of N1-N5 units are not available. The exploration of the “gap” deposits is based on two sets of correlated, summarized notes that have some information (see Appendix 1).

The “gap” is defined as Layer 9 in the North Area in the correlation notes and Reeves’ (1978: 169) publication but was not given a level designation in the field. It varies from approximately 5 to 18 inches (12.7 to 45.7 cm) thick (Figure 15). Reeves (1978: 169) claims that Layer 9 is sterile and corelates it with the sterile units in the South Area. However, his notes state that some bone and charcoal fragments were found, in addition to a paleosol and that it correlates with Level 9 of Unit X, which is not sterile. The bone and charcoal fragments would indicate that Layer 9 is not sterile even if it lacks artifacts. Unfortunately, even if it was collected in the field, none of the material from Layer 9 is at the RAM so there are no remains to submit for radiocarbon dating.

The excavation strata of the North Area that were correlated to Level 8 of the composite profile are N3 Level 3 and N4 Level 6. The excavation strata that were correlated with Level 10a of the composite profile, the upper most sublevel of Level 10,

are N1 Levels 2, 3, and 4; N3 Level 5; N4 Level 7 and Level 9; N5 Levels 6, 7, and 8. Radiocarbon dates were submitted from these levels.

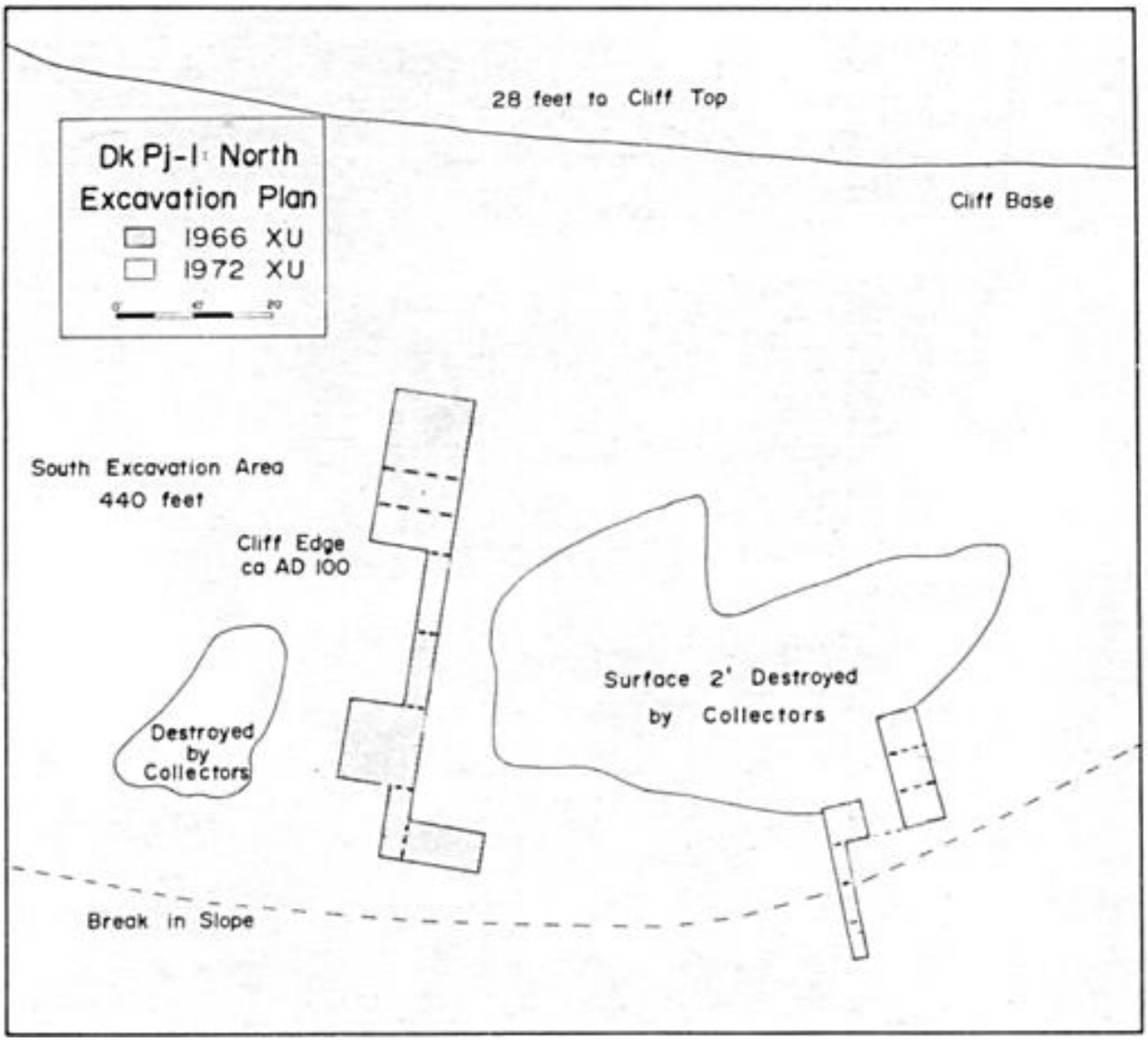

Figure 14: North Area excavation map from Reeves (1978: 161).

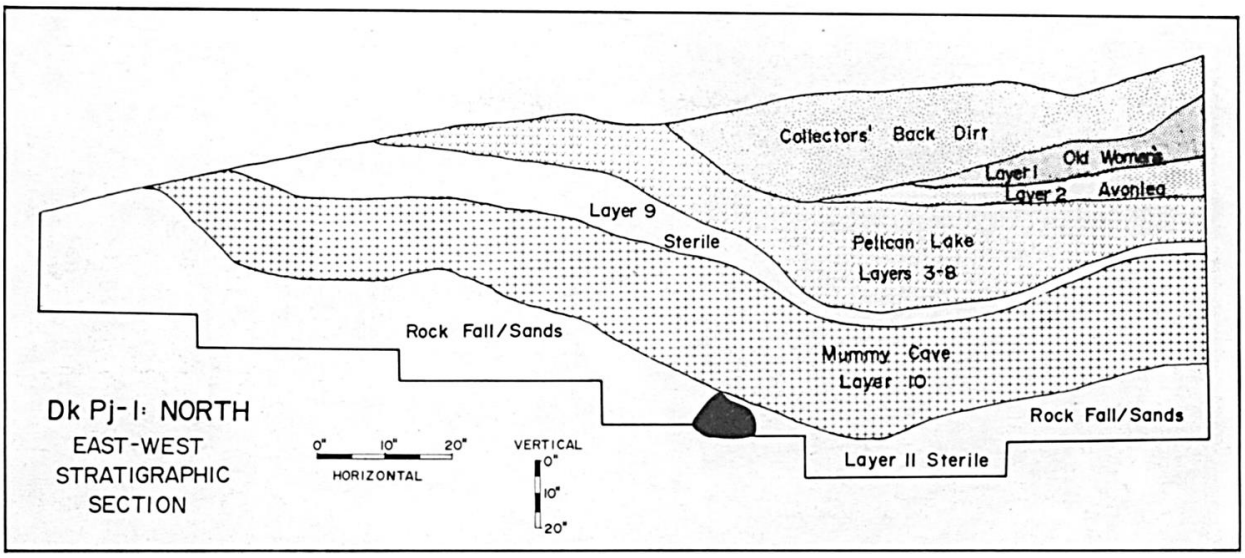

Figure 15: North Area east-west stratigraphic section from Reeves (1978: 169).

Radiocarbon Dating Program

Based on the limitations described above, the North Area excavations and Unit X were targeted for radiocarbon dating. The radiocarbon dating plan changed as the understanding of the stratigraphy evolved. Radiocarbon dates were submitted in three batches so that new questions raised by the prior batch could be addressed.

All specimens chosen for radiocarbon dating were *Bison sp.* bones. Whenever possible, dense bones with good surface integrity were selected. Each bone was identified to element and sided prior to being cut for sampling. Before and after photographs were taken of each specimen. Samples were cut with a Dremel, and the cutting wheel was changed between each sample. This work was conducted at the Royal Alberta Museum. The samples were weighed on a digital scale and then mailed to the radiocarbon laboratory.

The radiocarbon dating plan for the North Area of the kill site was to date Levels 8 and 10a as identified in Reeves (1978: 167) as well as the levels above and below them for certainty. In addition, when the first two batches of radiocarbon dates led to confusion regarding the date of Level 8, we obtained additional dates from the levels above in order to resolve this issue. Our hope was that we would be able to correlate the North and South Areas of the site using absolute dates rather than just artifact typology and seriation and the original field notes. Unfortunately, this did not work out as is shown in Figure 16.

As explained above, Unit X was the only excavation unit in the South Area of the site that was viable for investigating the lowest levels of HSIBJ. Initial confusion regarding the level numbers 12 through 16 in Reeves' 1978 publication and the same numbers in Unit X led to us to obtain several dates from the bottom of the Mummy Cave component of the unit. Though interesting, these results were not the intent, therefore, a second batch of radiocarbon dates were submitted. We obtained a series of dates through most of the "unknown" levels and Mummy Cave levels of Unit X (Figure 16). It was decided not to date Level 9 of Unit X because the box labels indicate that those bones are mixed with bones from Level 7.

Radiocarbon Dating Results

The dates from our radiocarbon program are listed in Table 2, along with Brink's (2016: 16) dates, and are noted on figure 16. The dates were calibrated using the OxCal formula (Ramsey, 2009) and are given in Appendix 2. The dates we obtained from the lowest levels of the HSIBJ kill site are consistent with Brink's (2016: 16) dates.

Table 2: All AMS radiocarbon dates from the kill site component of HSIBJ.

Lab number	Sample Number	Project	Location	Unit	Field Level	Correlated Level	Result	Range	Mean Cal BP	Status
Beta 396503	DkPjl-X16	Brink, 2016	South	X	16	South 16	5 010	±30	5 762	Accepted
Beta 396502	DkPjl-10d	Brink, 2016	North	unclear	unclear	North 10d	5 780	±30	6 581	Accepted
Beta 396501	DkPjl-10c	Brink, 2016	North	unclear	unclear	North 10c	5 470	±30	6 266	Accepted
UOC-22346	2023-S1	Sawchuk, 2025	South	X	8b	Equates to South 15	2 501	±20	2 595	Rejected
UOC-22347	2023-S2	Sawchuk, 2025	South	X	8b	Equates to South 15	4 227	±20	4 789	Accepted
UOC-22348	2023-S3	Sawchuk, 2025	South	X	10	Equates to South 15	4 209	±21	4 755	Accepted
UOC-22349	2023-S4	Sawchuk, 2025	North	N-4	6	Bottom of North 8	5 596	±22	6 360	??
UOC-22350	2023-S5	Sawchuk, 2025	North	N-4	6	Bottom of North 8	2 728	±26	2 816	??
Keck 271752	HSI R-1	Sawchuk, 2025	South	X	16	Should be South 16	5 015	±20	5 773	Accepted
Keck 271753	HSI R-2	Sawchuk, 2025	South	X	15	Should be South 16	5 020	±20	5 786	Accepted
Keck 271754	HSI R-3	Sawchuk, 2025	South	X	15	Should be South 16	4 720	±15	5 423	Accepted
Keck 271755	HSI R-4	Sawchuk, 2025	South	X	14	Should be South 16	4 385	±20	4 937	Accepted
Keck N/A	HSI R-5	Sawchuk, 2025	South	A	13 (6-12 in)	South 11b	FAILED	N/A	N/A	N/A
Keck N/A	HSI R-6	Sawchuk, 2025	South	A	13 (6-12 in)	South 11b	FAILED	N/A	N/A	N/A
Keck 271756	HSI R-7	Sawchuk, 2025	South	X	12	Should be South 16	4 390	±20	4 943	Accepted
Keck 271757	HSI R-8	Sawchuk, 2025	North	N-5	11	North 10d	5 565	±20	6 394	Accepted
Keck 271758	HSI R-9	Sawchuk, 2025	North	N-4	9	North 10a	1 925	±15	1 845	Rejected
Keck 271759	HSI R-10	Sawchuk, 2025	North	N-4	9	North 10a	5 605	±25	6 366	Accepted
Keck 271760	HSI R-11	Sawchuk, 2025	North	N-5	9	North 10b	5 440	±25	6 243	Accepted
Keck 271761	HSI R-12	Sawchuk, 2025	North	N-5	8	North 10a	5 585	±25	6 356	Accepted
Keck N/A	HSI R-13	Sawchuk, 2025	North	N-4	8	Should be South 16	FAILED	N/A	N/A	N/A
Keck 271762	HSI R-14	Sawchuk, 2025	North	N-5	6	North 10a	2 800	±20	2 903	Rejected
Keck N/A	HSI3-A	Sawchuk, 2025	North	N-4	5	North 7	FAILED	N/A	N/A	N/A
Keck N/A	HSI3-B	Sawchuk, 2025	North	N-4	4	North 6	FAILED	N/A	N/A	N/A
Keck N/A	HSI3-C	Sawchuk, 2025	North	N-4	5	North 7	FAILED	N/A	N/A	N/A
Keck 290714	HSI3-D	Sawchuk, 2025	North	N-5	5	North 6	2 620	±15	2 748	Accepted

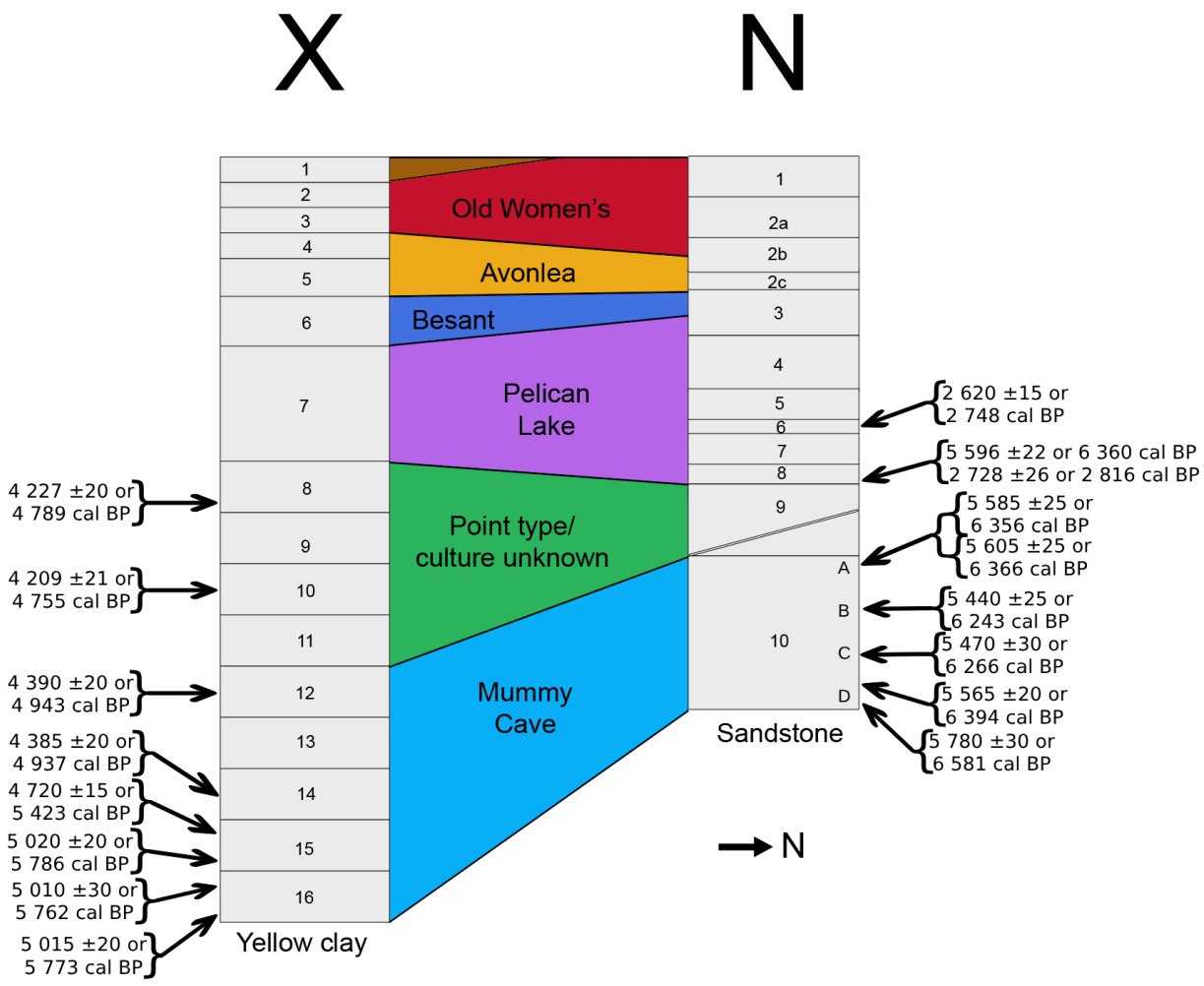

Figure 16: Accepted AMS radiocarbon dates from the kill site at HSIBJ in stratigraphic context, with the projectile point identifications noted.

Six of our dates failed, HSI R-5, HSI R-6, HSI R-13, HSI3-A, HSI3-B, and HSI-C. We are confident that this was due to poor preservation of the specimens and not lab error or insufficient material, although, upon inspection, most appeared to be preserved as well as the ones that succeeded. Samples 2023-S1, HSI R-9, and HSI R-14 were rejected because these dates are thousands of years younger than the projectile points

found within those levels and the surrounding radiocarbon dates. It is likely that some bones got mixed into the wrong bags prior to being sent to the RAM. As discussed above, the collection arrived at the RAM decades ago, with several organizational and packing issues. One of the most problematic concerns is that some of the paper bags the bones were stored in have ripped and spilled into each other. Together with RAM staff, I tried to mitigate these issues and avoided taking bones from possibly mixed bags. Also, as discussed above, some specimens were mixed up prior to accessioning at the RAM, which was the case with Unit X Levels 9 and 7. Regardless, the majority of the radiocarbon dates returned a result and were accepted. From these, a more complete understanding of the site has been achieved, and new discoveries were made.

North Excavation, Pelican Lake Levels

A total of six radiocarbon samples were submitted from the lower levels of the North Area excavations that Reeves (1978) assigned as Pelican Lake (Table 2). As stated previously, it is not possible to figure out which specific projectile points he used to make this determination. Three of the dates that were submitted produced a result, the rest failed despite there being no noticeable difference in preservation between the successful and failed samples.

The three successful dates are HSI 3-D, 2023-S4, and 2023-S5 (Table 2). The dates are depicted in relation to each other in in Figure 16. Given that there is a greater than 3 000-year discrepancy between the two dates from the bottom of North Level 8, 2023-S4 and 2023-S5 (6 360 cal BP and 2 816 cal BP respectively), one of these dates

is likely due to mixing between the boxes. Contamination does appear to be an issue with some of the North Area boxes as seen with the extremely young dates in the Mummy Cave levels (see above). Samples HSI 3-A through HSI 3-D were submitted to determine which of these dates is legitimate and possibly detect a trace of the Hanna component or the Unit X Level 8-11 mystery component.

Unfortunately, this did not work out. HSI 3-D from North Level 6 was the only successful date and was 2 748 cal BP (Table 2). There are two possible explanations for this date. The first possibility is that the date of 6 360 cal BP for 2023-S4 is the result of contamination. This would support Reeves (1978) original projectile point identifications. This interpretation also does not interfere with Peck's (2011) reclassification of these points as Bracken since these dates roughly correspond to when Peck (2011) claims Bracken begins. If this interpretation is correct, the North Area Levels 8, 7, and 6 span approximately 70 years and have a total thickness of 1.3 feet (~39.6 cm).

The second possibility is that the date of 2 816 cal BP for 2023-S5 is the result of contamination. This possibility holds more substantial ramifications for the overall understanding of the North Area of the kill site. It would indicate that North Level 9 does not represent or correlate with the South Area sterile levels. Thus, Reeves' (1978) proposed site abandonment would be invalid. Accepting the date of 2 816 cal BP would mean that Levels 8, 9 and 10a are approximately the same age, leaving no temporal space for the hiatus in site use to occur. This is not surprising as North Level 9 is reported to have contained bone fragments, charcoal, and a paleosol in the original field notes (see above) while being as thin as 5 inches (12.7 cm) in places. However, this would also mean that North Area Level 9 does not correlate with Unit X Level 9 as

Reeves' notes proposed (see above). In addition, this level was not the only instance of a North Area Mummy Cave material getting mixed with Pelican Lake material.

This does raise the possibility that Reeves (1978) misidentified the projectile points that came from North Level 8 (see Appendix 1). One explanation for this is that North Level 8 contained more of what Reeves (1978) called "Pelican Lake-like" Mummy Cave points and it may be that he thought they were actual Pelican Lake points. Another possibility is that, since some Bitterroot style Mummy Cave points can exhibit barbs (Peck, 2011: 140; Peck 2019: fig 2), Reeves may have called some point fragments Pelican Lake based on that attribute. This would only be likely if the base of the point was missing such that it was not possible to determine if it was corner-notched or side-notched. It is unfortunate that the artifacts Reeves (1978) found are not currently available at the RAM for re-analysis to help clear up this issue.

Lastly, if the date of 6 360 cal BP for North Level 8 is legitimate and 2 748 cal BP for North Level 6 is as well, that leaves the age of North Level 7 as an open question. Without additional information, it will be impossible to determine if Level 7 is a continuation of the North Level 8 Mummy Cave component, the Unit X Levels 8-11 mystery component, a Hanna component, or a continuation of the North Level 6 Pelican Lake/Bracken component. With the radiocarbon budget exhausted, more dates were not possible, though the contamination issues and lack of dateable materials within pertinent levels may mean further dating is not viable.

Mummy Cave Dates

As discussed above, there are several dates from the Mummy Cave levels of HSIBJ and they indicate a long and continuous use of the site for two millennia. It is peculiar that the Mummy Cave levels in the North and South Areas cannot be chronologically correlated with each other. The upper portion North Area Mummy Cave component has a significantly older dates than the bottom of the Unit X Mummy Cave component (Figure 16). During the Mummy Cave era, the North Area was used prior to 6 000 cal BP and Unit X in the South Area after 6 000 cal BP. This finding again emphasizes the patchiness of the kill site deposits. It is too bad that no datable material was saved from Units A and Z as it would be interesting to see if this pattern holds for the whole of the South Area. Moreover, it is unfortunate that we are unable to link the specific Mummy Cave point types to specific levels or areas of the site. This would help complete our understanding of this period of use of HSIBJ and aid in refining the temporal relationship between these subtypes of Mummy Cave points.

Unknown Levels of Unit X and Filling in the "Gap" – the Oxbow Component?

As shown in Figure 9, there are no sterile levels in Unit X and the existence of one in the North Area is unlikely based on Reeves' notes. Based on these findings, there does not seem to be a hiatus in site use during the Middle Precontact period. If this result is accepted, that there is no hiatus in the cultural sequence, the cultural assemblage connected to this time period needs to be determined. Ideally, the projectile point style that likely exists in this part of the sequence and specifically in the "unknown" levels of Unit X should be identified. To address this research problem, the possibility

that the people who used the Oxbow point and its direct predecessor point style was explored.

The timeframe for Oxbow points in Alberta is typically taken to be 4 500 - 4 100 BP, which is well placed between what is traditionally considered the end of the Mummy Cave era at 4 500 BP (Bubel et al., 2012: 52) and the start of Hanna at 3 900 BP (Bubel et al., 2012: 60). Reeves (1978: 162) did retrieve a classic Oxbow date of 2 100 ± 100 BCE (~4 100 BP) but he did not favour it due to a lack of accompanying points (see below for additional discussion of this date). It was impossible to determine the level or unit this date comes from. Moreover, the Gak lab which dated the sample, is now known to have had substantial problems. As Peck (2011: 206) noted, this date needs to be discarded but it does fall within the Oxbow point time period.

Level 8 of Unit X was dated to 4 227 ± 20 BP (4 789 cal BP) and Level 10 of Unit X to 4 209 ± 21 (4 755 cal BP). These dates are firmly within the classic Oxbow timeframe of 4 100 - 4 500 BP (Bubel et al., 2012: 54). Recent research has suggested that the true date range for the timeframe of Oxbow points is larger than traditionally thought. Taylor (2006: 319) expands it to 5 000 BP to 3 500 BP. In Saskatchewan, Boser (2022: 116) claims it to be 4 700 BP to 3 800 BP. Lastly, Cole (2015: 75) puts Oxbow from 5 200 BP to 3 800 BP based on recent discoveries. The dates for Levels 8 and 10 of Unit X fall firmly within all of these timespans. In addition, the Oxbow timeframe fits well within the proposed “gap” at HSIBJ.

It is widely agreed by researchers that the people who made the projectile points in the centuries prior to classic Oxbow are the ancestors of the people of the classic Oxbow era (Peck, 2011: 176; Cole, 2015: 75). Regarding Oxbow ancestors, Peck (2011:

176) redefined the Mummy Cave projectile points in Alberta from 4 900 – 4 500 BP as the Estevan phase and describe it to be the direct precursor to the Oxbow style. Peck (2011: 176) groups the two into an archaeological tradition. Alternatively, Cole (2015: 75) proposes the Gowen-Oxbow series. In this seriation classification scheme, the Gowen complex lasts from approximately 6 100 to 4 700 BP while the Oxbow complex lasts from approximately 5 200 to 3 800 BP. Also, Estevan style points are considered part of the variation within the Oxbow complex. Cole (2015: 77) asserts that the relationship between the Gowen and Oxbow complexes justifies putting them into an archaeological series is based on similarities in geography, subsistence, and lithic raw material, in addition to point styles and technology. Cole's (2015: 75) new time range for the Oxbow complex of 5 200 to 3 800 BP fits even better into the "gap" between Mummy Cave and Hanna at HSIBJ as proposed by Reeves than the tradition date range. Furthermore, Walker (1992: 141) redesignated some of the Mummy Cave points from the HSIBJ kill site as Gowen (Figure 3: I), which further supports the claim that the people who used Oxbow points and their predecessors used the site.

Further supporting evidence are the two or three Oxbow points (Figure 17) that were found in the spring channel area of the campsite component during the excavations at HSIBJ in the 1980s. Brink & Dawe's (1989: 218) publication gives the following description: *"*These specimens are morphologically quite similar. Both have shallow, V-shaped bases and broad, shallow, parabolic side notches that expand proximally to form angular, obliquely oriented "ears"…" Another Oxbow point was found during excavations at the Dersch locality, a southern extension of HSIBJ (Peck, 2011: 300).

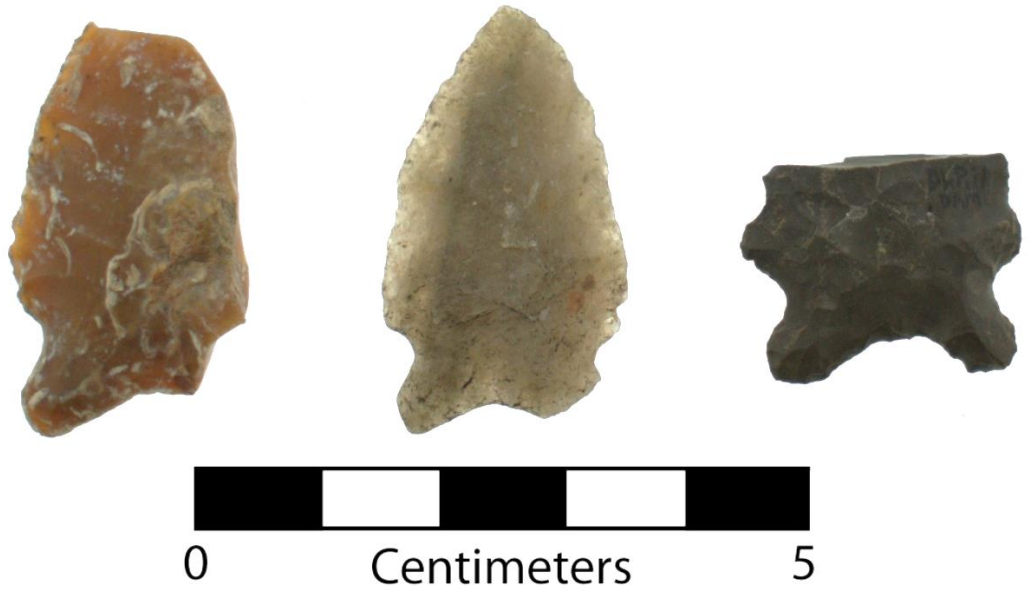

Figure 17: The two confirmed and one probable Oxbow points from the campsite component of HSIBJ excavated by Brink & Dawe (1989: 218). Composite photograph by author.

Brink and Dawe (1989: 254) propose that there was Oxbow use of the site and that since Reeves excavated a very small portion of a very large site, he simply could have missed it. This is a logical explanation since not all of the Middle Precontact projectile point styles were found in the deep units of the kill site excavations. For instance, Unit A in the South Area is the only unit to have Hanna points, but it also lacks Pelican Lake points commonly found in other units (Figure 9). In addition, the recovery of four Oxbow points in the campsite is comparable to the number of other Middle Precontact point types known from the kill site. As detailed above, there have only been three Hanna and three Mummy Cave points found in the campsite.

Reeves (1978: 162) retrieved two radiocarbon dates for the terminal Mummy Cave component of HSIBJ. The one from the North Area is 3 130 ± 120 BCE and the one from the South Area is 2 100 ± 100 BCE. Reeves (1978: 161) preferred the 3 130

BCE date due to the lack of classic Oxbow points from his assemblage. However, Brink and Dawe (1989: 254) argue that the 2 100 BCE date is valid because they found at least two Oxbow points in the campsite excavations. Unfortunately, issues with the Gak lab require that this date be discarded (Peck, 2011: 260).

Alternatively, a possible critique of the proposition of Oxbow use of HSIBJ is that the Oxbow complex is not associated with large communal bison kills (Peck, 2011: 192). Instead, the stalking of individual animals was apparently practiced exclusively. There are no excavated Oxbow kill sites as of the writing of Morlan's (1994) paper or Green's (1998) thesis and Peck (2011: 192) does not list any Oxbow kill sites in Alberta. The Gowen complex does have a few communal kill sites associated with it, such as the Norby site and, according to Walker's (1992: 141) projectile point reclassification, Head-Smashed-In Buffalo Jump (Cole, 2015: 68). It has been suggested that the lack of well researched Oxbow sites (and Early Middle-Precontact/Middle Middle-Precontact sites in general) is preventing us from developing an accurate understanding of their lifeways (Brink & Dawe, 1989: 254; Cole, 2015: 78).

Intriguingly, Dyck (1977: 56) argues that the Harder site, a large Oxbow winter campsite in Saskatchewan, shows evidence that its occupants had engaged in communal hunting. This is based on the large number of bison (between 93 and 138 individuals) unearthed at the single use site. Dyck (1977: 56) suggests that the communal hunting method was most likely a pound. The environmental setting in the parkland would have been ideal, although a pedestrian surround was also considered. Moreover, there is a possible pound site 200 m west-by-southwest of the Harder site. Two Oxbow points were found associated with the bone concentration, but it was not

able to be excavated at the time and there is no record of it being revisited since. It is important for this locality to be properly investigated.

Morlan (1994: 770) reanalyzed the Harder site and determined that the nearly equally mixed sex profile and winter seasonality implies a combination of communal hunting and the pursuit of lone males. However, male herds can also be hunted communally as seen at the Norby site, which contained Gowen points and has winter seasonality (Zurburg, 1991: ii). The proposed reason to hunt males in winter is that they may have more fat than pregnant females, especially if the parkland provided bison with more and better food than the plains during the winter season (Morlan, 1994: 770). Lastly, Morlan (1994: 770) suggests that the canid remains from the Harder site are consistent with being a discarded wolf disguise as used by Buffalo Runners, a key component of hunting practice at large communal bison kills. Specifically, the bones of the feet, head and neck were present, but not the rest of the skeleton.

In summary, our understanding of subsistence in the Oxbow period is hampered by a lack of evidence; their lifeways are inferred from a small number of excavated campsites. While a focus on stalking individual animals is presented in the literature this may be because of the lack of large kill sites. HSIBJ offers tantalizing evidence that the people who used Oxbow points did take part in communal hunting.

Building on this hypothesis, the cultural deposits of Head-Smashed-In Buffalo Jump present a conundrum. It is not only the oldest confirmed bison jump, but for more than a three millennium, it is the only confirmed bison jump in use (Brink, 2016: 16). Thus, the question is: Was it truly the only bison jump at that time or are we missing other Middle Precontact bison jumps and other communal kill sites such as pounds?

Neither option seems to be substantially more plausible than the other. What is clear is that the people who used the Oxbow points did use HSIBJ. It is possible that they also used other communal kill sites just as their predecessors and successors did.

Conclusions and Directions for Further Research

There is ample evidence to indicate that HSIBJ was used continuously after having been established as bison jump. There is an uninterrupted sequence of cultural deposits from the Mummy Cave period to the Old Women's phase in Unit X and in the North Area. New radiocarbon dates combined with a complete projectile point sequence for the last approximately 6 600 years supports the stratigraphic findings.

The proposed hiatus in the use of HSIBJ, thought to have spanned from 3 130 BCE to 1 090 BCE (Reeves, 1978: 167) has been rejected. We now have multiple ^{14}C dates from the kill site that fall within that timeframe. In terms of projectile points, there is a "gap" in the typological sequence between Mummy Cave and Hanna points but the discovery of multiple Oxbow points in the campsite of HSIBJ and the identification of a Gowen point in the kill site deposits confirm a significant cultural presence within the Gowen-Oxbow Series period at the site, thereby filling up the "gap". The new radiocarbon dates also support the assignment of Oxbow points to the "gap" and confirm that cultural activities took place during that time.

There are multiple avenues for further research. Generally, it would be useful to date bone specimens from the North Area Levels 6, 7, and 8 to resolve the existing confusion of the temporal sequence of the post-Mummy Cave use of the North Area of HSIBJ.

Additional kill site excavations are warranted. There are several target areas that should be investigated by such a project. One goal should be to excavate near Unit A to find the Hanna component. As HSIBJ is the only known Hanna bison jump (although Reeves (1983: 332) does report a Hanna point for the Women's jump), it is important to get radiocarbon dates for this component. It would be beneficial to determine if the Hanna use of the jump spanned the full period that Hanna points are in use in Alberta. In addition, trying to identify the affinity of the levels directly below the Hanna component would be useful to better contextualize the full history of the site in the early to middle-Middle Precontact period. If the large, sterile layer is encountered, it is recommended to use Optically Stimulated Luminescence (OSL) to date the top and bottom of it to situate its deposition into the chronology of HSIBJ.

Another target of such a project should be to excavate near Unit X to try to find projectile points from the layers of Unit X (Levels 8-11) that are listed as "unknown occupation". The goal of this would be to confirm if these levels have Gowen-Oxbow affinity. This should also enable the retrieval of material to be dated from the bottom of Unit X Level 7, clarifying the transition from the unknown, likely Oxbow, component to the Pelican Lake component. Another benefit of excavating near Unit X is that the Mummy Cave component is shallower here than at any other known part of the South Area of HSIBJ (Figure 9). New excavations of the Mummy Cave levels would be useful to examine the relationship between different subtypes of Mummy Cave points and situate them chronologically.

Investigations into the Mummy Cave component of the site would be further assisted by additional excavations in the North Area. The Mummy Cave deposits here

are the oldest currently dated at the kill site by several hundred years (Figure 16) and thus will likely have different projectile point forms than those found around Unit X. It would also be beneficial to find the bone and charcoal fragments in North Area Level 9 for radiocarbon dating. These may have been too small to radiocarbon date when Reeves excavated the site but can likely be dated with current AMS technology. If no organic materials are found, OSL dating can be done at the top and bottom of the North Area Level 9 to determine its duration and how it relates to the rest of the North Area chronology.

Lastly, additional excavations should be conducted in the South Area that go deeper than Reeves' excavations did. All three of the deep units Reeves excavated in the South Area were floored by a hard yellow clay. This seems, from its description in Reeves' notes, to be similar to the matrix the ULeth-RAM team are digging through to find pre-Mummy Cave artifacts in the HSIBJ campsite. Given the success the ULeth-RAM team have had, extending the kill site excavations down an additional 2 m at least will be the best way to answer the question of whether or not the kill site was used by the people who occupied the campsite during the Boss Hill and Cody Complex timeframe. Along the way, samples could be taken to try to find Mazama ash, a key stratigraphic marker in South and Central Alberta.

There are two possible approaches that could be taken. A team could excavate near Unit X because the overlying deposits are not as deep there as they are near Units A and Z (Figure 9). The other option is to find the excavation unit that Reeves capped but did not backfill and continue excavating it. The available notes do not specify which unit is still open, but it is supposed to be in the South Area and deep enough to have

reached the Mummy Cave component (Bubel, *pers comm.*). Given that Unit X collapsed during excavation, that leaves Units A and Z as possible options. The ULeth-RAM team is currently working on locating the unfilled unit. Given the patchy distribution of kill site use, multiple excavations below the Mummy Cave levels will likely be necessary to find all of the hypothesized earlier uses. It may be fruitful for one of these excavations to be directly against the cliff as there should be a higher concentration of projectile points there than in the areas Reeves' dug, which were significantly further back from the cliff.

The ongoing joint ULeth-RAM project at the HSIBJ campsite has already expanded our understanding of the chronology of the site considerably with new radiocarbon dates and older projectile points (Bubel et al., 2023). It will be exciting to see what else they uncover in the upcoming field schools.

Chapter 3: North American Bison Evolution and Taxonomy Explored at Head-Smashed-In Buffalo Jump

Introduction

Previous researchers at HSIBJ, including Reeves (1978) and Smith (1980), assumed that only the modern *Bison bison* was hunted at the site. However, it is likely that the extinct taxon *Bison antiquus occidentalis* was present in the region during the Mummy Cave period. This thesis research component explores the possibility that this earlier form of bison was hunted at HSIBJ.

The bovid genus *Bison* originated in Eurasia and first arrived in North America between 195 and 135 kya (Froese et al., 2017: 3460). This is based on Optically Stimulated Luminescence (OSL) dated sediments associated with the oldest *Bison* fossils found thus far on the continent and molecular clock analysis of those same specimens (Froese et al., 2017: 3460). Soon after their arrival, the species *Bison latifrons*, the giant long-horned bison (Figure 18), developed in North America, south of the continental ice sheets at about 125 kya (Díaz-Sibaja et al., 2020: 1; Carrillo-López et al., 2023: 145). Following these events, a second wave of *Bison* migration across Beringia occurred at approximately 50 kya. This new species was the Holarctic steppe bison *Bison priscus* (Figure 19), and a population of that evolved into the species *Bison antiquus* (Figure 20) in North America. Modern bison (*Bison bison*) (Figure 21) evolved from the *Bison antiquus* lineage through a chronospecies or chronomorph known as *Bison occidentalis* (Wilson et al., 2008: 854; Martin et al., 2018: 4565) (Figure 22).

Figure 18: *Bison latifrons* skeleton cast on display at the Royal Alberta Museum.

Figure 19: *Bison priscus* skull from Alberta.

Figure 20: *Bison antiquus* skull from Alberta.

Figure 21: *Bison bison* skull from Alberta (nasal bones are missing).

Figure 22: *Bison antiquus occidentalis* skull from the Horse Hills of Alberta. It is radiocarbon dated to 6 518 cal BP.

Defining *Bison antiquus occidentalis*

Bison occidentalis is a taxon of much debate. It was first named as its own species in 1898 by Lucas before being changed to a subspecies of *Bison antiquus* called *Bison antiquus occidentalis* by some researchers such as McDonald (1981: 94). Others have proposed to make it a subspecies of *Bison bison* called *Bison bison occidentalis,* but this has little support (Díaz-Sibaja et al., 2020: 2). Díaz-Sibaja et al. (2020: 2) and Wilson et al. (2008: 854) found that *Bison occidentalis* and its proposed reclassifications as a subspecies are all invalid. Instead, they determined that the type is

just a morphology of *Bison antiquus*. The fact that *Bison occidentalis* is not monophyletic (Díaz-Sibaja et al., 2020: 2) supports this determination. What this means is that the fossils we identify as *Bison occidentalis* are from several distinct lineages, therefore, a single taxonomic name for all of them would be incorrect in taxonomy and systematics.

The taxonomic assignment of *Bison antiquus occidentalis* is as follows:

SYSTEMATIC PALAEONTOLOGY
CLASS: Mammalia Linnaeus, 1758
ORDER: Artiodactyla Owen, 1848
FAMILY: Bovidae Gray, 1821
GENUS: *Bison* Smith, 1827
SPECIES: *Bison antiquus* Leidy, 1852
SPECIES (former) *Bison occidentalis* Lucas, 1898
SUBSPECIES: *Bison antiquus occidentalis* McDonald, 1981

What is widely agreed upon is that what is/was understood to be *Bison occidentalis* is a transitional form between *Bison antiquus* and *Bison bison*, indicating that modern bison evolved *in situ*. Researchers consider *Bison occidentalis* to be the Holocene chronomorph of the species *Bison antiquus* (Wilson et al., 2008: 854; Carrillo-López et al., 2023: 146). *Bison antiquus* specimens from the Pleistocene are said to have the “antiquus” morphology and those from the Holocene are described as having the “occidentalis” morphology. For the remainder of this thesis, *Bison antiquus occidentalis* will be used for clarity; however, this does not indicate my position on the taxonomic debate.

Bison antiquus occidentalis lived in Alberta by approximately 10 000 BP (Wilson et al., 2008: 854). Between 4 000 and 5 000 BP it evolved into the modern bison, *Bison bison* (McDonald, 1981: 86). The calibrated equivalent of that date range is approximately 4 600 and 5 800 BP.

The most recent evolutionary event in *Bison* taxonomy is the development of the wood bison and plains bison subspecies of the modern *Bison bison*. It is generally thought that the change occurred at approximately 5 000 BP, which makes understanding the split difficult (Species at Risk Committee, 2016). At that time, the Holocene Climatic Optimum had resulted in the expansion of forests and boreal peatlands. The wood bison subspecies adapted to thrive off of eating the sedges that were ubiquitous in this expanding environment. This was a departure in the history of North American *Bison* species, all of whom were grassland specialists up until that point.

There are two possible scenarios regarding the development of the two *Bison bison* subspecies (Species at Risk Committee, 2016). The first is that the plains bison is the ancestral form, having evolved from *Bison antiquus occidentalis*, and wood bison developed from a population with the plains bison character that was enveloped by the expanding boreal environment. Another possibility is that the wood bison morphology is ancestral and while the northern population was adapted to the boreal sedge meadows, the southern population adapted to the modern short grass prairie ecosystem and evolved into the plains bison morphology. Unraveling this situation with genetics is made additionally difficult by the possibility of significant gene flow between plains bison at the northern edge of their distribution and wood bison at the southern end of their

distribution. Also, the genetic bottleneck that occurred in the 19th century due to colonialism and the associated overhunting makes genetic studies on bison especially challenging because much of the precontact genetic diversity of the species was lost (see Asis et al., 2024 for examples).

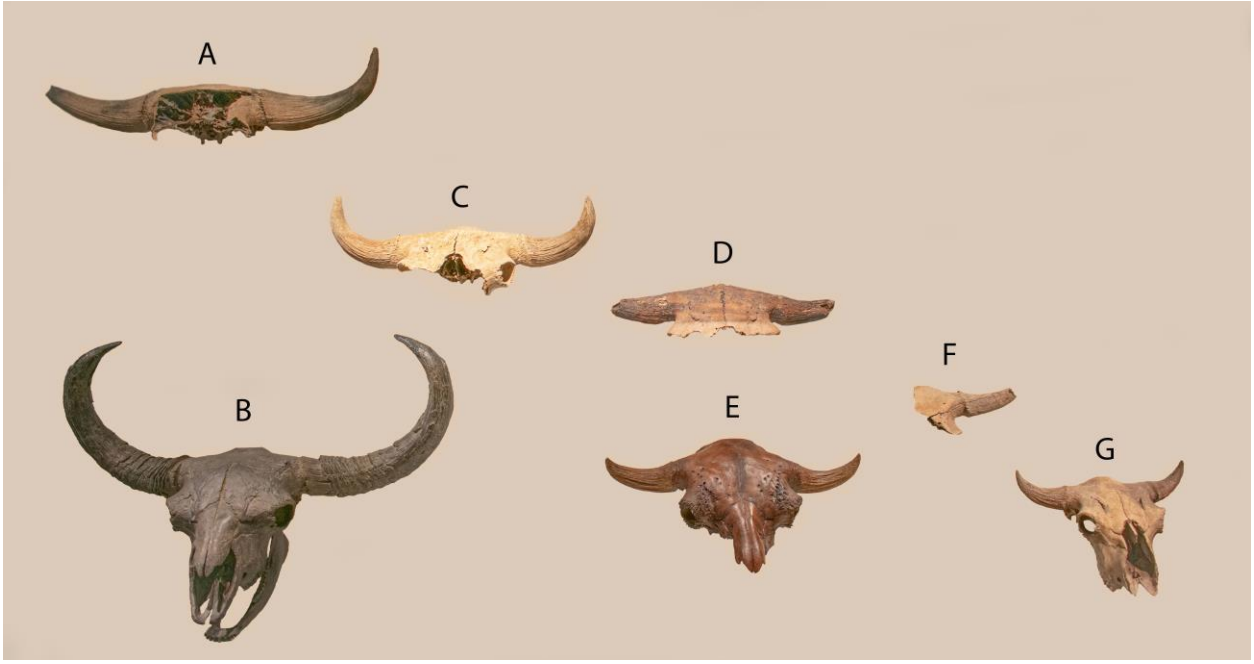

Figure 23: Display of bison skulls at the Royal Alberta Museum. A and B are *Bison priscus*; A is from Alberta and B from Alaska. C, D, and E are *Bison antiquus*. F is 4 950 years old and is not identified to the species level. G is *Bison bison*.

The main trends in bison evolution in North America since their introduction have been reductions in body size and horn size (Figure 23). Hill et al. (2008: 1767) examined *Bison sp*. remains dated between 37 000 BP and 250 BP from across North America and found that the body size decrease happened in short bursts rather than steadily and gradually over time. They also found that climatic shifts and their impact on

food quality were the most likely factors prompting bison body size reduction. The reduction in horn and body size is thought to be correlated with an increase in herd size and social behaviour (Guthrie, 1990: 154). There is no evidence to suggest that human hunting had any influence on bison body size. Rather, these morphological and behavioural changes led the bison to be viable targets for communal hunting practices. Indigenous groups exploited these herd behaviours, including the tendency to group up tightly and stampede together when threatened (Brink, 2008: 140).

Bison antiquus occidentalis at Head-Smashed-In Buffalo Jump

The need to explore the possibility that there may be *Bison antiquus occidentalis* remains at HSIBJ is not driven by the fact that taxonomic identification is a standard part of zooarchaeological research or because of personal scientific curiosity. This study was incorporated into this thesis research because the of the joint ULeth-RAM excavations currently taking place at the site. One of the main research goals of the project is to investigate the Cody complex material found at the site (Bubel et al., 2023: 3). Between 9 500 and 7 500 years ago the only available prey would have been *Bison antiquus occidentalis,* which has never been documented at a confirmed jump before. Though we cannot be certain that *Bison antiquus occidentalis* had the behavioural traits necessary to be a viable target for a jump, confirming that *Bison antiquus occidentalis* was hunted using the cliff at HSIBJ in early Middle Precontact period would, by extension, not preclude the possibility that Cody complex people used the jump in a similar way.

Given the fact that the lower levels of the site are within the timeframe for the transition from *Bison antiquus occidentalis* to *Bison bison*, which occurred at roughly

5 000 BP (McDonald, 1981: 86), it is reasonable to expect faunal remains of *Bison antiquus occidentalis* to be present (Table 3). A *Bison antiquus occidentalis* skull from the Horse Hills of Alberta was discovered (see Figure 22 above). It is dated to 6 518 cal BP (Heintzman et al., 2016) which is contemporaneous with the lowest levels of HSIBJ.

To investigate the possible presence of *Bison antiquus occidentalis* at HSIBJ, the faunal remains collected from the lower excavation levels of the kill site by Reeves and his team were studied. These specimens are stored at the RAM and were examined on site.

Species Determination Method

Bison antiquus occidentalis is highly variable in morphology, but skeletal biometrics have proven viable for delineating this type (McDonald, 1981: 86). The bones used in the biometrics are the skull, humerus, radius, femur, tibia, metacarpal, and metatarsal. Each sex has a separate set of biometrics as all *Bison* taxa are substantially sexually dimorphic.

The biometric tables in McDonald (1981: 87, 88) were used to determine whether the specimens from the lowest levels of the HSIBJ kill site are *Bison bison* or *Bison antiquus occidentalis*. This resource remains the standard reference for North American bison biometrics and is used by researchers at the Royal Alberta Museum (Jass and Barron-Ortiz, *pers. comm*.). All more recent taxonomic references focus on the skull. Unfortunately, no complete specimens have been found at HSIBJ, and fragments of the skulls are typically too small to use. The biometric values are the taxonomic characteristics for delineating the adults of different bison taxa. It is important to note

that all of these characteristics are continuous rather than discontinuous (discrete) and that the measurements must be evaluated as such. Calipers were used to measure the specimens to a precision of 0.1 mm.

Species identification values are given for the metapodials, radius, humerus, femur, and tibia in McDonald's (1981: 88) reference. Two humeri, two metacarpals, and a metatarsal in the HSIBJ collection were intact enough to be analyzed (Figures 24-28). All other specimens were either too damaged to collect more than one of the required measurements, were from a level that was too recent or had a later period cultural affiliation, or came from a context that could not be associated with the stratigraphic column.

Both *Bison antiquus occidentalis* and *Bison bison* are sexually dimorphic with the males being larger. Given that female herds were the target of buffalo jumps (Brink, 2008: 67), the female rather than male biometric tables were used, while remaining open to the possibility of males in the assemblage. It should be noted that there is significant overlap in size between an adult female *Bison antiquus occidentalis* and an adult male *Bison bison* (see McDonald, 1981: 88 and 97). Moreover, since most of the long bones were broken, as is typical at a kill site due to the disarticulation of the carcasses, one cannot be certain the individuals these bones are from were adults. Signs of epiphyseal fusing were looked for to confirm the bones belong to an adult animal. Unfused bones were not used in the analysis even if from the lowest levels.

Table 3: Provenience information for the specimens used in the taxonomic analysis.

Specimen	Unit	Level	Correlated level	Level date cal BP
MT0001	N5	11	North 10d	6 581
MT0002	N5	10	North 10c	6 266
MT0003	N4	10	North 10c	6 266
MT0752	N4	10	North 10c	6 266
MT0115	X	12	Likely South 16	4 943

Table 4: Measurements of *Bison sp.* near complete limb bone specimens from the lowest excavation levels of HSIBJ compared to *Bison antiquus occidentalis* biometric ranges in McDonald (1981: 88).

Biometrics for *B. a. occidentalsis*	**Female size range (mm)**	**HSIBJ Specimen measurements (mm)**	
HUMERUS	McDonald, 1981	MT0752	MTO115
approximate rotational length	286-395	N/A	N/A
anterior-posterior minimum of diaphysis	44-67	61	45
transverse minimum of diaphysis	35-44	51	37
METATARSAL	McDonald, 1981	MT0003	
total length	230-284	232	
anterior-posterior minimum of diaphysis	25-35	30	
transverse minimum of diaphysis	25-39	31	
METACARPAL	McDonald, 1981	MT0001	MT0002
total length	194-233	177	180
anterior-posterior minimum of diaphysis	22-32	25	25
transverse minimum of diaphysis	32-40	N/A	35

Figure 24: Specimen MT0001 from Unit N5 Level 11. The sampling and breakage was from a project carried out in the 1980s.

Figure 25: Specimen MT0002 from Unit N4 Level 10.

Figure 26: Specimen MT0003 from Unit N4 Level 10.

Figure 27: Specimen MT0115 from Unit X Level 12. The breakage is cultural.

Figure 28: Specimen MT0752 from Unit N4 Level 10. The breakage is cultural.

Results and Discussion

The results of this investigation regarding the presence of *Bison antiquus occidentalis* at HSIBJ are inconclusive (Table 4). Of the five specimens, MT0003 is the only one that is complete and within the biometric range of *Bison antiquus occidentalis*. While MT0752 and MT0115 are missing a measurement, their remaining measurements are also within the biometric range of *Bison antiquus occidentalis*. The specimen MT0002 is complete but too short. It falls within the range of *Bison bison*. MT0001 is incomplete and also too short to be *Bison antiquus occidentalis*.

In summary, the results of the biometric morphological analysis do not conclusively indicate the presence of *Bison antiquus occidentalis* at HSIBJ. However, when put in the context of the dates from the relevant levels (Table 3), which regularly

exceed the 4 000 BP to 5 000 BP timeframe for the transition between *Bison antiquus occidentalis* and *Bison bison* even if calibrated, the results appear quite promising. The existence of coeval palaeontological specimens of *Bison antiquus occidentalis* in Alberta such as the one shown in Figure 22, also provides significant support. It may be that the Mummy Cave levels contain *Bison antiquus occidentalis* and that they were the target taxon of HSIBJ.

This finding is in contrast to what is stated in McDonald (1981: 102). He lists the lowest levels of HSIBJ as containing the modern species *Bison bison*, although how he came to that conclusion is unclear. Since McDonald does not list referred specimens as he does elsewhere in his resource, it appears that he assigned this classification based on Reeves' (1978) publication as he also lists Reeves' radiocarbon dates. However, neither Reeves (1978) or Smith (1980) did an analysis to determine the exact taxon of *Bison* present at HSIBJ. Therefore, while the results are inconclusive, it is likely that *Bison antiquus occidentalis* animals were hunted at HSIBJ due to the timeframe of the Mummy Cave levels.

There are some sites where *Bison antiquus occidentalis* were ambushed and killed in substantial numbers, although not as many as Brink (2008: 3) states would be taken at a jump. In Alberta, at the approximately 7 800 BP Everblue Springs site (EgPn-700) at least 42 *Bison antiquus occidentalis* were ambushed in a wetland (Vivian et al., 2011: 98). Taxonomic identification conducted on the main bonebed of the Everblue Springs site was based on 24 intact metacarpals. All of their measurements were within the minimum ranges for *Bison antiquus occidentalis*. There was also a skull with intact horn cores found 30 cm above the bonebed and the two metrics they used to test it put

it in the range of a male *Bison antiquus occidentalis*. This taxonomic assignment allowed Vivian et al. (2011: 48) to conclude that the bison remains in the bonebed below are also *Bison antiquus occidentalis*.

The presence of so many intact metacarpals at the Everblue Springs site indicates that the carcasses were not processed as thoroughly as the ones at HSIBJ were approximately a millennia later. Having said that, the Everblue Springs site is still considered to show a high intensity of processing, especially when compared to preceding Cody Complex sites, but less so than late Middle Precontact sites (Vivian et al., 2011: 106). According to Vivian et al. (2011: 106), the Everblue Springs site showcases the transition from the relatively low intensity butchering practiced at Early Precontact sites to the very thorough butchering carried out in the Mid and Late Precontact periods, including at the bison jumps.

The seasonality evidence of the kill at the Everblue Springs site is mixed but led the researchers to favour a fall or early winter kill (Vivian et al., 2011: 106). Smith (1980: 53) was only able to estimate seasonality for one of seven subsections of the Mummy Cave levels at HSIBJ and determined it to be summer event due to the presence of one bone from an individual of less than 6 months. This is scant evidence, especially given 5-10% of bison calves are born outside the normal period (Vivian et al., 2011: 66).

Directions for Future Research

There are limited options for continuing to address this research question. A full discussion of *Bison* genetics is beyond the scope of this project, but it should be noted that at this time there is no entry for *Bison antiquus occidentalis* in GenBank. Therefore,

resolving this question with genetics would first require establishing the specific genetic sequence for this taxon. Doing so is complicated by the fact it is a transitional taxon of unclear rank and the exact relationship between the various North American *Bison* clades during the timespan when *Bison antiquus* existed is still being sorted out. Moreover, previous work on *Bison* genetics has found that *Bison antiquus occidentalis* is not monophyletic (Díaz-Sibaja et al., 2020: 2). This means that the bison with the "occidentalis" morphology are not a valid taxonomic unit, likely due to having emerged more than once. Thus, not all *Bison antiquus occidentalis* are part of the same lineage making it not possible to identify as one genetic type.

It is unlikely that future excavations at the kill site or campsite at HSIBJ will resolve this question. Finding enough complete, unbutchered elements to statistically evaluate the biometric data is unrealistic. Thus, definitive morphological evidence may continue to elude us.

Chapter 4: The Zooarchaeology of the Head-Smashed-In Buffalo Jump Kill Site Area

Introduction

The third research component of this thesis project involved the zooarchaeological study of the faunal remains recovered from HSIBJ during Reeves' excavations, principally at the kill site. Smith (1980) carried out a zooarchaeology examination of the kill site deposits, which served as a starting point for this research. The context of these faunal specimens is discussed, as well as the issues encountered when trying to evaluate this information. Smith's findings were then compared with a contemporary analysis of the specimens in the faunal collection held at the Royal Alberta Museum. Additional observations were added to Smith's dataset where appropriate. Reflections on the age, sex, and seasonality are highlighted, along with insights into secondary butchering practices carried out at the kill site. The combined faunal data from Smith's and this analysis were used to better understand the butchering practices carried out at HSIBJ.

The second part of this chapter presents the comparative study of faunal assemblages at large bison kill sites dated to similar time periods. The overarching goal of this research was to contextualize the use of HSIBJ within the subsistence activities documented across the northwestern Great Plains region. Also resulting from this study were several noteworthy aspects of the faunal assemblage collected from HSIBJ. Butchering intensity as it relates to food waste, bison skulls, and associated ceremonial features, and non-bison faunal remains were also investigated.

Smith's HSIBJ Kill Site Zooarchaeology Report

Smith (1980) conducted a zooarchaeological analysis of the bones that Reeves' excavation teams collected at HSIBJ in the 1960s and 1970s, with Reeves overseeing the work. In addition to basic element classification, Smith sought to determine MNI (minimum number of individuals), sex ratios and herd structure, age, seasonality and butchering patterns in the assemblages.

The report is not organized by excavation units or the levels within them. Instead, it is tied to the description of excavation areas and the correlated levels as presented in Reeves' (1978: 167) publication. This means that the report references correlated levels from Reeves (1978: 167) and not the actual units. How the correlations were determined is not laid out in the report except for one remark about the components of Unit X, noted to be a part of the South Area Level 15 in Reeves' (1978: 167) publication. These components contain many butchered bones but no projectile points. A summary of the original field notes, which include the excavation units and the levels, is included as Appendix 1.

The lack of provenience information in Smith's (1980) report makes it impossible to deduce if levels that are mentioned as containing bone in the field notes, but for which no boxes of bones exist at the RAM, actually had bones collected from them. Though there are many curated boxes of bone at the RAM, several bone yielding levels are absent. Examples include Levels 15, 19, 20, and 21 of Unit A. The mention of a horn core from one of the levels of Unit X (with no projectile points) is important. There were no horn cores in any of Reeves' boxes containing material from the Middle Precontact timeframe. This means that more faunal remains were collected and

available for analysis in 1979 than are available at the museum now. This has been discussed with the staff at the RAM to add context to the collection.

Other challenges involve the Hanna component of the site in Unit A, which is spread across Levels 12, 13, and 14, and is combined with Pelican Lake Levels from Units Z and X. Thus, it is impossible to differentiate the Hanna use of the site from the Pelican Lake use of the site. Here it should be mentioned that Reeves considered Hanna to be a direct precursor to Pelican Lake and therefore closely related (Peck, 2011: 226), but Hanna is not mentioned in Smith (1980). However, Hanna is now considered part of the McKean series (Peck, 2011: 200; Bubel et al., 2012: 60). Moreover, given that the McKean series is agreed to reflect a migration of people from the Bighorn Basin eastwards onto the Great Plains and north into Canada (Peck, 2011: 202; Webster, 2004: 125), it would be interesting to see if there are differences in site use. Since Hanna is a late expression of the McKean series points, appearing only after these people have been on the Northern Plains for centuries (Webster, 2004: 117), it is likely that they would be fully and similarly adapted to the region and thus not have a distinctly different strategy of using HSIBJ. Lastly, Hanna points do not date to the same time as Pelican Lake or Bracken points (Bubel et al., 2012: 60), meaning that these units/levels are temporally mixed.

Another issue is that Smith (1980: 7) claims that Besant points were not present in the South Area despite the fact that both the field notes (see Appendix 1) and Reeves' (1978: 158) publication states that these points were found in the South Area, specifically in Units A and X. This leads to the same issue as with the Hanna material, that it is combined with Pelican Lake material from Unit Z. Besant does not occur at the

same time as Pelican Lake or Bracken (Bubel et al., 2012: 31; Peck, 2011: 3), meaning that these combination units/levels were temporally mixed as well.

The Mummy Cave component is also problematic. Modern radiocarbon dates indicate that the Mummy Cave component in Unit X lasts for approximately 800 years (Figure 16 in Chapter 2). If dates from the other South Area excavation units with Mummy Cave components were available, it may increase the temporal range of the South Area since the oldest Mummy Cave date from the North Area is approximately 900 years older than the oldest date in Unit X. While this dating sequence of the Mummy Cave component of HSIBJ was not available when the report was being written, it does further draw attention to the fact that the way chronology was handled makes comparing its results to other sites difficult due to a lack of specificity on provenience. Also, by compressing centuries or millennia of jump events together, it is not possible to adequately interrogate various trends through time. Lastly, current research seeks to subdivide the Mummy Cave complex (see Chapter 2 for how this applies to HSIBJ). Doing so requires distinct archaeologically defined groups, which are not reflected in Smith's report.

Age, Sex, and Seasonality

In several instances, Smith (1980: 3) uses long bone fusion in European bison to determine the age of the recovered bison bones and from that, the seasonality of the kill. In his report he states that *Bison bison* have later fusion times than *Bison bonasus*, the European bison. The time difference between the fusion times may have introduced error into their age profiles and thus, seasonality results that have even a one- or two-

month difference could fall into a different season. Smith (1980) does not specifically mention if he applied an adjustment to compensate for this. However, depending on the difference, this might not affect overall interpretation of the hunters' lifeways. For example, mistaking an August kill for an October kill or vice versa could still be readily argued in favour of the winter provisioning hypothesis (see below). At present, no one has thoroughly investigated long bone fusion in *Bison bison* so the actual time difference between their bone fusion and that of *Bison bonasus* is currently unknown.

Smith (1980) inferred that the specimens in the collection belonged to *Bison bison* so he did not explore the possibility that *Bison antiquus occidentalis* is present. This may have influenced the sexing results in the Mummy Cave period since, as discussed in Chapter 3, extinct forms of bison are larger than modern ones. This may be the case in the correlated Level 16a assemblage in the South Area where Smith (1980: 53) noted that there is an unusually large phalange and lumbar vertebrae that he believed to be indicative of a male bison. The same claim is made of a large tibia in correlated Level 16c. Sexing of astragali in correlated Level 16b and 16c in the South Area as well as Level 10b are used to show the presence of mature male bison. The tibia is one of the bones used to differentiate *Bison bison* from *Bison antiquus occidentalis* (McDonald, 1981: 88) and the astragalus articulates with the tibia and thus must scale with it. This issue could affect broader interpretations of the site, such as with seasonality. The presence of several adult males in an assemblage can be used to indicate a seasonality of the late summer, typically August-September, based on the rut. While Smith (1980) does not use this line of reasoning for the Mummy Cave levels, he

does use this logic elsewhere in his report, such as correlated Level 14 in the South Area, and other researchers use it at other large bison kill sites (i.e.: Landals, 2009).

Using bison teeth to estimate age, and thus seasonality, is a widely used method that has come under scrutiny in the last several years (Kondor, 2022; Walde, 2006; Whittaker & Enloe, 2000). In the case of Smith (1980), the methods he used are imprecise compared to methods developed later. More specifically, Frison & Reher's methods (1970), used by Smith (1980), assigns elements to 6-month intervals whereas Brumley's (1995) method places some elements into age ranges that last a number of days to weeks. Setting aside the fact that both methods can be critiqued, there may be differences in the archaeological interpretation when they are applied.

Another major issue with using age estimates to determine seasonality is that the bison breeding season is longer than previously thought and that the gestation period can vary by up to 30 days (Walde, 2006: 482). In reviewing studies on bison lifecycles, Walde (2006: 482) found that up to 20% of births occur out of season. From another perspective, 95% of births occur over a period of more than three months. This likely explains why even single component sites can produce differing seasonality results (see Shortt, 1993 and Kondor, 2022 for examples). This issue can be mitigated with large sample sizes because the outliers can be identified more clearly. However, none of the HSIBJ Middle Precontact levels in Smith's (1980) analysis have a significant sample size suitable for aging with confidence.

Despite the methodological issues discussed above, Smith's (1980) seasonality results should still be considered. He calculated a mix of indeterminable, fall, and summer, usually late summer seasons for the Middle Precontact period (Smith, 1980: 5,

6, 7, 8, and 9). For the Late Precontact, the results were uniformly summer to early fall. The high frequency of summer results may initially seem to contradict the dominant paradigm of fall kills for winter provisioning discussed by Brink (2008: 68) and Speth (2017: 531), though the overlap of summer and fall results negate the disconnection, especially given the frequent determination of late summer.

Brink (2008: 68) explains that fall is the season when bison females are the fattest and thus have the most food value. He also points out that the effects of giving birth and nursing on bison's physical state "quickly tapers off" after the first month or two, meaning that by August or early September, months of high-quality grazing have returned the females to good condition. Moreover, Kondor (2022: 98) points out that drying meat, a key part of the pemmican making process, is easier during summer conditions when its hotter and drier than in the fall.

Other than food, the most important bison product for survival on the plains was hides, especially for the construction of lodges or tipis (Brink, 2008: 224). The number of hides used for shelter would have been quite substantial. Based on the average diameter of the tipi rings found in Alberta, the average number of bison hides used to construct a lodge would have been 24, with the minimum being 9 and the maximum being 59 (Kristensen & Moffat, 2024). It would have taken 624 bison hides to make lodges for all of the tipi rings at the Ross Glen Site (DlOp-2) and between 789 and 1 539 hides for the Muddy Creek site, both later Middle Precontact campsites (Reily, 2015: 166). Moreover, tipi covers needed to be replaced every few years (Laubin & Laubin, 1977: 201). Reily (2015: 168) suggests that large communal bison kills were needed to supply this staggering utilization of hides.

Bison hides vary in thickness throughout the year, getting thicker as winter approaches and reaching their thinnest in spring (Brink, 2008: 224). Female bison hides were preferred for making tipis and tipi liners because they are thinner and have a more consistent thickness (Laubin & Laubin, 1977: 201). Brink (2008: 225) suggests that some large communal bison kills, including jumps, took place in the spring in order to acquire enough hides for lodges. While spring kills are attested to in the archaeological record (Speth, 2017: 536), they are still quite rare. Perhaps summer kills were an effective way to balance the competing needs of food and shelter. In August, the hides would not be optimally thin but may have been thin enough to be viable for tipi making, and, while the bison would not have been at their fattest, they had enough fat to yield good quality food for several months. If the need for tipi hides was low, the priority may have shifted to ensure that the group was well supplied with heavier, furrier bison hides for blankets and robes for winter. Thus, the kill event could have been moved to the fall when the hides were suitable for this need.

Discussing Smith's (1980) Conclusion of Secondary Processing

Smith (1980: 5, 7) concludes that the units excavated by Reeves (1978) are where secondary processing took place. This is largely based on the fact that the assemblage of these units principally contains long bones smashed open for marrow extraction while bones that are lacking in utility after the initial disarticulation of the carcass are barely represented. The generally agreed upon spatial representation of the butchering process is that primary processing, which involves disarticulating the carcass and stripping the hide and main muscle groups, would happen in and closely adjacent

to the kill zone (Figure 29). These goods would then taken to the camp while bones lacking in utility, such as the vertebrae, were left where they lied. Marrow rich bones, such as the long bones having been stripped of meat, would then be brought away from the central butchering location of the kill to be smashed open for marrow and processed for grease. Of course, as Smith (1980) points out, the bones could have been scattered around as the work proceeded, thereby contaminating other areas.

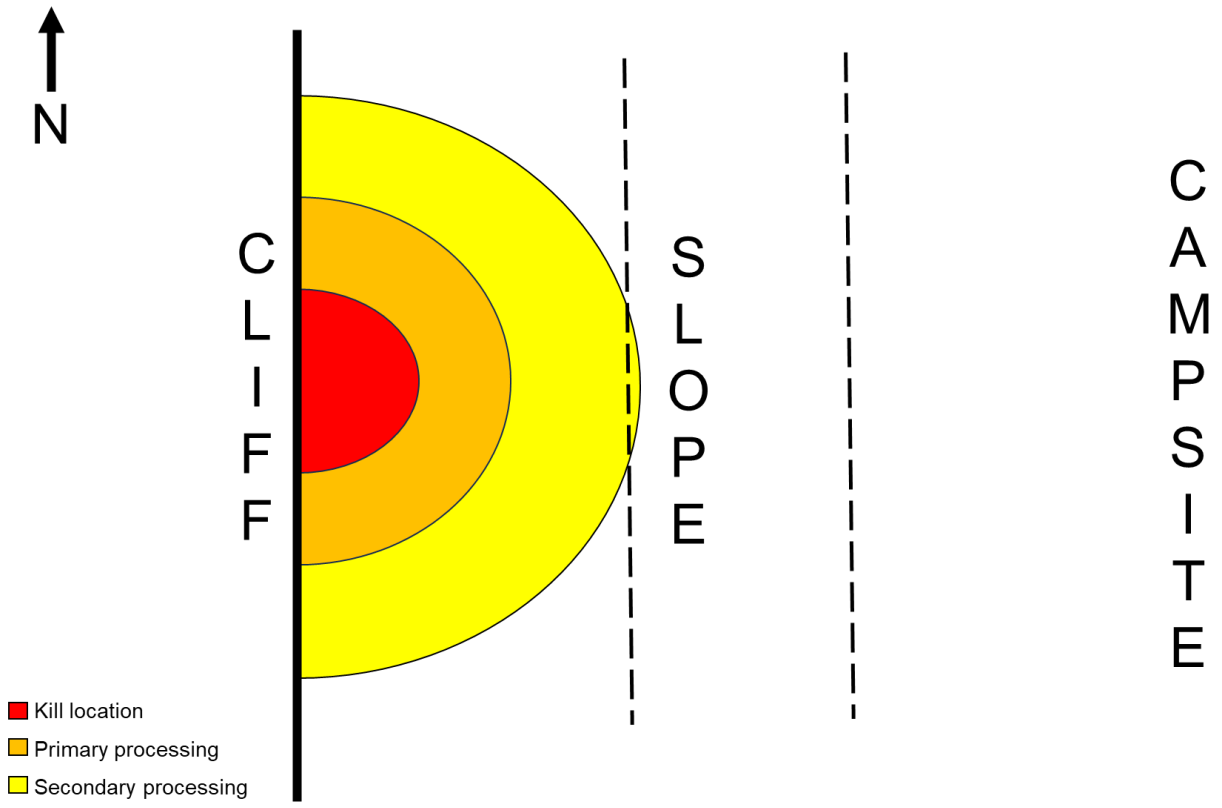

Figure 29: Plan view of a hypothetical kill spot and processing areas within the HSIBJ kill site after a single kill event as interpreted from Smith (1980). Sections and products of the bison would then be carried to the campsite for additional processing, which included boiling, cooking, and drying. Note that after repeated kill events and compaction, the entire zone abutting the cliff face will have kill deposits that obscure the spatial data from previous kill events and areas used for secondary processing due to faunal overlap. Not to scale.

The Smyth bison jump (DjPm-116) gives us an opportunity to test this interpretation. It was excavated in a set of blocks designed to capture the kill site, the processing area, the campsite, and the areas in between. This is different from Reeves' (1978: 156) excavation approach at HSIBJ, because he sought to dig a series of units in the kill site to reveal the cultural stratigraphy for projectile point seriation.

Landals (2009: 92) is less eager to assign a specific interpretation to many of the excavation blocks at the Symth site than Smith (1980) did at HSIBJ, but she does assert that Block L is within the processing area. This concurs with Smith's (1980) general conclusions about spatial distribution at kills sites as Block L is the only excavation block where limb elements and their fragments are more common than axial elements (see below for further discussion). Moreover, the blocks Landals (2009: 63) labels as kill site, Blocks C and D, were dominated by axial elements as would be assumed in Smith's (1980) model.

This makes sense spatially. The near edge of Block C of the Smyth site is approximately 4 meters from the cliff edge and the near edge of Block D is approximately 6 meters from the cliff edge (Landals, 2009: 48). Meanwhile, the near edge of Block L is approximately 24 meters away from the cliff and extends 7 meters further from it. At HSIBJ, Unit A is approximately 29 meters from the cliff, Unit Z is approximately 34 meters away, Unit X is 49 meters away (Figure 13), and the North Area unit starts at approximately 26.5 meters away and extends seemingly approximately 36.5 meters from the cliff (Figure 14) (Reeves, 1978: 158).

Thus, the conclusion that Reeves only excavated secondary processing areas rather than the kill site proper appears valid (Figure 30). This may be because he dug

too far from the cliff wall to encounter the actual kill locations. Brink and Dawe (1989: 182) offer another explanation. They suggest that the kill may have taken place closer to or in the Spring Channel part of the cliff with the butchering work spread out along the foot of the cliff.

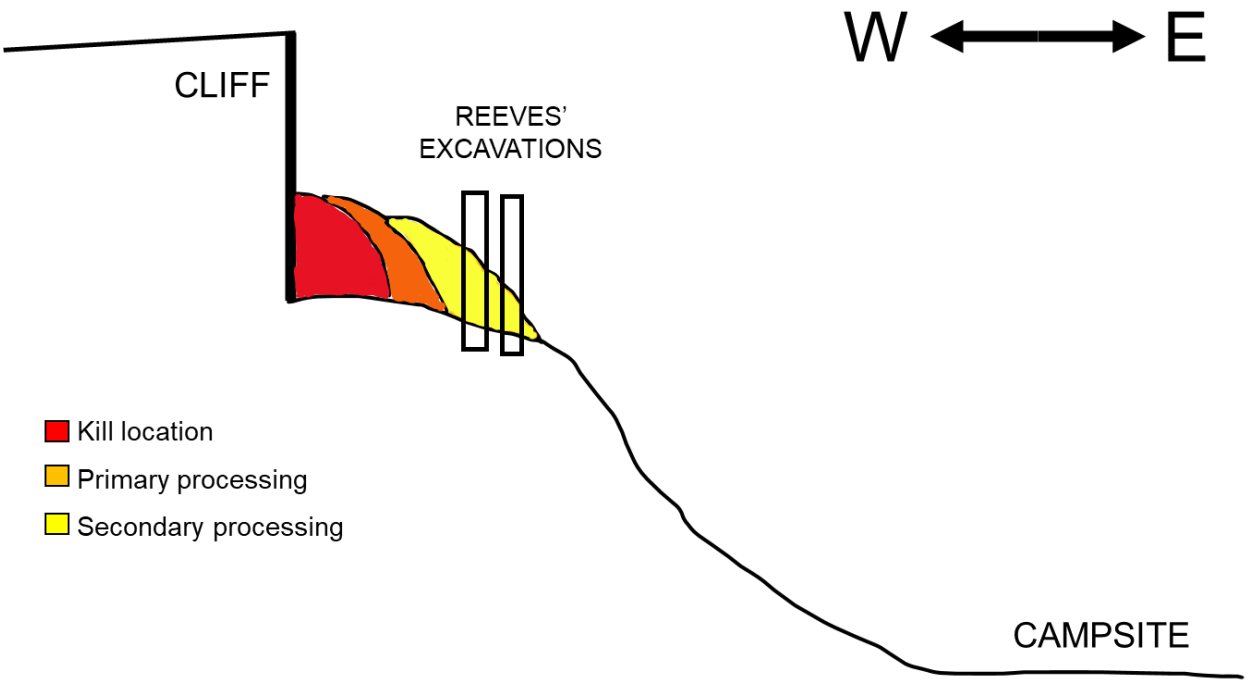

Figure 30: Hypothetical schema of the HSIBJ cliff side activity area arrangement after millennia of use as interpreted from Smith (1980). Looking north with the approximate locations of Reeves' units noted. Not to scale.

If these units do denote a secondary processing area, the presence of projectile points is not problematic. Block L of the Smyth site contained some projectile points (Landals, 2009: 101). Projectile points can be easily broken or lost in the chaos of dispatching wounded animals and their initial disarticulation. Also, any bison that

survived the fall, perhaps only minimally injured, and rolled off the pile and away from the main kill, were dispatched quickly by the hunters (Brink, 2008: 162). There were two reasons for this. The first was to prevent them from rampaging through the campsite. The second reason is told in through Indigenous traditional knowledge, that if a bison escaped, they would inform other bison of the hunting techniques associated with the cliff, thereby preventing the method from working in the future (Brink, 2008: 157).

Comparisons to other Middle Precontact Sites

The results from the zooarchaeological research were compared with those from other large bison kill sites on the Northwestern Plains that date to the Middle Precontact period. The aim is to contextualize HSIBJ within the region and temporal period. It is important to note that HSIBJ is an outlier for much of the Middle Precontact period as it is the only known bison jump in the world (Brink, 2016: 16). The only other bison jump in the northwestern Great Plains with a layer that exceeds approximately 3 000 BP is the Pincher Creek jump. That radiocarbon date is on a bone layer found in auger tests but was never excavated (Ball, 1987), far beneath the approximately 3 000-year-old level (Beaudoin, 1988). In addition, few bison jump kill sites have been excavated. Some were destroyed by bone miners for phosphorus, and some excavations did not save the bones or conduct zooarchaeological analysis, such as at the Women's Jump (Forbis, 1962).

Bison pounds are the next best comparison to bison jumps. The oldest bison pound currently known is the Scoggin site in Wyoming dated to 5 200 cal BP (Brink, 2016: 18). Like bison jumps, bison pounds are rare until the latter part of the Middle

Precontact (Brink, 2016: 18). Many of these comparison sites are large kill sites made using favourable topography for ambushes or pounds, but they are quite different in the amount of preparedness and sophistication of a bison jump.

It is also important to note that at heavily used sites like HSIBJ, it is not possible to delineate individual kill events stratigraphically (Reeves, 1978: 164) and it is impossible to delineate them geochemically (Dormaar & Beaudoin, 1991: 97). Therefore, any comparisons to other, especially single occupation sites, will be imperfect because the HSIBJ results are a summary of a time period, not a specific event. In addition, these data are not directly comparable because the different research projects conducted over the decades used different methodologies and different types of quantitative analyses. The site comparisons presented here take these issues into consideration by focusing on the overarching published conclusions rather than specific statistical results.

Lastly, it was not possible to compare every component present in the HSIBJ kill site to other bison kills. This was especially the case for the Hanna levels and the South Area Besant levels because the only large, well documented Hanna kill sites have mixed stratigraphy with the levels above them. Also, Smith (1980) combined the HSIBJ Hanna Levels with Pelican Lake/Bracken Levels in his analysis making any comparisons questionable. The South Area Besant levels at HSIBJ were mixed with Pelican Lake/Bracken Levels as well.

The Happy Valley Bison Pound (Besant/Outlook – Pelican Lake)

The Happy Valley Bison Pound (EgPn-290) is located in Calgary and dates to 2 270 cal BP (Shortt, 1993: 43). The projectile point assemblage of this site makes it an especially good comparison to HSIBJ. HSIBJ North Area Level 3 is a mixed Pelican Lake/Bracken and Besant Level (Appendix 1; Reeves, 1978: 171). The Happy Valley site also exhibits this phenomenon (Shortt, 1993: 57). Peck (2011: 246) assigns these Besant points to the Outlook phase due to their earlier age and elongated morphology. This phase is thought to reflect a group moving into the Canadian Plains from the southeast. In addition, the Happy Valley site has two projectile points Shortt (1993: 45) assigns as Pincher Creek side-notched, although Peck (2011: 246) considers these points to be Outlook. Pincher Creek side-notched is a very rare style first identified at the Pincher Creek Buffalo Jump (DjPl-1) and associated with the even more rare Pincher Creek double side-notched (see Ball, 1987). Neither of these projectile point styles have been found at HSIBJ (see Table 1).

The MNI of North Area Level 3 of HSIBJ is 36 based on aging mandibular and maxillary teeth (Smith, 1980: 35) while at the Happy Valley site it is 43 based on mandible fragments (Shortt, 1993: 71). This difference is influenced by the differing size of the areas excavated. Smith (1980: 38) concludes that North Area Level 3 of HSIBJ was the secondary processing area of a fall kill. Shortt (1993: 144) is less definitive of his seasonality estimate for the Happy Valley site but settles on late summer being the most likely. In contrast, the Happy Valley site is considered a kill site as the interior of the pound was excavated (Shortt, 1993: 13). Both sites had substantial evidence of burning (Shortt, 1993: 65; Appendix 1).

While skull fragments are uncommon at the Happy Valley site (Shortt, 1993: 80), they are more poorly represented at HSIBJ and more fragmentary (Smith, 1980: 35). Mandibles were significantly more common at Happy Valley than at HSIBJ and both sites have evidence that they were smashed open for marrow. Due to the North Area Level 3 of HSIBJ being a secondary processing zone, very few vertebral fragments were found (Smith, 1980: 36), whereas they are common in the Happy Valley assemblage (Shortt, 1993: 83). The butchering marks and damage to these specimens displays extensive processing of the axial skeleton, including decapitation and removal of the ribs, hump, shoulder, and back muscles. Ribs are uncommon at both sites, interpreted as having been removed to the campsite for cooking.

Humeri are moderately represented at both sites and in both cases every specimen is heavily fragmented for marrow extraction (Smith, 1980: 36; Shortt, 1993: 106). The radii are also moderately represented at both sites and were typically smashed open for marrow. However, at Happy Valley the distal portion is most common while at HSIBJ the proximal end is most common. Smith (1980: 36) interprets this to mean that this element was taken elsewhere in the site for the marrow production. At HSIBJ, the metacarpals are all fragmented (Smith, 1980: 37) while the majority of the ones at the Happy Valley site are complete (Shortt, 1993: 114). This indicates that a more intensive butchering of the metacarpal took place at HSIBJ, likely with the goal of collecting marrow.

The femur is notably rare at both sites relative to other long bones but the fragments that were found all display evidence of marrow extraction, such as spiral fractures (Smith, 1980: 37; Shortt, 1993: 120). The tibia is moderately represented at

both sites. They were heavily processed for marrow extraction with no complete examples being found. Astragali are well represented at both sites although the majority of the ones from Happy Valley are complete (Shortt, 1993: 122) whereas the ones at HSIBJ are fragmented by the butchering process (Smith, 1980: 38). Metatarsals were more common at the Happy Valley site than at HSIBJ. At HSIBJ, the phalanges are minimally represented whereas 324 phalanges or fragments are found at the Happy Valley site. Smith (1980: 38) attributes the lack of phalanges to their removal being a step in the primary butchering process and thus they would not be found in the sampled area, or that it is possible that they were retained for some purpose. Intriguingly, distal phalanges are the least common element at the Happy Valley site and Shortt (1993: 134) suggests that they may have been removed from the kill site for additional processing. The most likely purpose to collect distal phalanges at either site would be gathering hooves to be processed into glue (Verbickey-Todd, 1984: 192).

A rather curious find at the Happy Valley pound are several broken bison long bones that were possibly modified into expedient tools to assist with butchering (Shortt, 1993: 59). These elements in question are humeri, radii, and tibia. Much of the use-wear was obliterated by root etching rendering their identification as tools uncertain. Smith (1980) and Reeves (1978) did not find any bison bone fragment in the HSIBJ kill site that they thought to be an expedient bone tool. However, Brink et al. (1985: 191) did find a proximal end of a radius and another of a tibia in the campsite that they suggest may be expedient butchering tools. Other bison kill sites have similar artifacts, such as the Wold Bison Jump (Pelton et al., 2019: 78). These artifacts are thought to be created

and used when the hunters lacked the quantity of stone needed to complete their butchering work (Shortt, 1993: 57).

In summary, the HSIBJ faunal assemblage during this late Middle Precontact phase is similar to that of the Happy Valley bison pound. The differences in the abundance of certain elements are consistent with the interpretation of the sampled portion of HSIBJ being a secondary processing area while at the Happy Valley site, the interior of the pound reflects the kill and primary processing area.

The Fincastle site (Besant/Outlook – Pelican Lake)

The Fincastle site (DlOx-5) is a bison ambush site that took place in an ancient interdune pond (Bubel, 2014: 237). It has been assigned to the Outlook complex as has the North Area Besant Level 3 at the HSIBJ kill site, and dates to approximately 2 500 cal BP (Peck, 2011: 245; Bubel, 2014: 213). The MNI of Fincastle assemblage is 62 (Bubel, 2014: 215) and 36 for the North Area Level 3 of HSIBJ (Smith, 1980: 35). North Area Level 3 of HSIBJ was determined to be a fall kill (Smith, 1980: 35) while Fincastle's seasonality results ranged from summer to fall (Kondor, 2022: 83). The East Block of Fincastle will be used for this comparison as it is the most thoroughly investigated.

Fragments of the skull are quite rare at both sites (Smith, 1980: 35; Watts, 2010: 14). While the mandible representation at Fincastle is high (Watts, 2010: 39), it is low at HSIBJ (Smith, 1980: 36). The reason for this difference is two-fold. Mandibles were the most commonly used element in the ceremonial features, which were well-preserved below the bone bed. In addition, the portion of Fincastle that was excavated was a primary processing area where mandible disarticulation occurred (Watts, 2010: 40)

while the excavated portion of the North Area Besant Level of HSIBJ is a secondary processing area (Smith, 1980: 38). Both sites contain mandibles broken in a way that was interpreted as evidence of marrow extraction (Smith, 1980: 36; Watts, 2010: 41, Kondor, 2022: 54).

In the North Area Level 3 of the HSIBJ kill site, vertebrae are rare and heavily fragmented (Smith, 1980: 36). Vertebrae are more common at Fincastle, and most had evidence of thorough butchering, including the articulated lengths (Watts, 2010: 14). Caudal vertebrae are quite common at Fincastle and absent from HSIBJ North Level 3, likely due to caudal vertebrae being discarded during the primary butchering and skinning process. Pelvis fragments are small and rare at both sites (Smith, 1980: 37; Watts, 2010: 52).

Only two rib fragments were found at this part of the HSIBJ kill site. Smith (1980: 36) states that this is because rib removal happened at the primary butchering area and these discards were unintentionally moved during the work. In contrast, rib fragments are the most common element in the Fincastle East Block at 2026 pieces with an additional four complete elements (Watts, 2010: 47). These fragments evidence that extensive meat removal work was conducted on the ribs.

Scapula fragments are more frequent at Fincastle than the North Area Level 3 of the HSIBJ kill site (Smith, 1980: 36; Watts, 2010: 54). The humerus is considered moderately represented at HSIBJ with all examples being distal or shaft fragments (Smith, 1980: 37). The situation is similar at Fincastle (Watts, 2010: 56) and at both sites. Marrow processing is suggested to have been conducted on all humeri. Proximal and shaft fragments of the radius are moderately common at HSIBJ, which

approximately mirrors the results from Fincastle with marrow extraction evident on all radii. Ulna fragments are rare at HSIBJ and uncommon at Fincastle. Regarding the metacarpal, all are fragmented at North Area Level 3 of the HSIBJ kill site but fewer than half are at Fincastle (Smith, 1980: 37; Watts, 2010: 62). This may indicate more thorough carcass utilization was occurring at HSIBJ in this period.

The femur has a low frequency in both assemblages and is highly fragmented due to marrow extraction (Smith, 1980: 37; Watts, 2010: 64). The tibia is a bit more common and heavily fragmented. The metatarsal is not mentioned in Smith's (1980) analysis of Level 3 of the North Area of HSIBJ. Having looked through the collection at the RAM, none were found. At Fincastle, 22.5% of metatarsals are complete indicating that the hunters left some marrow behind (Watts, 1980: 70). Phalanges are quite common at Fincastle but rare at HSIBJ (Smith, 1980: 38; Watts, 2010: 72). Smith (1980) suggests that they may have been retained at HSIBJ for some other function, likely using the hoof to make glue (Verbickey-Todd, 1984: 192).

In summary, both faunal assemblages for these sites show that thorough butchering took place. There are a couple of elements that indicate the butchering may have been more thorough at HSIBJ, such as the metacarpal. The differences in the quantities of the elements are likely explained by Fincastle East Block being the kill zone and primary butchering area while North Area Level 3 of HSIBJ is a secondary processing area.

The Smyth Bison Jump (Pelican Lake/Bracken)

The Smyth site (DjPm-116) is a bison jump site along the Oldman River that saw heavy use during the Middle Precontact period (Landals, 2009: 130). The jump was used at least three and up to 30 times between 2 800 cal BP and 2 200 cal BP. It was originally identified as a Pelican Lake site but Peck (2011: 263) recategorized the points as Bracken points as he did to the Pelican Lake points at HSIBJ. Regardless of the projectile point identification, the Smyth site is a useful comparison.

The season of use for the Smyth site was determined to be late summer based on an almost exactly even sex ratio determined from long bones, indicating that the hunt took place during the rut (Landals, 2009: 115). Smith (1980: 31, 63, 67) was unable to determine the seasonality for either the North or South Areas of the HSIBJ kill site Pelican Lake levels except the correlated Unit 14 of the South Area, which he suggests could be summer seasonality based on 16.33% of the assemblage being male. It should be noted that correlated Unit 14 does include some of the Hanna Levels in addition to Pelican Lake ones and thus should treated as mixed (see above).

Smith (1980: 31) characterizes the Pelican Lake levels in the North Area of the HSIBJ kill site as having a very low representation of the axial skeleton and moderate representation of the appendicular skeleton, with hind elements being slightly less common than fore elements. He claims that this portion of the site was principally used for secondary butchering of the limbs and opening the long bones for marrow extraction. This is most similar to the results of Block L of the Smyth site, the only excavation block of that site that was definitively determined to be a processing area (Landals, 2009: 106). It lies approximately 8 meters north and 10 meters west of the edge of Block C,

the nearest of the two kill site excavations and is 36 m². It is the only excavation block where appendicular elements are more common than axial elements, although the difference is not as stark as it is with the North Area Pelican Lake levels at HSIBJ. At both sites, the fore limb elements are slightly more common than the hind limb elements.

There are some substantial differences between the North Area Pelican Lake levels of HSIBJ and the Smyth site Block L. Fragments of the skull and ribs are significantly more common in Block L than in the North Area Pelican Lake levels at HSIBJ. Block L contains three scrapers, two of which were broken, and 126 pieces of FBR, although 109 of them were under 10 cm. No features were associated with the FBR. The Pelican Lake levels at HSIBJ do not contain either of those types of artifacts. A possible explanation for this difference is that these small pieces of FBR and broken scrapers were discarded away from the unexcavated workspace they were used at. Meanwhile, the slope up to the kill site at HSIBJ makes this type of butchering inconvenient. Instead, scrapers and FBR were left scattered around the campsite area of HSIBJ (Brink & Dawe, 2003).

Another noteworthy difference is that at the Smyth site the phalanges were broken for marrow extraction (Landals, 2009: 125), whereas this activity was not noted as being present at HSIBJ in Smith's (1980) report. However, in the North Area Pelican Lake levels the distal phalanx is unusually rare compared to the other phalanges. Smith (1980: 34) suggests it may have been removed for a subsistence purpose, but as noted in the previous comparisons, they could have been collected as the first stage of gathering hooves to be processed into glue (Verbickey-Todd, 1984: 192).

The Norby site (Gowen/Late Mummy Cave)

Due to the complete lack of known bison jumps or pounds coeval with the lowest levels of HSIBJ (Brink, 2016: 18), a less structured large-scale kill will have to be used as a comparison. The Norby site (FbNp-56) is situated on an ancient river terrace in Saskatoon and dates to approximately 5 800 BP (Zurburg, 1991: 1). It is described as a single use Mummy Cave site due to the discovery of three side-notched points, two of which are assigned as Gowen points, and a stemmed point. It is regarded as a winter kill site based on dentition analysis. The hunting technique is proposed to be either an ambush of a herd as they were going down to the river for water, or the herd was driven into a snow drift trap. The MNI is 26 from the portion of the site that was excavated. All of the bison were determined to be adult male *Bison antiquus occidentalis*.

The Norby site is quite different from HSIBJ as it is an ambush or trap rather than a jump and this may explain many of the differences in the faunal data between the two sites. Also, the portion excavated is a kill and primary processing zone (Zurburg, 1991: 81) while the portion of HSIBJ that is coeval with the Norby site, the South Area Mummy Cave levels, is a secondary processing zone (Smith, 1980: 56). There was minimal evidence for seasonality at HSIBJ in the relevant levels but correlated Level 16a was interpreted as summer utilization based on three long bones aged to less than 6 months (Smith, 1980). In contrast, the Norby site is a winter kill (Zurburg, 1991: 174). The fact the hunters at the Norby site targeted a male herd instead of a cow/calf herd is extremely unusual. This contrasts it not just from HSIBJ but from all but a couple of other known bison kill sites, such as the Hawken site (Zurburg, 1991: 126). The reason

male herds were so rarely hunted is because female bison are more nutritious during most of the year (Brink, 2008: 49). In addition, it is thought that male bison are more difficult to manipulate due to behavioural difference between the sexes (Zurburg, 1991: 173), although the ethnohistoric and archaeological record have examples of successful pound events of mixed herds during the rutting season (Shortt, 1993: 183).

In general, the Norby site displays much less intensive processing than HSIBJ all though Zurburg (1991: 81) is open to the possibility that intensive processing could have occurred elsewhere on site. Substantial weathering and poor preservation hampers analysis of the Norby site relative to HSIBJ. Despite the significant fragmentation observed at the Norby site, Zurburg (1991: 178) states that there is no evidence of marrow extraction while HSIBJ does have evidence of that activity in the same era (Smith, 1980). It is noteworthy that the nearby and slightly earlier Gowen sites do contain evidence of marrow extraction (Walker, 1992: 97). More specifically, there are three complete radii and four complete tibias from the Norby site (Zurburg, 1991: 115), whereas these elements are all smashed open at HSIBJ (Smith, 1980: 55). One characteristic both sites share is that none of the femurs and humeri are intact while the metapodials typically are. In terms of the axial skeleton, it has been suggested at both sites that the tongue and brain were deliberately sought after, although there were significantly more skull fragments recovered from the Norby site (Zurburg, 1991: 97; Smith, 1980: 54). Whole vertebrae are rare at the Norby site and absent from HSIBJ. Lastly, articulations are somewhat common in the Norby site (Zurburg, 1991: 107) but absent at HSIBJ (Smith, 1980: 54).

The Gooseberry site (Salmon River Points/Early Mummy Cave)

The Gooseberry site (EgPn-625) is a large-scale bison ambush site at the mouth of a gully in western Calgary (Vivian et al., 2011: 199). The site has three distinct bone concentrations, although Vivian et al. (2011: 129) only considers the deepest, Component 3, to be *in situ* with the upper two components likely being intrusive to the location. These upper bone concentrations are probably translocated remains from neighbouring kill sites that are yet to be discovered. Component 2 contains a projectile point identified as a Salmon River style, which is one of the Mummy Cave subtypes Reeves (1978: 171) identified at HSIBJ. Component 3 of the Gooseberry kill site was radiocarbon dated to 7 935 cal BP and contains projectile points belonging to the Hawkwood subphase of the early Mummy Cave Complex (Vivian et al., 2011: 192). As it was the only component in primary context, Component 3 was the most thoroughly studied. This component will be used as the comparison to the HSIBJ North Area Mummy Cave Level 10 despite being approximately 1 300 years older and associated with a different subphase of the Mummy Cave Complex. It is one of the few known large scale Mummy Cave hunts other than HSIBJ.

The MNI of Component 3 of the Gooseberry site is 42 (Vivian et al., 2011: 154). The faunal remains of the site were not analyzed to determine the specific type of *Bison* present although the researchers observed a few larger elements that they suggest could be of a transitional form, thus *Bison antiquus occidentalis*. The presence of *Bison antiquus occidentalis* at HSIBJ is likely but inconclusive (see Chapter 3). At both sites the target was a cow/calf herd. Vivian et al. (2011: 189) concluded that bulk butchering

was employed at the Gooseberry site which is somewhat similar with Smith's (1980) analysis that the bison remains at HSIBJ were heavily processed.

The skull and mandible are low to moderately represented in the North Area Level 10 of HSIBJ (Smith, 1980: 24). While cranial elements are more common at the Gooseberry site (Vivian et al., 2011: 171), the interpretations are fairly similar. Skulls were smashed open, likely to retrieve the brain for hide tanning. There are intact or nearly intact mandibles at Gooseberry but not at HSIBJ. Vivian et al. (2011: 176) suggest that this may indicate that more than one technique was used to separate the mandible from the cranium. Which method or methods were used at HSIBJ is unknown. This is difficult to assess because the mandibles at HSIBJ were also broken open for marrow extraction (Smith, 1980: 25), which would have obscured evidence of them being removed from the skull in a particular way. Fragments of the great cornu of the hyoid were present at both sites but only Smith (1980: 25) used this as evidence of tongue removal.

Vertebral fragments are rare in the North Area Mummy Cave Level of HSIBJ (Smith, 1980: 25) and common at the Gooseberry site (Vivian et al., 2011: 178). This difference is likely because the excavated portion of the North Area of HSIBJ is a secondary processing zone (Smith, 1980: 28), while the kill site was excavated at the Gooseberry site (Vivian et al., 2011: 199). Intact vertebrae and articulated lengths of vertebrae were infrequently observed at the Gooseberry site (Vivian et al., 2011: 179), but are not present at HSIBJ (Smith, 1980: 25). This may be because a more thorough processing procedure was used at HSIBJ than at the Gooseberry site although intensive processing is noted. Rib fragments are also very rare at HSIBJ and

uncommon at the Gooseberry site suggesting that in both cases the rib cage was detached from the carcass and removed to a separate area for additional processing.

The scapula is poorly represented at both sites and is fragmented from the removal of associated musculature (Smith, 1980: 26; Vivian et al., 2011: 183). Distal fragments of the humerus are more common than proximal fragments at both sites. The mid and proximal portions were likely being taken elsewhere for marrow extraction. The radii are moderately represented at both sites. While all radii from the North Area Mummy Cave level of HSIBJ were broken open for marrow extraction, all but three were at the Gooseberry site, again showing that the carcasses at HSIBJ were slightly more intensively processed. At both sites the ulna is uncommon relative to the radius and was heavily fragmented during the disarticulation process. Carpals are common and often found intact at both sites. Metacarpals are moderately represented at both sites with complete examples being observed indicating that they were a low priority for marrow production or only broken occasionally during the disarticulation process. Regarding the three phalanges, they are roughly equally common at the Gooseberry site (Vivian et al., 2011: 189) but at HSIBJ the distal phalanx is significantly less common, leading Smith (1980: 28) to suggest that the hoof was being retained for reasons not relating to food. Hooves can be used as glue (Verbickey-Todd, 1984: 192) and evidence of glue production is tied to increased intensity of carcass utilization at HSIBJ.

Fragments of the pelvis are far less common in the North Area Mummy Cave level of HSIBJ than at the Gooseberry site (Smith, 1980: 27; Vivian et al., 2011: 185). This difference is likely because the Gooseberry site deposits are from the main kill zone (Vivian et al., 2011: 199) while the HSIBJ excavations hit the secondary

processing zone at the cliff base adjacent to the kill (Smith, 1980: 5). The femur is moderately to well represented at HSIBJ but uncommon at the Gooseberry site. Vivian et al. (2011: 185) suggest that, since the femur is a high priority marrow bone, it was moved out of the kill site for marrow extraction. This difference thus aligns with Smith's (1980: 28) interpretation that the excavated portion of the Mummy Cave level of the North Area of HSIBJ is a secondary processing zone. The tibia is nearly as common as the femur at HSIBJ and all tibias were smashed open for marrow extraction. Tibia are common in the Gooseberry faunal collection and all but two were smashed. Like the radius, they have slightly less marrow than the bones proximal to them so perhaps were less processed than those at HSIBJ. Regarding the metatarsal, this element is common at the Gooseberry site and moderately common at HSIBJ, but complete specimens are more frequent at the Gooseberry site. As with the radii and tibia mentioned above, this difference is indicative that the hunters at the Gooseberry site were less thorough than those at HSIBJ.

Discussing Waste at Bison Jumps

It is important to address the question of how many animals were not processed at HSIBJ and at bison jumps. There is frequent speculation that the hunters did not manage to or decided not to process every animal killed during a jump (Brink, 2008: 155). While this speculation is typically rooted in an effort to counter the "noble savage" myth (see Hames, 2007), it is important to evaluate any evidence that exists to support this suggestion. The following discussion addresses the issue while focusing on Middle Precontact sites since that is the era of focus in this thesis. Much of this evaluation will

be applicable to the Late Precontact period as well. Smith (1980: 111) in his analysis of the HSIBJ kill site concluded that the “butchering practices were similar through time”. The comparisons between HSIBJ and other sites discussed above support this for the Middle Precontact Period. It should also be noted that Brink and Dawe (1989: 166, 167) found that there is minimal variation through time in the HSIBJ kill site faunal data regarding the proportion of element frequency. Their finding suggests that the butchering practices were consistent for the entire roughly 6 600 years of use of HSIBJ.

If bison were not butchered or were only partly processed, there should be complete elements in anatomical articulation, that is assuming no secondary formation processes altered their provenience. In the examination of the HSIBJ faunal collection from the Middle Precontact, no such evidence of waste was found. Except for a few metapodials (n=10), all meat and marrow bearing bones were heavily fragmented. Given that metapodials lack musculature and contain far less marrow and skeletal grease than other long bones (Emerson, 1990; Brink, 1997: 262), finding only a few of them intact does not constitute evidence of wastage. This assessment matches Smith’s (1980: 60) as the only instance of waste he believes may be present are femurs from the culturally unknown component of Unit X. He notes that it was not possible to tell whether or not they were processed for marrow after being smashed open in the disarticulation process. Articulated intact limbs or long intact sections of the thoracic vertebral column are not mentioned in Smith’s (1980) report or Reeves’ field notes.

Despite the lack of evidence of waste at HSIBJ, it is not possible to claim that there was no waste because Reeves’ kill site excavations almost exclusively encountered secondary processing areas. Evidence of waste, if it occurred, would be

found right against the cliff, where the bison most deeply buried in the pile would be left untouched. Until deep excavations are carried out directly against the cliff, the question of waste at HSIBJ should remain open.

In fact, bison jumps are the type of kill site where waste was unlikely to occur. While bison jumps produced the largest number of mammal carcasses and total mass of raw food to be processed of any hunting strategy (Brink, 2008: 3), they are also the hunting strategy that allowed for extensive preparation for the upcoming task of processing the carcasses. First let us consider proximity. The camp at HSIBJ with its processing infrastructure is only tens of metres away from the cliff and downhill from it. It is known historically and ethnographically that Plains Indigenous people, including the Blackfoot, butchered carcasses more thoroughly when their hunting location was close to camp (Verbickey-Todd, 1984: 169). The workforce was also larger. Both men and women would have laboured to process the carcasses from communal kills, in contrast to animals hunted further afield (Verbickey-Todd, 1984: 168; Brink, 2008: 138). Ethnographic informants from the Blackfoot community claimed to be capable of butchering 5-12 bison in one day (Verbickey-Todd, 1984: 169). Given that these hunting events would bring together several groups of socially related people, possibly totalling in the hundreds, to hunt approximately 100-300 bison (Brink, 200: 9, 868), it is feasible that all of the carcasses could be thoroughly processed before spoilage occurred even with the added step of having to spread out the pile of carcasses.

Moreover, two of the theories tied to the main motivation for conducting bison jumps are founded on the premise that the hunters maximised the quantity of bison products they obtained and minimized waste. These are the “winter provisioning model”

and the “trade theory” (see above). If the users of jumps were trying to stock up on food for winter, wasting a significant amount of potential food was counter-productive, even more so when there were dozens, or in the case of very large camps, hundreds of dogs to feed as well. If the users of jumps were intending to create a surplus to trade with groups in other regions, they would have produced as much as possible so that they could exchange the surplus for larger quantities of other goods. Given that many of the goods imported into the Alberta plains, such as lithic raw materials for tool making, were critically important to the livelihoods of people and minimally available locally, it would behoove the hunters to process the bison as thoroughly as possible to be used as exchange goods. The third theory proposed to explain the use of bison jumps is the “social/political model”, where the gathering itself served as a way to bring people together to forge alliances, marriages, exchange knowledge, participate in shared ceremonial experiences, and more. The number of people of the assembled tribe could be so high that all available food was processed to supply the associated feast. This may have been the situation, but there is insufficient stratification in the campsite to determine the total number of participants beyond an estimate in the hundreds (Brink, 2008: 9). Therefore, testing this theory is not currently possible.

The last and most critical consideration is that bison jumps offered the users more opportunity to set up for processing beforehand than any other hunting method. Jumps that saw regular use did so because people could rely on the bison being there when they came to hunt them (Brink, 2008: 74). The associated gathering basin was typically prime bison habitat with plentiful food for grazing (Brink, 2008: 74) and people conducted controlled burns in the gathering basin earlier in the year to promote grass

growth to attract bison (Roos et al., 2018: 8147). People would have arrived well before the hunt to prepare and spent several days digging boiling pits, collecting boiling stones, building roasting pits and drying racks, and gathering fuel both in the form of wood and bison dung (Brink, 2008: 187; Brink & Dawe, 2003).

The best comparison for the kill site of HSIBJ is the kill site at the Calderwood jump (DkPj-27 with DkPj-3 being its associated campsite). This bison jump, approximately 1 km to the north of the HSIBJ Interpretative Centre, is tied to the same gathering basin and shares its drive lane network with HSIBJ; it is effectively just a different component of the same site (Marshall, 1988: 164). The Calderwood jump has clear use in both the Late and Middle Precontact periods based on projectile point types and radiocarbon dates. The earliest use of the site is somewhat unclear. The oldest radiocarbon date is 2 910 ± 90 ^{14}C years BP (Marshall, 1988: 60) but three early side-notched dart points were found. The smallest was tentatively assigned as the Bitterroot subtype of the Mummy Cave complex (Marshall, 1988: 88) and the other two remain unidentified. It is likely that this site was used far earlier than the radiocarbon dates indicate.

The analysis of the butchering activities at the Calderwood site revealed that there was little, if any, waste (Marshall, 1988: 146). Nearly all the long bones were either removed from the kill site for additional processing or broken on site for marrow extraction. There were only five articulations found in the whole excavation. The first was a set of three broken lower lumbar vertebrae. Two radii were found with the ulna still attached. An occipital condyle was articulated with the atlas. Lastly, there was an articulation that is a bit unclear, but it seems to contain an L4, L5, and sacrum. None of

these articulations are indicative of significant waste. Short lengths of articulated vertebrae are still possible even after thorough meat removal (Watts, 2010).

The Smyth site (DjPm-116), discussed in the comparison section above, is a Middle Precontact bison jump site located along the Oldman River that was used regularly between 3 000 BP and 2 000 BP (Landals, 2009: 130). Block C in the kill site contained just 17 instances of articulations, two of which included butchered limb bones. The rest were short lengths of vertebral sections and it was undetermined if butchering had occurred. There were three lumbar sections, one set of four thoracic vertebrae from a “very young animal”, and four sets of 2-4 vertebrae containing the C7 and T1.

In Block D of the Smyth kill site there were two instances of articulated limbs one of which contained evidence of butchering and the other carnivore gnawing (Landals, 2009). It was not possible to determine if the carnivore gnawing is from domestic dogs or some species of wild canids, felids, badger, or bears. There were also ten instances of articulated vertebrae measuring 2 to 7 elements long. Landals (2009: 63) does not specify how many of these had any particular type of vertebrae but does state that some contained cervical, thoracic, or lumbar. She also notes that most thoracic vertebrae had their spinous process removed and most lumbar vertebrae had their transverse processes removed. This would be expected if the elements were butchered because the processes are meat yielding, though heavy weathering made it unclear if these breaks were cultural or taphonomic. Across the rest of the Smyth site a few vertebral articulations were found in the other excavation blocks further from the kill, and all of these have their vertebral and spinous processes removed in a manner that indicates butchering.

Landals (2009: 70) also states that long bones are disproportionately uncommon in the kill site compared to axial elements. Among those that remained, complete examples are very rare, most having been chopped open for marrow extraction. The most common complete long bones are the metapodials, which have far less marrow value and significantly less bone fat and grease than the other long bones (Emerson, 1990; Brink, 1997: 262) and no musculature. There were 45 complete metapodials found in the 89 m² area of the kill site they excavated. The radius is next common, which makes sense because it has the least marrow value after the metapodials. In summary, the faunal material indicates that every animal at the Smyth site was heavily processed and none were unbutchered, thus, waste did not occur at the Smyth site bison jump.

The Happy Valley site, a Middle Precontact bison pound in Calgary detailed above, also lacks evidence of waste. The only noteworthy difference in element breakage between the two sites is that significantly fewer metapodials were smashed open for marrow at Happy Valley than at HSIBJ. This is inconsequential given the low marrow value of these elements. In addition, all articulations found the Happy Valley site were either ends of long bones forming a joint but lacking the shafts or pairs of tarsals (Shortt, 1993: 105, 119). As the excavation was at the very center of the pound, it is reasonable to assume that there were no bison left unbutchered.

The Dry Island Buffalo Jump seems to be the only bison jump site where substantial waste was detected (Ball, 1984: 35). Dry Island Buffalo Jump is situated in the Alberta Badlands and is the namesake of the provincial park containing the world-famous *Albertosaurus sarcophagus* bonebed. It is the northern most bison jump (Wright

and Ball, 1983). There was a small excavation of both the kill site and campsite with a report submitted by Ball (1984). Radiocarbon dates and projectile points indicate that this site was used both during the Middle and Late Precontact periods. However, the small number of dates and points combined with the limited scale of the excavation means that there is insufficient chronostratigraphic information to discuss the Middle and Late Precontact periods separately. The suspected reason for the unusually low number of points is that at 40-50 meters this is the highest bison jump ever discovered and the lethality of the fall would result in few animals needing to be dispatched by hunters (Wright and Ball, 1983).

Ball (1984: 33) notes that the small sample size prevented them from conducting MNI, population analysis, or investigating the processing of the bison, though they claim that they could determine that only the best cuts of meat were taken and that no marrow processing occurred, leaving plenty of waste. They also commented that the bone fragmentation they observed was caused taphonomically rather than culturally. Less than 25% of the faunal remains they collected were taxonomically identifiable. Thus, it is possible that S-breaks and other evidence of extensive butchering was simply obliterated by taphonomic processes. Unfortunately, the lack of a detailed description or photographs of the condition of the finds restricts further exploration. Regarding articulations, Ball (1984: 33) reports that two sets were found. There was one in the kill site and one in the campsite. It is not mentioned what elements made up the kill site articulation, but the campsite articulation had several foot bones and, therefore, does not provide conclusive evidence of food waste. In summary, the claim of substantial waste at the Dry Island Buffalo Jump is unsupported with reliable evidence.

In conclusion, bison jumps used during the Middle Precontact lack evidence of significant waste. This is not to say that Indigenous people did not ever waste possible food from their kills. For instance, the Norby ambush site has many articulations and lacks evidence of marrow extraction (Zurburg, 1991: 111). Rather, bison jumps provided and created conditions that inherently minimized waste.

Ceremonial Bison Skull Features

One of the main aspects that differentiates HSIBJ from other well-documented communal bison kills sites is the absence of ceremonial bison skull features. While skulls are disproportionately rare in the overall faunal assemblage of major kill sites, ceremonial bison skull features are well attested. Brink (2008: 214) discusses the historic and ethnographic literature on the ceremonial uses of bison skulls and how these ceremonial uses can help explain the disproportionate lack of cranial fragments at large kill sites. The ceremonies can vary between different Great Plains groups, but the more common ones seem to be to call the bison back to that place to be hunted again and to honour the bison that were killed.

This practice has great antiquity on the Great Plains. At the Folsom era Ravenscroft arroyo kill site, a pile of bison skulls was discovered, which may be a ceremonial structure (Larrick et al., 2019). At the similar Folsom Cooper site, a painted bison skull was found (Muhammad, 2017). At the Smyth Jump, a Middle Precontact period site in Alberta, a pair of intact stacked bison skulls were excavated in Block H (Landals, 2009: 86), which is unlike other ceremonial bison skull features documented at later period sites. The Late Precontact period on the northwestern Great Plains has

the most archaeologically known examples. For instance, the Vore bison jump has three large rings of skulls with the noses pointing inward (Reher and Frison, 1980). The Ruby pound site has an arc of six bison skulls associated with a probable ceremonial structure (St. Clair, 2003: 23).

No such feature has been found at HSIBJ in either the kill site or the campsite Brink (2008: 214). This may be because the ceremonial skulls were placed at the cliff edge, a documented Blackfoot practice in historic times (St. Clair, 2003: 18) and were later disturbed. Given the enormity of HSIBJ, it is quite possible that ceremonial features, like those at the Smyth site, have yet to be discovered. Reeves alleges to have seen several bison skulls eroding from the terminus of the main spring channel, where it meets the next outflow a few hundred meters east of the cliff (Dawe, *pers. comm*.). Recent foot surveys have not rediscovered this feature and thus, shovel testing should be attempted.

There is a different form of ceremonial feature at HSIBJ involving bison skulls in pit features. Two of these have been found, both containing at least one unusually large bison skull and some painted bison bones, in addition to lithic and ceramic artifacts (Damkjar, 2023: 68). These are attributed to the Avonlea phase at HSIBJ. Similar ceremonial pit features are known elsewhere in southern Alberta, often associated with Avonlea phase bison pounds.

The results from the analysis of the faunal collections from the HSIBJ kill site stored at the RAM lend credence to Brink's (2008: 216) theory that the missing bison skulls were removed from the site for ceremonial reasons. In both the Late and Middle Precontact periods, horn sheaths greatly out number horn cores in the HSIBJ kill site

collection at the RAM. Within the Middle Precontact period assemblage, 20 horn sheaths were found (see Figure 31 for examples) and no horn cores, although Smith (1980: 57) reports seeing one when he was analysing the collection. There are many more horn sheaths in the Late Precontact collection, but these were not dealt with for this project.

The horn sheaths must have been intentionally removed from the skulls by the Indigenous people who used the jump. Removing the horn sheaths from a skull is quite difficult and time consuming. Little documented accounts of the process are known; no ethnographic references to how Indigenous people would have traditionally completed this task were found despite extensive research. The Alaska Department of Fish and Game has a method for cleaning skulls listed on their website that takes several days and recommends boiling a bear skull for eight hours (Gronquist, 2024). A bison skull, being larger, would take longer to clean than a bear skull. It is fair to be somewhat skeptical that, with all the skinning, butchering, and cooking that took place after a kill, people had time to clean the bison skulls. Moreover, none of the boiling pits documented from the campsite are large enough to accommodate a bison skull (see Brink & Dawe, 1989: 57, Brink et al., 1986: 29, Brink et al., 1985: 85, and Dawe & Brink, 1991: 151 for examples). In addition, cleaning the skulls in the campsite would not explain why discarded horn sheaths were found beneath the cliff, nearly twenty meters straight uphill from the campsite. If skull boiling occurred, the horn sheaths would be found near these features. Instead, it is more likely that the skulls were placed off to the side beneath the cliff, and left for nature do the cleaning. The hunters later returned after several months or years to retrieve the skulls for ceremonial purposes and discarded

the now loosened horn sheaths next to the kill spot. It is worth mentioning that not every bison skull would be used for ceremonial purposes. It has been well documented ethnographically that Indigenous people used bison brains for hide tanning (Verbickey-Todd, 1984: 190) and this practice can be seen archaeologically by the small number of bison skull fragments found at HSIBJ and other communal kill sites.

Figure 31: Horn sheaths from Unit N4 Level 0. This correlates to North Area Level 3 in Reeves (1978) and is the level containing what Reeves identified as Besant and Pelican Lake style points.

Non-Bison Faunal Remains

One of the peculiarities of HSIBJ is the relative lack of non-bison bones from the kill site. This may be at least partially because the base of the cliff is on top of a significant incline and an unlikely place for other animals to be. To expand the dataset, non-bison faunal remains found in the campsite were included when comparing HSIBJ to other bison kills.

The remains discussed below are of animals that appear to have died at the site. There are also numerous examples of animal remains that were turned into tools or used as ornamentation, which were lost or discarded at the site. Examples include elk tooth pendants from the Symth site (Landals, 2009: 112) and canid metapodial derived beads, a pronghorn bone awl, and a deer antler hammer from the Vore site (Walker, 1980: 164). While bone artifacts were not found at the kill site of HSIBJ (Appendix 1), they were recovered in campsite (Brink & Dawe, 1989: 288).

Canid

Canid (Family Canidae) remains are commonly found at bison kill sites. Examples include the Horner site (Frison and Todd 1987: 335) (Vivian et al., 2011), Everblue Springs (Vivian et al., 2011), the Gooseberry site (Vivian et al., 2011), the Snack site (Vivian et al., 2011), the Norby site (Zurburg, 1991: 89), the Smyth site (Landals, 2009: 63), the Dry Island Buffalo Jump (Ball, 1984: 35), the Fincastle site (Bubel, 2014: 219), the Happy Valley Bison Pound site (Shortt, 1993: 60), the Willow Springs Bison Pound (Bupp, 1981: 29), the Bodo Bison Pound site (Grekul, 2007: 39),

the Boarding School Bison Drive Site (Kehoe, 1967: 72), the Castle Forks Buffalo Jump (Landals, 1991: 74), and the Vore site (Walker, 1980: 163).

Identifying canid remains to species without the use of genetic analysis is quite difficult and prone to error (Fisher, 2019). For this reason, many researchers avoid doing so and leave their analysis at the taxonomic level of Family or Genus. Possible taxa of canids on the northwestern Great Plains include wolves (*Canis lupus*), coyotes (*Canis lantrans*), red fox (*Vulpes vulpes*), swift fox (*Vulpes velox*), domestic dog (*Canis lupus familiaris* although many authors still use *Canis familiaris*), wolf-dog hybrids, and dog-coyote hybrids.

At the HSIBJ kill site, a butchered *Canis sp*. from Level 2 of Unit Z was recorded (Smith, 1980: 97), which is correlated with South Area Level 6 in Reeves' (1978: 167) publication. This places it within the Old Women's phase. The butchered canid consists of a radius, axis, and a fragment of scapula, tibia, and sacrum. Canid remains have also been found in the campsite (Brink et al., 1985: 193; Brink et al., 1986: 213; Brink & Dawe, 1989: 79; Dawe et al., 2023: 34). Based on dental characteristics, one of these specimens was hypothesized to be a dog and another a wolf (Brink et al., 1985: 202). In addition, canid remains were found in the bone beds of the Calderwood Jump (Marshall, 1988: 64).

The presence of wild canid remains at HSIBJ may reflect a practice that Indigenous hunters used at communal kill sites to trap predators looking to scavenge from the leftover bison carcasses (Krozer, 1991: 83). Wolves needed to be hunted to make disguises for the Buffalo Runners, who often posed as wolves to stalk the herd (Morlan, 1994; Brink, 2008). There are several bison kills where the canid remains have

marks indicative of being skinned (Bubel, 2014: 219; Krozer, 1991: 83; Walker, 1980: 163). Morlan (1994: 771) suggests that a discarded wolf disguise would appear in the archaeological record as an assemblage containing a skull, a mandible, and some carpals, tarsals, and phalanges. None of the assemblages of canid remains documented from HSIBJ fit that description. However, the butchered canid in the kill site consists of the elements other than those identified by Morlan (1994: 771) making it possible that this find represents the creation rather than the discard of a wolf disguise.

Domestic canid remains at bison kill sites are harder to explain. If a significant proportion of canid remains are dogs, then they are too common to be explained as having coincidently died of old age at the kill site (Krozer, 1991: 84). The two most common theories, both of which lack good evidence, is that dogs either got caught up in the excitement and chaos of hunt and were trampled or crushed by falling bison or they died in confrontation with the butchers whose work they were interrupting and stealing from. These are sometimes called the “stupid-dog hypothesis” and “bad-dog hypothesis” respectively (Krozer, 1991: 82). The major fault with these hypotheses is that a large bison kill like a jump or pound would produce many tonnes of goods that would need to be carried away from the kill. Regularly losing pack animals because they were not leashed implies a degree of disorganisation and poor planning that seems implausible in light of how much planning went into the rest of the hunt.

Dawe et al. (2023) report on a roasting pit containing two canids in addition to scrap bison long bones. The context of the canid remains suggests that they were cooked and consumed. Dawe’s interpretation of this unusual find is that it was an act of desperation in a dire situation. Not only does it signal a lack of available bison,

augmented by the fact that one of the canid's last meal was a rabbit (Family: Leporidae), the Blackfoot and some other Indigenous groups living in the Plains abhorred eating dogs and only did so in dire circumstances. There are other Plains tribes that did so either ceremonially or regularly. Some grease does persist in bison long bones for several months after discard. Dawe et al. (2023: 57) propose that starving people came to HSIBJ to scavenge the remains of their previous kill for further processing. It is also likely that wild canids may have come to do the same and were hunted by Indigenous people for a more substantial meal.

Birds

Bird bones (Class: Aves) have been found at several bison kill sites. Examples include the Gooseberry site (Vivian et al., 2011), Everblue Springs (Vivian et al., 2011: 56), the Smyth site (Landals, 2009), and the Vore site (Walker, 1980: 155). At the HSIBJ kill site, a bird bone was found at the kill site in the North Area Level 10 (Appendix 1), a Mummy Cave level. It is not in the RAM collections so unfortunately, it could not be identified or examined. The lack of clear taxonomic identification of bird remains at most kill sites limits their interpretation. While birds were not a significant food source for Plains Indigenous people, feathers from several different species had ceremonial uses. A relevant example to the find at the HSIBJ kill site are eagles. Eagles are known to engage in scavenging (Watson et al., 2019: 1735) and would likely be attracted to the kill site, where Plains Indigenous people could have hunted them for their feathers (Verbickey-Todd, 1984: 7), much like how they hunted other predators attracted to large bison kills.

Cervids

Deer (*Odocoilus sp.*) are often found at bison kill sites. Examples of bison kill sites with deer remains include the Horner site (Frison & Todd 1987: 337) (Vivian et al., 2011: 48), the Gooseberry site (Vivian et al., 2011: 149), Everblue Springs (Vivian et al., 2011: 48), the Smyth site (Landals, 2009: 63), the Willow Springs Bison Pound (Bupp, 1981: 29), the Castle Forks Buffalo Jump (Landals, 1991: 74), and the Vore site (Walker, 1980: 164). While deer bones were not found in the HSIBJ kill site (Appendix 1), they were found in the campsite (Brink et al., 1985: 210; Brink et al., 1986: 187; Brink & Dawe, 1989: 79). The small sample size of deer bones from the HSIBJ campsite prevented researchers from determining if they were deposited by cultural or natural events.

Deer were hunted to add variety to people's diet and their hides were used for warm weather clothing (Vivian et al., 2011: 50). It is also possible that deer were hunted some distance from the site and transported to it, perhaps to feed the people setting up at the jump for the kill event in the days prior. Deer are common at HSIBJ today.

Elk (*Cervus canadensis*) are rare in the assemblages of bison kill sites. They have been found at the Dry Island Buffalo Jump (Ball, 1984: 35), the Boarding School Bison Drive Site (Kehoe, 1967: 73), and two elk tooth ornaments were found at the Smyth site (Landals, 2009: 112). Three elk bones were identified in the HSIBJ kill site collection at the RAM: an astragalus, a second phalanx, and a distal fragment of a metapodial. They are from Unit A Level 6, which is dated to the Old Women's phase in the South Area of the kill site. Elk were more common in the region before European contact and may have been hunted opportunistically. In addition to diversifying their diet,

Indigenous people living in southern Alberta used elk hides for clothing and their incisors as pendants to decorate dresses and make jewelry (Giering, 2018).

Both elk and deer antlers were used to make a variety of tools. Acquiring antlers did not require hunting as elk and deer shed their antlers annually. Thus, antler artifacts can be found at a site where deer hunting did not take place. At the HSIBJ campsite, a piece of worked deer antler was found, which Brink et al. (1986: 98) propose to be the discard from creating an antler point. They elaborate that antler points are known from Plains Indigenous groups ethnographically but have yet to be recovered from HSIBJ. They also point out that similar artifacts have been found at other bison kill sites, including the Boarding School Bison Drive site.

Pronghorn

Pronghorn (*Antilocapra americana*) are commonly found at bison kill sites. Examples include Everblue Springs (Vivian et al., 2011: 48), the Fincastle site (Bubel, 2014: 219), Wold Bison Jump (Pelton et al., 2019: 78), the Willow Springs Bison Pound (Bupp, 1981: 29), and the Vore site (Walker, 1980: 164). It is thought that pronghorns living alongside bison either got caught up in stampede or that the extremely curious animals approached the kill site after the hunt and were dispatched (Vivian et al., 2011: 50). Pronghorn inquisitiveness seems to stem from the fact they are the second fastest land animal on the planet with a top speed of 89 km/h (Kauffman et al., 2020: 80); they can typically easily escape whatever they choose to investigate unless the subject is armed with atlatls or bows. The reason for this extreme speed relative to the available predators is thought to be because pronghorn evolved alongside the felid *Miracinonyx*

trumani, which was interpreted as having a comparable speed and ecological niche of the modern cheetah (*Acinonyx jubatus*) (Figueirido et al., 2023). Recent anatomical studies have cast doubt on the speed of *Miracinonyx trumani*, however, leaving the source of selective pressure for the extreme speed of pronghorns somewhat elusive.

No pronghorn remains have been reported from HSIBJ. While the site is not within the modern ecological range of Pronghorn, it was along the edge of it in precontact times (Kauffman et al., 2020: 81), thus making it plausible that their remains will be discovered during future excavations. Pronghorn underwent a substantial range reduction during colonialization and had their population reduced from 30-40 million to just under 1 million (Jones et al., 2023). Pronghorn were regularly hunted on the Northern Plains in precontact times to add variety to the diet and because their hides were ideal for warm weather clothing (Brink, 2013: 24).

Bear

Bear (Family Ursidae) remains have been found at some bison kill sites including the Smyth site (Landals, 2009: 80) and the Vore site (Walker, 1980: 156). At HSIBJ, two bear teeth, a canine and a molar, were found in the campsite in 2021 (Bubel, *pers. comm.*) but none have been found at the kill site. These have been determined to most likely be grizzly bear (*Ursus arctos horribilis*) based on morphology, as were the Vore site examples. The bones from the Smyth site were not identified to species (Landals, 2009: 80). Grizzly bears have been largely extirpated from the plains post European contact, but black bears (*Ursus americanus*) are spotted at HSIBJ regularly (Bubel, *pers. comm*.).

The presence of bear remains at HSIBJ may be tied to the practice of Indigenous hunters using communal kill sites as locations to hunt predators looking to scavenge from the leftover bison carcasses. Bears are an extremely important animal in the spiritual lives of Northwestern Plains people, including the Blackfoot (Peck & Hudecek-Cuffe, 2021: 26). Parts of the bodies of bears were used in the creation of ceremonial objects such as a 2 700-year-old bear claw necklace found in southern Alberta (Brink, 2008: 220). Knives made of bear mandibles, are known both ethnographically and archaeologically from the early Old Women's phase occupation of the Morkin site (DlPk-2) in southern Alberta (Peck & Hudecek-Cuffe, 2021: 22).

Summary

This chapter presents the studies of several aspects of the zooarchaeology of the HSIBJ assemblage. Research on the ecofacts accessioned at the RAM began with an examination of the data in Smith's (1980) report on the kill site faunal remains and his conclusions. This study concurs with Smith (1980), that Reeves excavated secondary processing areas adjacent to the cliff. The faunal elements Reeves and his team recovered and their distribution at the kill site matches the faunal remains at the Smythe bison jump. In addition, Smith's findings that the phases of use of HSIBJ were fairly consistent through time and that these hunting events occurred in the late summer-fall were supported by this study. The butchering data presented in Smith's (1980) report for HSIBJ were then compared to other bison kill sites on the Northwestern Great Plains of similar ages. Though the site comparison datasets are limited, the jumps and pounds were most similar to HSIBJ.

This chapter also includes a discussion about waste at bison jumps. The archaeological and ethnographic evidence supports the claim that very little of the bison was wasted following the hunt. The predominance of fragmented elements, lack of complete meat and marrow yielding bones, few articulated skeletal sections, and missing elements, along with their spatial location, evidence intense butchering activities and the use of all parts of the animals. Additional excavations directly beneath the cliff would be necessary to confirm that little waste occurred.

The absence of both bison skulls and bison skull monuments at HSIBJ was also explored. Based on the numerous horn sheaths found in levels lacking horn cores, and the difficulty of cleaning such large skulls, it was concluded that skulls were being left at the kill to let nature clean them and they were retrieved at a later time. That the skulls were removed from the kill site suggests they were taken to a secondary location, perhaps used in a ceremonial context, but this remains hypothetical.

Finally, the non-bison faunal remains of HSIBJ were reported on. These ecofacts, the bones and species present, and their location are mostly consistent with other large bison kills except for the lack of pronghorn remains.

The results of this research contribute to the overall understanding of the butchering processes carried out at HSIBJ and showcase similarities to other large-scale bison hunts conducted in the Northwestern Great Plains. Re-examining the faunal collection accessioned at the RAM was productive and a valuable learning experience.

Conclusions

This project used the collection of archaeological material excavated from HSIBJ that is now curated by the RAM to re-investigate the site. The focus was on the Middle Precontact usage of HSIBJ, principally the kill site component excavated by Reeves. The original field notes, records, images, and labels on the boxes of artifacts from Reeves' excavations served as a starting point to explore the stratigraphic record and cultural activities carried out at the site. As many research projects are, this was an iterative process. One of the main goals was to create a more complete model of the stratigraphy of the HSIBJ kill site (Figure 9), but additional discoveries were gained along the way.

Several new insights were gleaned from the reanalysis of the kill site stratigraphy, especially when combined with the new radiocarbon dates and evidence acquired from excavations subsequent to Reeves' work. The synthesis of the various projectile point types that were found in the different excavation units and their chronological assignments between the Mummy Cave complex and Avonlea phase revealed a patchy distribution at the site. This is a significant deliverable that can be used for future excavations because specific archaeological components can be targeted. Moreover, it is now clear that the absence of a particular phase or component in a given excavation unit does not equate to its absence at the site. This thesis research confirmed cultural presence at the site in all the archaeologically defined cultural phases for the last ~6 600 years, with earlier phases currently being documented.

Another discovery from this thesis research is that the Mummy Cave component of the site is far more substantial than first understood. A series of new radiocarbon

dates on faunal remains in the accessioned collection at the RAM show regular occupation of the site for roughly 2 000 years of the Mummy Cave timeframe. This merges with possibly the most significant result noted above: That HSIBJ continuously operated from the first usage of the cliffs until the 1800s. This finding negates the “Gap” hypothesis, which postulated site abandonment between the Mummy Cave and Hanna periods. The new interpretation, that the site was continuously used, is supported by multiple lines of evidence. The first is based on the stratigraphy of Unit X and the North Area, neither of which have a sterile level representing a hiatus of occupation. In addition, the updated projectile point sequence now includes the Gowen-Oxbow series based on artifacts found in both the kill site and campsite. This series fits into the temporal space of the “Gap”. Lastly, two Oxbow age radiocarbon dates from levels above the Mummy Cave component of Unit X were obtained, providing further evidence of occupation at that time.

This project also sought to evaluate the taxonomy of the bison hunted at HSIBJ during its earliest uses. The oldest dates of the site are at a time when *Bison antiquus occidentalis* inhabited Alberta. Their possible presence at HSIBJ had not yet been explored. Unfortunately, due to the extensive processing that the hunters carried out as they sought bone marrow, the biometric analysis carried out on the faunal elements from this time period was inconclusive. However, it is likely that *Bison antiquus occidentalis* was hunted at the site given that specimens of this taxon have been found in Alberta with radiocarbon dates that overlap with the oldest radiocarbon dates retrieved from the kill site.

A high-level zooarchaeological examination of the Middle Precontact period of HSIBJ was also performed as part of this research project. Smith (1980), in his report on the faunal remains recovered during Reeves' excavations, claimed that Reeves' main excavation units were within secondary processing areas adjacent to the actual kill. Comparing his results to the Smyth site supported his interpretation. The findings in Smith's (1980) report on butchering practices at HSIBJ were also compared to other large-scale bison kills that took place at different times. The sites that were most similar to HSIBJ were bison jumps and pounds from the more recent periods, which was the anticipated result. Jumps and pounds allowed for more preparation prior to the hunt, which likely also enabled more complete butchering. More people were needed and available for these tasks. The differences that were observed between other sites and HSIBJ were what was expected given that the comparative sites were typically excavated in the center of the kill, unlike at HSIBJ. However, HSIBJ often contained evidence of more thorough processing than other sites, including more smashed open metapodials and distal phalanges to make glue. Unfortunately, there are no known bison jumps or pounds other than HSIBJ until the latter part of the Middle Precontact period, limiting site comparisons in older time periods. Compared to other Mummy Cave bison kills, the bison carcasses hunted at HSIBJ were processed far more thoroughly. One pattern that held for HSIBJ and all sites except the Norby site is a late summer to fall seasonality estimate.

Questioning the suggestion that some animals were left unbutchered or that waste occurred at bison jumps in the Middle Precontact was also insightful. By closely looking at the information gathered from the analysis of the faunal assemblages

recovered from HSIBJ, the Smyth site, and others, it was determined that there is no evidence for waste at these sites. There were few articulated skeletal sections noted in the excavation reports and most of the faunal remains in these collections were heavily fragmented. Many specimens evidenced carcass disarticulation efforts and marrow extraction breaks. The substantial preparation that occurred prior to the hunt and the need to make the most of the resources the hunters had worked hard to acquire were offered as explanations for the lack of waste.

Finally, going through the faunal remains stored at the RAM also offered an insightful contribution to a lasting question about HSIBJ. It has been observed that HSIBJ has a lack of bison skulls relative to other elements. Moreover, no bison skull ceremonial features, which are well documented at other major bison communal kills have been found. Several bison horn sheaths were discovered in the kill site collection stored at the RAM, far exceeding the number of horn cores. Given how difficult it is to remove horn sheaths from horn cores on recently killed animals, their presence may well reflect an Indigenous practice of placing the skulls beside the kill deposits to let natural decomposition do the work. The skulls were then retrieved by the hunters when they returned to the site, and perhaps they used them in ceremony at a location not yet discovered. Lastly, the non-bison faunal remains of HSIBJ were contextualized with other major bison kills on the Northwestern Great Plains.

In conclusion, the archaeological material and field records curated at the Royal Alberta Museum were instrumental in revising and expanding our knowledge of one of most important archaeological sites in the Great Plains, Head-Smashed-In Buffalo Jump. There were some challenges working with a collection excavated more than fifty

years ago, namely determining the contexts of the remains, completeness of the records, and the documentation of the excavations, but these were largely overcome. The staff at the RAM were exceedingly helpful throughout this thesis research and we were able to make some improvements to the storage and organization of the collection as work on this project proceeded. In addition, this project was able to synthesize decades worth of research on the projectile points, chronology, and zooarchaeology of HSIBJ, which can be used as a foundation for future research on the material accessioned at the RAM and the site itself.

There are many possible directions for future research on HSIBJ, some of which are ongoing at the time of writing. The most fruitful direction for additional research related to the topics covered in this thesis would be new excavations at the kill site as detailed above. Targeting the Hanna levels, the levels described as Unknown in Unit X that have been argued to have Oxbow affinity, and the Mummy Cave levels could be especially insightful. Following that, excavating two meters below the Mummy Cave levels, ideally in multiple locations, would be extremely beneficial. The goal would be to find transitional period and Cody Complex material that match what has been recovered from the campsite. This would confirm that Indigenous hunters used the cliff to jump bison in these earlier times, solving a question that has frustrated archaeologists since the 1940s. It would also significantly contribute to our understanding of Indigenous history and lifeways on the Northwestern Great Plains.

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Appendix 1

Introduction

The following is the reworking of the original field notes from the Reeves' excavations in 1965, 1966 and 1972. They have been rewritten, annotated and edited for clarity. The south excavation units are A, B, C, X, Z, and Y. The north excavation units are N1 through N5. Unit D, sometimes called the East area, was omitted as it is at the base of the hill rather than the base of the cliff and is thus outside the scope of this project.

There are some important caveats with these notes, firstly they were not all written by Reeves himself and it is often difficult to discern exactly who wrote which section. The next issue is that they are incomplete and frequently contain typos. All that is accessible is what is currently in possession of the RAM. The two key things that are known to be currently not at the RAM are the stratigraphic section drawings for nearly every one of the excavation units and individual unit notes for the North Area excavation units. All that is available for the North Area excavation units are Reeves' summary and composite notes. The notes at the RAM include Reeves' original catalog sheets for lithic artifacts which have been omitted from the summary as they are outside the scope of this project. The level record forms from have been omitted from this summary for the same reason.

Units Y + Z (South Area) by Larry Ludwick [phytolith expert]

The south wall was sampled. [I presume the units to be feet]

L1: (0-0.5) sod and quarry rubble
L2: (0.5-1) Ah soil in between rubble and 1st bone layer, reddish brown
L3: (1-1.3) Bm horizon with burnt bone below
L4: (1.3-1.5) orange ash horizon with burnt bone
L5: (1.5-2.05) black horizon with burnt bone, possible incipient Ah [horizon]
L6: (2.05-2.55) burned black at the top, brown below, little bone
L7: (2.55-3.55) “burned white below bone horizon with lenses of orange bone”
L8: (3.55-3.8) brown horizon with some burning
L9: (3.8-4.3) grey horizon, bone mostly burned
L10: (4.3-5.0) chocolate brown, B [horizon]
L11: (5.0-5.5) brown soil
L12: (5.5-5.9) Ah [horizon]
L13: (5.9-6.4) not as organic as above, Bm? (sic) [horizon]
L14: (6.4-8.3) “much the same as before”
L15: (8.3-8.8) “AB? (sic) 2” [inch] white streak below is left out” [of the analysis?]
L16: (8.8-9.1) light brown horizon
L17: (9.1-9.4) “darker above and lighter below”
L18: (9.4-9.8) light brown horizon
L19: (9.8-10.4) [no information given]
L20: (10.4-10.8) “darker layer above bone, white below”
L21: (10.8-11.5) [no info given]
L22: (11.5-12.0) brown grey above a dark Ah [horizon]
L23: (12.0-12.8) “dark Ah [horizon] like thing”
L24: (12.4-13.4) [no info given]
L25: (13.4-13.7) Ah [horizon]
L26: (13.7-14.7) “B(?)” (sic) [horizon]
L27: (14.7-15.0) Ah [horizon]
L28: (15.0-15.6) B [horizon]
L29: (15.6-16.3) C [horizon]
L30: (16.3-16.6) Ah [horizon]

L31: “ 6 ” [←screenshot, not a ‘6’ based on other 6s, likely a C (horizon)] (16.6-18.6) Ah [horizon] (18.6-19.3)

L32: (19.3-20.6) C [horizon]

L33: (20.6-20.8) Ah [horizon]

L34: (20.8-21.4) C [horizon]

L35: (21.4-21.6) Ah [horizon]

L36: (21.6-27.2) C [horizon]

L37: (27.2-27.6) Ah [horizon]

L38: (27.6-32.6) C [horizon]

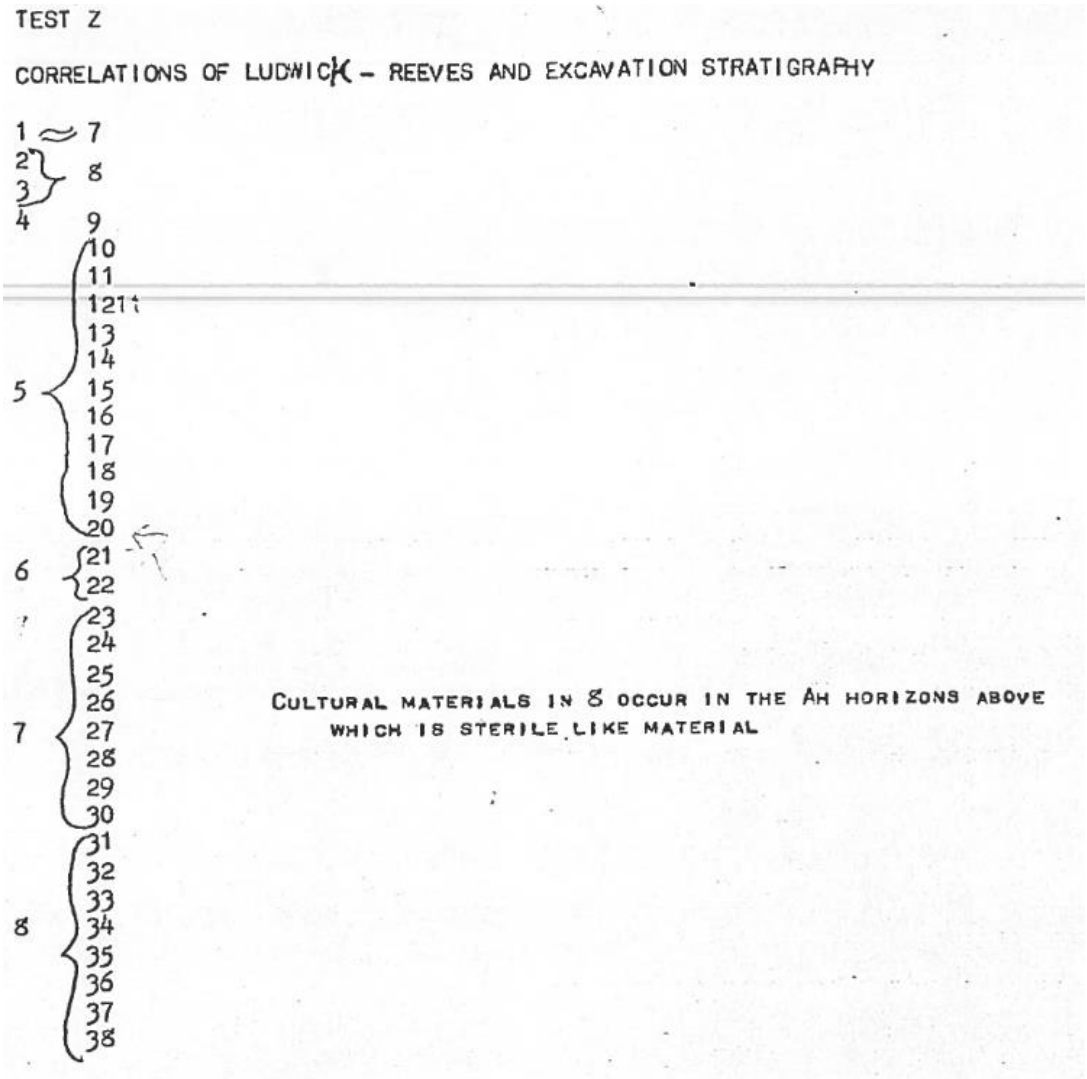


Figure 32: Correlations between Units Z and Y copied from Reeves’ unpublished notes.

Unit A (South Area) 10 x 20 feet [Main Excavation]

L1: [likely 1 ft but unclear] looter's back dirt

L2: [no thickness given] disturbed/removed by looters

L3: [no thickness given] several projectile points [type not specified]

L4: [no thickness given] several projectile points [type not specified]

L5: [no thickness given] several projectile points [type not specified]

L6: (1 ft<) lots of thoroughly burned bone, some non-bison bone [taxa unspecified] cobble choppers and many projectile points [type not specified] and scrapers, 1 knife

L7: [no thickness given] dark black burned layer; bones (some calcined) and projectile points [type not specified], sample taken for dating

L8: (1 ft) brown soil with bone

L9: (4-6 in) bone carbonized with some burned to white. Writer was away during excavation of L8/L9 thus "difficulty" understanding stratigraphy

L10: (48-50 in, dug in 6 in levels) "black organic stain thru brown", some sandstone slabs, less bone than other levels

- First: many points [type not specified] and tools [type not specified]
- Second: "localized" burned bone, front phalanges only
- Third: [no information given]
- Fourth: soil same as before
- Fifth: [no information given]
- Sixth: [no information given]
- Seventh: [no information given]
- Fourth: (sic) [no information given]

L11: (6 in) "dark organic black-grey layer", sandy soil, ash, bone

L12: (6 in) brownish soil, bone, "tailing out of cultural Avonlea"

L13: (52 in in total, 6 in levels) grey soil, rock falls

- 1st: little bone, "crude side notch Avonlea like points"
- 2nd: little bone, Besant points, worked flakes
- 3rd: little bone, fine sand, ^{14}C sample taken
- 4th: same as above, many Besant points, chips [=flakes], choppers
- 5th: [no information given]
- 6th: more bone than above

- 7th: little bone, large rocks, TNT through a 3ft block of sandstone
- 8th: (42-52 in) little bone, Hanna point

L14: “thin black layer of charcoal wash type soil”, bagged with L13 42-52 [L13 8th], “several” 2 ft thick sandstone blocks that were removed with TNT

L15: (42 in in total, 6 in levels)

- 1st: dark brown (dry) sandy soil, sandstone, wet sediment, bone, Hanna points, possible contamination from TNT use in L14 [according to the notes] ^{14}C sample
- 2nd: dark brown sandy soil, less sandstone, wet sediment
- 3rd: “little bone”, wet sediment, “little cultural material”
- 4th: wet sediment, dark grey to light grey, charcoal, now 10x10 [ft]
- 5th: little bone, 2 projectile points [or] 6 points (1 complete) [presumably Hanna points] [there is disagreement about point count in the notes], some flakes/chips
- 6th: “little bone”, “few chips” [probably means flakes], 1 “body frag” [projectile point, presumably Hanna]
- 7th: [no information given] [later it was redesignated as the first 6in level of L16]

L16: (12 in in total, 6 in levels; 36-42 in of L15 [7th] is first level of L16)

- 2nd: “light brown soil separated by a burn from 15, approximately 1[in] thick” [what is 1 in thick? A burned lens?], ^{14}C sample taken

L17: (6 in levels) dark horizon/carbon stain, sandy, little bone

- 1st: bone, charcoal, no artifacts
- 2nd: brown sand, no artifacts except a point from wall fall, excavations ceased

Auger 1: South end of Unit A, grey sandy silt soil, bone frags at 4 ft deep, at 4 ft 4 in sandstone encountered

Auger 2: slightly NW of Auger 1, lots of bone from 4-5.5 ft, stopped at sandstone

Discussion and comments:

- “Level” and “layer” not used consistently. In Units X+Y “level” is used for arbitrary and “layer” for stratigraphic changes, in A “level” seems to mean stratigraphic contexts
- The projectile points found above L12 are presumed to be Avonlea. Based on other info, it appears the Old Woman’s and historic material was looted
- L15 projectile points are assumed to be Hanna
- The notes for the auger tests are unclear regarding if whether they think the bone level is cultural material or natural. It is likely cultural material

Stanley Schimpf notes contain the remaining Unit A information:

- Notes having done a test pit at bottom of Unit A. Claims to have dug and screened 3 ft and 1.5 ft to reach augered bone. Found sparse bone and Reeves said stop.
- Reeves returned to site to see test pit. Augured again to find lots of bone
- Dug all of Layer 18, exposing top of Layer 19
- Mention of “ash pit” and “headdress pit” being dug by female crew members elsewhere, it is not specified where those locations are, but they are not part of existing unit notes.
- Profiles were drawn of North wall of Unit A by female crew members, and most are not at the RAM.
- Soil samples taken by female crew members but does not say where.

Unit A Test Pit [from other Unit A notes probably 5 x 5 feet]

L18: (12 in levels [sometimes], 62 inches in total) “probably no different from [L]17” but called L18 to distinguish it from sterile layers

- 1st: very hard sand-clay soil, sterile
- 2nd: same as 1st
- 3rd: same as 1st with light brown bone stain in the NW corner
- 4th: small black lens at 42in deep, no bone, sterile
- 5th: (48-56in) no colour change, sterile, no bone,
- 6th: (56-62in) sterile, bottom horizontal rather than dipping east

L19:

- Stratum A: (1.5in) black [paleosol?] with bone extending into level below, 1 flake
- Stratum B: chocolate brown as L18 [word chocolate not used in L18], no artifacts

L20:

- Stratum A: (2in) “dark brown almost black” [paleosol?], uniform layer of bone
- Stratum B: (2in) light brown, 1 bone and worked flakes

L21: (4in) black soil, lots of bone, no artifacts

L22: (2in) light colour almost white, sand clay mix, very hard soil, 1 flake

Discussion and comments:

- L18 is 62 in which is 5.1 ft which is less than the approximately 6 ft of the gap in the 1978 publication
- That is a lot of probable paleosols (3-4?)
- It is unclear why they stopped digging. No mention of impassible sandstone
- Ladder of 2x4s attached to shoring
- There are two L20 bones at the RAM. It seems that they not save the rest of the bone from the lower components of this unit

Figure 33: Profile photograph of the west wall of Unit A Levels 2-11.

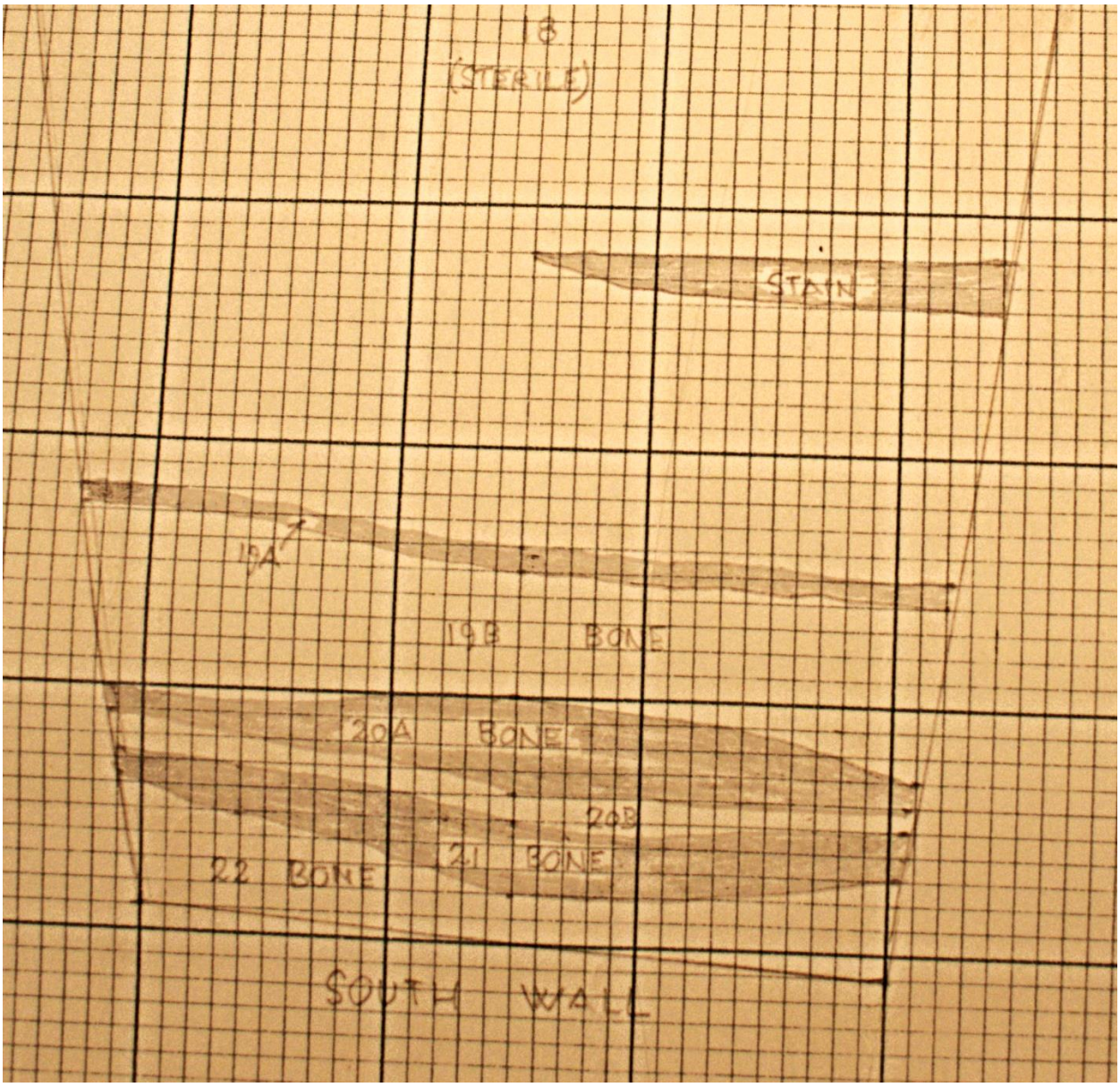


Figure 34: Profile drawing of the south wall of Unit A Levels 18-22 showing Mummy Cave bone beds. Drawn by A. Bennett and J. Macadam. Dated 25 August 1965.

Unit X, also referred to as Test Pit X (South Area)

L1: (0.5 ft) sod, disturbed, late side-notched points.

L2: (0.5 ft) reddish brown, may be a little burned material, poorly preserved bone, late side-notched points.

L3: (0.45 ft, [it was claimed to be 1.4ft total depth but this is probably a typo]), “powdery brown soil”, rootlets, some burnt bone giving a some grey colour, late side-notched/Avonlea points.

L4: (0.5 ft) lighter colour + similar texture as L3, grey burnt band, Avonlea points, proposed that L1-L4 is a single geological unit.

L5: (N: 0.45 ft/S: 0.75 ft), finer texture than above units, light brown with ash stains, more bone, multiple Avonlea and 1 Besant point.

L6: (1 ft, dug in 6 in levels), grey-black soil, Ah-like horizon, sandstone slabs, several FBR, lots of bone, knives/scrapers, 2 Besant and 1 Avonlea point, assigned as Pelican Lake [I think Reeves lumps Besant in Pelican Lake]. Also, the Avonlea point is probably from L5 since the SW corner was not dug deep enough before this layer was started.

L7: (2.3 ft), grey-black alternating Ah horizons, continuation of above, bone layer at bottom, assigned Pelican Lake [no mention of what projectile points were found to justify this assignment]

L8: [no thickness given], uniform grey, “Ah-like horizon”, caliche in it, bone, culture unknown

L9: (no thickness given, arbitrary levels → at least to 16 [see below for possible thickness] [I have bone from L10, L11, L12, L14, L15, L16]) described as quite similar to Layer 8; alternating AH horizons with lighter layers between, Level 16 has choppers/quartzite flakes/granite rock, bird bone [I cannot find the bird bones in the RAM collections]

Digging was stopped at “top of yellow clay which underlies the rock fall”, bone was taken for dating from the lowest part of the unit.

The unit then collapsed.

Discussion and comments:

- I suspect the Level 9 sublevels are listed as Levels 10 through 16.
- I suspect, based on the boxes of faunal material at the RAM, that L16 is the deepest one.
- I suspect that they were dug in 1 ft levels as the Unit Z and the North excavations switched to that thickness from 6 in levels normally used but it is still possible that they were dug in 6 in levels.
- Based on the 1978 publication and the ^{14}C dates, the quartzite artifacts belong to the Mummy Cave component.
- Depending on thickness of the arbitrary levels, the Mummy Cave component may be much shallower here than in the other units in the South Area.

Unit B (South Area) West of Unit A - Target depth is L6 in Unit A

Purpose: capture archaeological levels destroyed by looters in unit A

L1: (10in) sod + black soil, little bone (probably from L2) [followed by] a browny red soil with bones

L2: (5-7 [inches]) “brown – orange reddish soil”, many bones, metal points

L3: (1ft6in average), black carbon 3 [inches] thick, greyish brown sand (1ft), light brown lenses (max 1ft thick), few small black lenses, lots of bone, 50+ side-notched points

L4: (NW: 1ft6in / SE: 3in) “light to dark black soil”, lots of charcoal, 3 side-notched points, only 75% was screened at time of writing.

------- Author [Sandy most likely] left the site (along with Doug) --------

A trench was dug on north end of unit B approximately straight east to connect with middle of unit A. Material from this trench discarded [where it was discarded is not specified, it is likely it was discarded due to how disturbed it was]. Depth is unknown.

Discussion and comments:

- It seems that they intended to continue deeper at a later time but didn’t.
- This unit was revisited during the 1972 excavation to clarify the stratigraphy and collect two bones for ^{14}C which hadn’t been done previously. The samples were taken from the top and bottom of L3.

Unit Z (15 x 10 feet with long end East-West) goal depth 25 feet

L0: ([no thickness given]) looter's back dirt.

L1: ([no thickness given]) white burn bone layer, assigned culture is side-notched.

L2: ([no thickness given]) black horizon, some burnt bone and soil, considered burnt floor of L1 and top of L3.

L3: ([no thickness given]) "Brownish red horizon" from burning in above layer.

L4: ([no thickness given]) "Greyish-green horizon", lots of burnt black bone with some white bone frags [possibly calcined], sometimes it is brownish red, assigned culture is side-notched.

L5: (arbitrary 6 in levels, 48 in in total) "reddish brown to grey", powdery, no clear stratigraphy within, several bones, it was shored up.

- 1st: mostly side-notched points with some Avonlea points
- 2nd: more Avonlea points, fewer side-notched points
- 3rd: 64 points in total; 1 Plains Triangular and a few possible side-notched points, mostly Avonlea points.
- 4th: multiple Avonlea points, lots of bone
- 5th: multiple Avonlea points, 1 side-notched, burned lenses
- 6th: Avonlea "predominate", east 1/3 burnt, burned bone/ash, black lens [burned or paleosol?]
- 7th: burnt horizon continues
- 8th: top of grey, bone layer, 1 tanged point, some barbed points

L6: (6 in) grey layer

L7: (arbitrary 6 in levels, 54 in in total), dark brown soil, very compacted, several Ah horizons, charcoal, occasional large rocks. Suggested correlation is L9 in the North and bottom of L8/top of L9 in Unit X.

- 1st: no colour change
- "Corrections": Reeves arrived and found the SE corner not deep enough, some was redesignated as L6, rest is top part of L7
- 2nd: grey, little bone, many flakes, 4 points
- 3rd: few bones, soil hard and compacted
- 4th: dark band at 1.9 in deep from start of level [I assume it is a paleosol]
- 5th: dark-brown-grey soil
- 6th: "same-still Pelican Lake" [no soil info given]
- 7th: [no information given] [implied sterile in notes for L8]

- 8TH: [no information given] [implied sterile in notes for L8]
- 9TH: [no information given] [implied sterile in notes for L8]

L8: (1ft arbitrary levels) soft sand, tan-brown yellow to light grey and brown, “caliche staining”, correlates to L8 in test X and L10 in the north. The first artifact was found at ~5 ft [unclear if 5 ft from start of level or 5 ft since previous artifact]. It is listed as a flake and as a fragment of the proximal end a “thin prismatic blade”. The notes say it may be wall fall. At 18 ft below surface “the square was divided in half” to ensure completion by the end of the month, new square is 15x8 square

5x10 (arbitrary 1 ft levels) [I interpret this section of the notes to indicate that quartzite artifacts were found in each of the four levels]. Large rock fall at 8 ft below [what?] on north end. Work ceased on the north end 18 in above “bed rock clay”. South end was dug 2 ft down and then ceased because time out. A small trench was dug on east side until of “clay bedrock”.

Discussion and comments:

- The proposed correlations are confusing given that L7 has both a larger Pelican Lake occupation and a large sterile section.
- The clay bedrock is not mentioned in the 1978 publication. Also, clay is not technically a type of bedrock.
- I am not sure if they reached the target depth.
- I assume the barbed points are Pelican Lake. I’m unsure if the tanged point is also Pelican Lake or Hanna but given stratigraphy Pelican Lae is more likely.
- Unfortunately, no bone from after the first 6 in of L7 is in the RAM collections. It is possible they stopped saving the bone they excavated.
- I assume the 5x10 is the “half” mentioned above and 15x8 may be a typo.
- I assume the “quartzites” found throughout the 5x10 are artifacts of Mummy Cave age based on the Reeves’ 1978 publication.

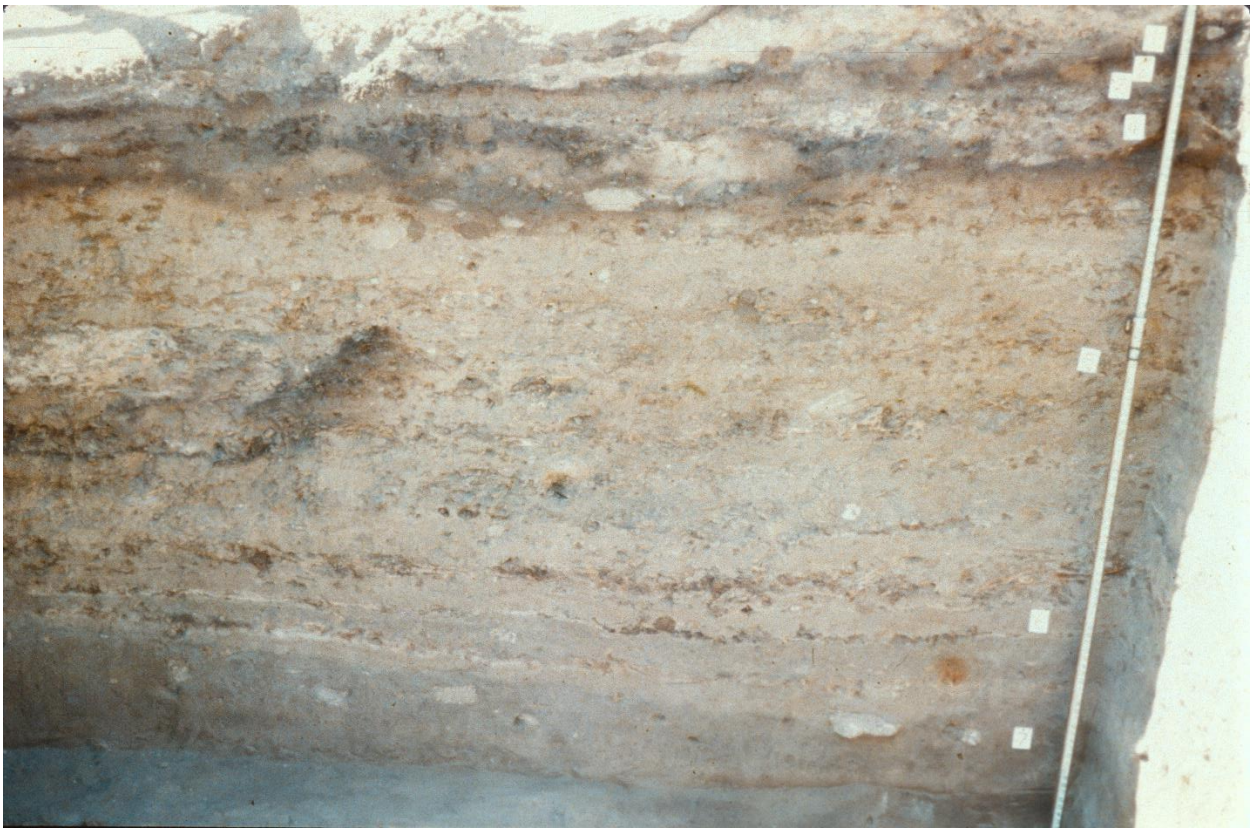


Figure 35: Profile photograph of the South wall of Unit Z Levels 1-7.

Unit C 10 x 12 feet (divided into 5 squares)

Four of the 5 squares were excavated by trowel and all projectile points mapped.

L0: (20-24in) looter's back dirt and rubble

L1[A]: (9in) orange powdery matrix. Burned, calcined and unburned bone

L1[B]: (2in) burned lens related to above

L1[C]: ([thickness not specified]) brown matrix unburned, bone frags, some calcined bone, some looter damage

L2: (10-12in) described as a calcined bone horizon, bottom is black from a burn

L3: (0-5in) bone, hair, hide, intestines, looting on the south edge of the square

L4: (6in) grey-brown matrix, calcined bone, some unburnt bone

L5: (~6in) same colour as L4, burned bone

L6: (18in) light brown (dries to grey) with some bone; Plains side-notched points

L7: (~12in) Top is a greyish Ah horizon (4-5in), the rest is B horizon (6-7in), some bone, Avonlea points

L8: [they stopped at ~12in having not reached the base of this layer] top is an Ah horizon (4in), bone and charcoal. [notes imply Avonlea points were found]

Discussion and comments:

- No maps of the projectile points have been sent to the RAM.
- From the wording, it is likely that L1A-L5 is Old Woman's and L8 is Avonlea

Figure 36: Profile photograph of Unit C Levels 1-8.

Unit Y (10 x 15 [feet])

NB: Thicknesses are from Ludwick Y-Z because the notes said to get them from there.

L1: (YZ 1 ∴ 0.5ft) sod, sandstone frags

L2: (YZ 2/3 ∴ 0.8ft but varies) burnt layer and bone at the bottom, [claimed to be] last jump, possibly multiple jumps

L3A: (YZ 4-6 ∴ 1.25ft) brownish red, “dark grey brown” on the west side, lots of burned and not burned bone

L3B: (YZ 7 ∴ 1ft) “white bone burn horizon” [calcined?], pinches out

L4: (YZ 8 ∴ 0.25ft) burnt soil due to overlying fire

L5: ([no thickness discernable]) “notched chopper”

--------Excavations ceased as it now correlates with Z--------

Discussion and comments:

- No bone from this unit is in the RAM.
- The notes claim that L2 of this unit represents the last jump but no evidence, such as musket balls or early bullets, are mentioned.

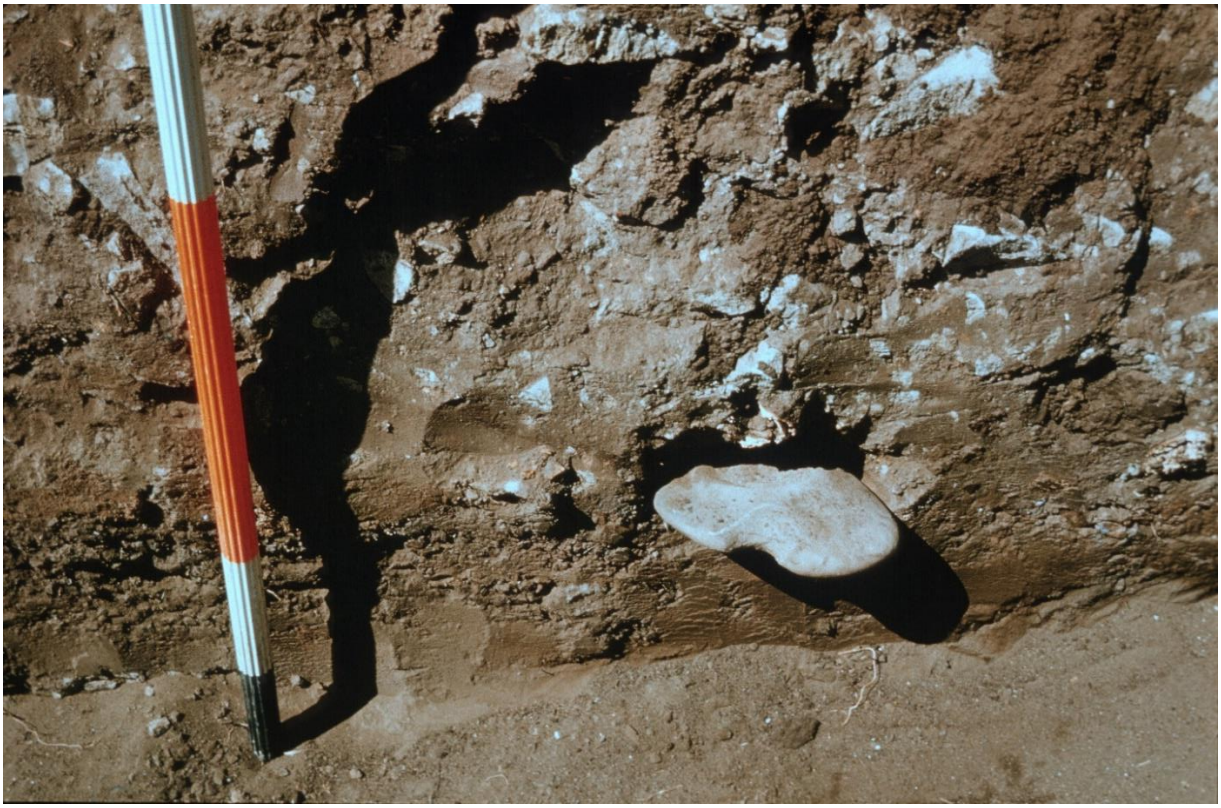


Figure 37: Notched chopper recovered from Unit Y *in situ*.

Composite Profile of South Area [thicknesses in feet]

This was used to make the diagram in Reeves' 1978 publication.

L1: (0-1.0)
This layer is described as "sod/Ah/black soil" and as sterile overburden, some sandstone rubble from quarry, Y has an Ah horizon on either side of rubble. Some bone fragments near the bottom of the level.

L2: (1.0-1.5) =B1, B2, Y2, BE1 (sic), BE2 (sic)
This layer is described as ranging in colour from orange-brown to red. The top was classified as an Ah horizon and the bottom as an Bm horizon. Plenty of bone, none of which is burnt. In excavation Y it appears there are three distinct uses of the jump separated by soil. However, the bone is monolithic in excavation B. [Given there are approximately 70ft between Y and B. How wide of an aperture does he think the bison are pouring out of?]

L3: (1.5-3.0) =B3, A2, A3, BE3 (sic), AE2 (sic)
Matrix is brown to grey (7.5YR 2/2 – 10YR 8/2). There is lots of burnt and unburnt bone but no calcined bone in addition to sandstone fragments.

L4: (3.0-4.5) =A4, A5, B4, C1, Y3A, AE4 (sic), [AE5 probably as well]
This layer is described as having a brown to reddish brown matrix with a dark grey-brown soil. There is unburned bone and some burnt and calcined bone in addition to sandstone fragments.

L5: (4.5-5.9) =A6, A7, C2, C3, Y3B, AE6 (sic), 21 (sic) [I don't know what this 21 means]
This layer is described as a bone horizon with an orange-white bone dust matrix. The top is burnt and calcined with an abrupt transition to an unburned section containing hair, hide, horn sheaths and intestine fragments.

L6a: (5.9-7.1) =A8, C4, Z2, Z3, Y4, Y5
L6b: (7.1-7.9) =A9, C5, Z4
This layer is described as a "Greyish brown-brownish red – dark brown horizon". Unburnt, burnt and calcined bone present throughout with burnt material more common in 6b than 6a. Calcined bone scatter defines the boundary between the sublevels.

L7a: =A10 [0]-6[in], A10 6-12[in], Z5 0-6[in], X2, C6
L7b: =A10 12-18[in], Z5 6-12[in], X3
(7.9-9.4) This layer has a powdery matrix that is light brown but dries to grey. 7a is chocolate brown while 7b is just described as brown. Most bone unburnt. Hair and horn sheaths present. Some sandstone present.

L8a: (9.4-9.9) =A[10] 18-25[in] (sic), Z[5] 12-18[in], [seems to include C7]
L8b: (9.9-10.4) =A[10] 24-30[in], Z[5] 18-25[in] (sic), [seems to include C7]
This layer is described as a burnt pseudo soil (sic) that consists of a grey coloured “Ah-like” horizon labelled ‘8a’ and a more brown coloured yet less organic rich Bm horizon labelled ‘8b’. Bone lenses and sandstone pieces are present in in both.

L9a: (10.4-11.5) =A10 30-36[in], Z[5] 24-30[in], C8 x 4 (sic) [does this mean X4?]
L9b: (11.5-11.2 (sic)) =A10 36-42[in], Z[5] 30-36[in]
L9c: (11.2-13.4) =A10 42-48[in], Z[5] 36-42[in]

L10a: (0.5ft) =A11 0-6[in], Z5 42-48[in], [seems to include X5]
L10b: (0.5ft) =A11 6-12[in], A12, Z5 48-54[in], Z6 [seems to include X5]
Layer 10 is described as “two soil like units”. L10a is described as “Ah like” and that is a sandy soil that is grey coloured with organic black staining. It contains ash [I assume from burning and not volcanic] and bone. L10b is described as a brownish grey soil in which sandstone pieces are more common than in L10a and bone is less common.

L11: (3.5ft)

- a: =A13 0-6[in], Z7 0-6[in]
- b: =A13 6-12[in], Z7 6-12[in]
- c: =A13 12-18[in], Z7 12-18[in] [the alignment is off on the page but it seems to also include =X6]
- d: =A13 18-24[in], Z7 18-24[in]
- e: =A13 24-30[in], Z7 24-30[in]
- f: =A13 30-36[in], Z7 24-30[in]
- g: =A13 36-42[in], Z7 24-30[in]

This layer is described as a sandy soil with a dark grey colour. It contains substantial sandstone from earlier rock falls concentrated at the lower levels. The largest ones among these blocks were dynamited. There is an Ah horizon at the top of the layer with another 1.5ft below surface.

L12: (0.5ft) =A14, Z7 30-36[in], X6 12-18[in] [there is an ‘X’ overlapping the ‘6’ in ‘X6’]
This layer is an Ah horizon that is dark in colour and contains debris from rock falls.

L13: (2.5ft)

- a: A15 0-6/6-12[in], Z7 36-42[in]
- b: =A15 12-18[in], Z7 42-48[in], X7 0-6[in] [X7 is not in line on the page so could be L13c]
- c: =A15 18-24/24-30[in]

This layer is described as a sandy soil with a dark brown colour. Sandstone pieces from ancient rock falls are common. The layer is water rich with unburned bone.

L14: (1ft) =A16, A15 30-36/36-42[in], Z7 48-54[in], X7 6-12[in]
[Its difficult to tell from the notes if this level is one or two paleosols] It is described as an dark brown Ah horizon paleosol. It is topped by a 0.1ft thick “charcoal burn” lens. There is some bone in it.

L15: (21.9-27.9) =A18 (6ft thick), “XU8” [I think Z8?, if so its 4ft thick]
This layer is described as a “Grey-brown sandy soil”. Ah paleosol “2.6[ft?] below tio (sic) [top?] of unit”, no sandstone present. Considered archaeologically sterile [despite some bone frags and charcoal at the top].

L16a: (27.9-28.6) =A19a, A19b, Z 1-12[in] [where is X?]
Described as an Ah paleosol within the C horizon.
L16b: (28.6-29.2) =A20a, A20b, “Z9L2-24)” (sic) [Z12-24in?]
Described as an Ah paleosol within the C horizon.
L16c: (29.2-29.6) =A21, Z 24-36/36-48[in]
Described as an Ah paleosol within the C horizon.

L17: (5ft) [no specific correlation given, only mentioned for excavation Z] described as light grey-white fine silt/sand (sic) that’s compact. Under the 5ft is a sandstone cobble [why only 1?] which marks a discontinuity between the silt and the Willow Creek formation. It is a sterile C horizon.

Discussion and comments:

- They fail to mention every excavation unit in the correlations for each level leading to some confusion, especially regarding unit X in the deeper layers.
- XU means excavation unit (Dawe, pers comm).
- In L15 the “XU8” is unclear. Does it mean level 8 of unit X?
- In none of the unit specific notes do they mention digging all the way through the silt level.

North Excavation Area 20 x 20 feet (total depth is 15 feet)

L1: (0-0.8ft) Ah horizon/sod, discontinuous burnt floor, sandstone frags, bones and artifacts from the sod down, culture is unspecified Precontact [likely Old Woman's side notched]

L2A: (0.8-1.6ftt) grey-brown reddish coloured matrix, burnt on the top and bottom, some sandstone, lots of bone, artifact typology was indeterminable.
L2B: (1.6-2.3ft) "grey-brown grey" lots of bone, floor discontinuously burned, assigned Avonlea and side-notched
L2C: (2.3-2.7ft) top is a "fine N.S. less soil", grey to brown based on burning, grey at the bottom with more sandstone frags, lots of bone -none of it burned, assigned Avonlea

L3: (2.7-3.6ft) "dark grey blackish" matrix, slightly more sandstone frags than above, the regular notes subdivide this level based on the three burn lenses but the natural stratigraphy notes claim these are too poorly defined, this is fine since those notes can't decide if the third burn should be part of L4 or not, unburned bone and calcined bone, Besant with some Pelican Lake near the bottom of the stratum

L4: (3.6-4.7ft) top is a burnt soil horizon, this grades into a chocolate brown soil [nat strat] or top is a light brown burnt soil that grades greyer until a discontinuous burnt layer is reached with the whole stratum being brown in the E, assigned Pelican Lake but a pincher point was also found near the top of the stratum

L5: (4.7-5.3ft, 2 arbitrary levels [I assume 0.3ft]) "reddish brown" soil [nat-strat] or "grey reddish soil", little sandstone, bottom burnt, lots of bone or little bone [I found more than 100 identifiable pieces in the collection], assigned Pelican Lake

L6: (5.3-5.6ft) burned black and grading downwards to a reddish brown, bottom also burned, some sandstone, assigned Pelican Lake

L7: (5.6-6.2ft) dark grey soil overlaid by red-stained matrix, little sandstone, bones, assigned Pelican Lake

L8: (6.2-6.6ft) grey to brown soil, described as an "Ah like horizon", little sandstone, some bone, discontinuous burn evidence across the bottom, assigned Pelican Lake

L9: (6.6-8ft) brown or dark brown grey-ish horizon, described as "B [horizon] like", little sandstone, some bone, some charcoal,

L10: (1ft arbitrary levels, ~3ft in the 1978 diagram) Homogenous gold-coloured sands, lots of bone [according to main notes, natural stratigraphy notes say only a little bone], several quartzite flakes and retouched [flakes], 1 Pelican Lake point with the sand adhered to it [seems to have been redesignated as Mummy Cave in the publication]

L11: [thickness not specified] Grey sand, cultural materials [are noted but not specified]

Comments and discussion:

- Based on the fact the Pincher point is not mentioned in the 1978 publication or elsewhere, it seems he changed his mind about its identification.
- Layer 11 is mentioned in the North area notes but not the North area natural stratigraphy document and thus the above description is strictly from the North area notes. The North area natural stratigraphy document describes layer 10 as going from 8ft depth from surface to 15ft depth from surface which corresponds to L10+L11 on the publication. This is likely why according to main notes there is a lot of bone in L10 while the natural stratigraphy notes say only a little, it was less relative to the total volume. Both documents claim the floor of the excavation is a sandstone rockfall.
- A hole was excavated through the sandstone rockfall the horizontal dimensions of which are not listed. The hole went through 4ft of sandstone rockfall until they hit another sandstone block which they suspected was bedrock. The contents of the hole were described as sterile. This is where the North area excavations ended. The notes claim that what they “should” have found is a fine grained grey aeolian sand underlaid by a yellow siltstone that they think is the Willow Creek Formation. Based on the notes, it seems they never found that sand or the siltstone.

Correlations for the North Area

1= “level” 10E0S, 15E0S, 20E0S, 30E0S, 40E0S, 40E2.5S, 40E0S (sic)

2A= “layer 2A” 10E0S, 15E0S, 20E0S, 40E0S, 40E2.5S

2B= “layer 2B” 15E0S, 20E0S, 30E0S, 10E0S, 40E0S, 40E2.5S

2C= “layer 2C” 15E0S, 20E0S, 40E0S, 40E2.5S, 10E0S

3= “layer 3” 0S0E, 5S0E, 10E0S, 15E0S, 20E0S, 30E0S, 40E0S, 40E2.5S; N-3 L0; N-4 L0, L1; N-5 L3

4= “layer 4” 0S0E, 10E0S, 15E0S, 40E0S, 40E2.5S; N-4 L2; N-5 L4

5= “layer 5” 40E0S; 40E2.5S; N-4 L3

6= “layer 6” 40E0S; N-4 L4; N-5 L5

7= 40E0S; N-4 L5

8= 40E0S 8, 9; 1054E 19-24, 14-19; N-3 L3; N-4 L6 [lowest part of the level]

9= 40S0E 9, “North Excavation 1972, Layer 4” [I’m not clear on the meaning of this]

10a= 40E0S 10(1-6); N-1 L2, L3, L4; N-3 L5; N-4 L7, L9; N-5 L6, L7, L8

10b= 40E0S 10(6-12); N-1 L5; N-3 L6; N-4 L9; N-5 L9

10c= 40E0S 10(12-18); N-1 L6; N-3 L7; N-4 L10; N-5 L10

10d= 40E0S 10(18-24); N-1 L7, L8; N-2 L1; N-4 L11; N-5 L11

Table 5: Correlations between Reeves' (1978) stratigraphic diagram of the South Area and the field unit levels recorded in his notes.

Correlated figure 17.16 South Area in Reeves (1978)	Excavation A	Excavation Z	Excavation X	Excavation B	Excavation C	Excavation Y	Projectile points
Level 1							sterile overburden
Level 2				1, 2		2	Metal points
Level 3	2, 3			3			Old Woman's
Level 4	4, 5			4		3A	Old Woman's
Level 5	6, 7				2, 3		
Level 6a	8	2			4	4, 5	
Level 6b	9	4			5		
Level 7a	10 (0-6, 6-12in)	5 (0-6in)	2		6		Old Woman's, Avonlea
Level 7b	10 (12-18in)	5 (6-12in)	3				Old Woman's, Avonlea
Level 8a	10 (18-24in)	5 (12-18in)			7?		Old Woman's, Avonlea
Level 8b	10 (24-30in)	5 (18-24in)			7?		Avonlea
Level 9a	10 (30-36in)	5 (24-30in)	4?		8		Avonlea
Level 9b	10 (36-42in)	5 (30-36in)					Avonlea
Level 9c	10 (42-48in)	5 (36-42in)					Avonlea
Level 10a	11 (0-6in)	5 (42-48in)	5?				
Level 10b	11 (6-12in), 12	5 (48-54in), 6	5?				Pelican Lake; Avolea?
Level 11a	13 (0-6in)	7 (0-6in)					Avolea?
Level 11b	13 (6-12in)	7 (6-12in)					Pelican Lake
Level 11c	13 (12-18in)	7 (12-18in)	6?				Besant?
Level 11d	13 (18-24in)	7 (18-24in)					Besant
Level 11e	13 (24-30in)	7 (24-30in)					
Level 11f	13 (30-36in)	7 (24-30in)					
Level 11g	13 (36-42in)	7 (24-30in)					Hanna
Level 12	14	7 (30-36in)	6 (12-18in)?				Pelican Lake
Level 13a	15 (0-6, 6-12in)	7 (36-42in)					Hanna
Level 13b	15 (12-18in)	7 (42-48in)	7?				Pelican Lake?
Level 13c	15 (18-24, 25-30in)		7?				Hanna; Pelican Lake?
Level 14	15 (30-36, 36-42in), 16	7 (48-54in)	7 (6-12in)				Hanna?; Pelican Lake?
Level 15	18	probably 8	8, 9, 10, 11*				sterile & unknown
Level 16a	19a, 19b	0-12	missing				Quartzite artifacts**
Level 16b	20a, 20b	12-24?	missing				Quartzite artifacts**
Level 16c	21	24-36, 36-48	missing				Quartzite artifacts**
Level 17							sterile

*Found in Smith (1980) rather than Reeves' notes

**Later determined to be Mummy Cave in Reeves (1978)

Table 6: Correlations between Reeves' (1978) stratigraphic diagram of the North Area and the field unit levels recorded in his notes.

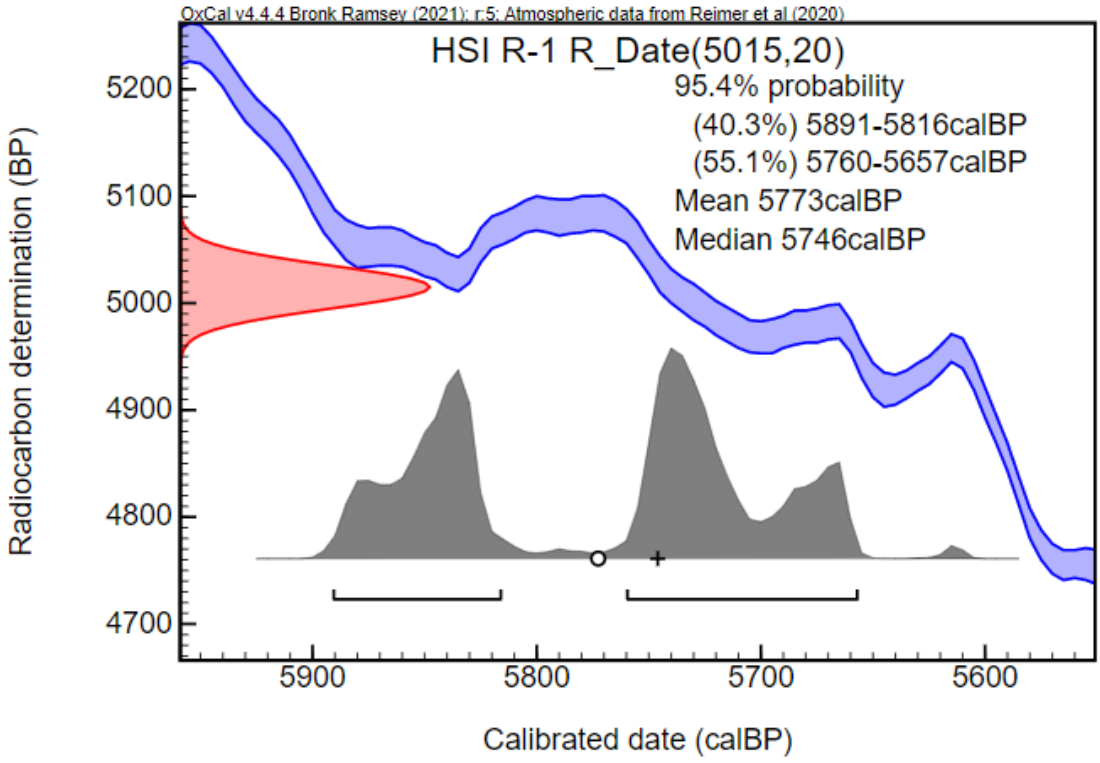
Correlated figure 17.16 North Area in Reeves (1978)	N-1	N-2	N-3	N-4	N-5	Trench	Projectile points
Level 1						10E0S, 15E0S, 20E0S, 30E0S, 40E0S, 40E2.5S, 40E0S (sic)	Old Woman's
Level 2a						10E0S, 15E0S, 20E0S, 40E0S, 40E2.5S	indeterminable
Level 2b						15E0S, 20E0S, 30E0S, 10E0S, 40E0S, 40E2.5S	Old Woman's, Avonlea
Level 2c						15E0S, 20E0S, 40E0S, 40E2.5S, 10E0S	Avonlea
Level 3			0	0, 1	3	0S0E, 5S0E, 10E0S, 15E0S, 20E0S, 30E0S, 40E0S, 40E2.5S	Besant, Pelican Lake
Level 4				2	4	0S0E, 10E0S, 15E0S, 40E0S, 40E2.5S	Pelican Lake*
Level 5				3		40E0S; 40E2.5S	Pelican Lake*
Level 6				4	5	40E0S	Pelican Lake*
Level 7				5		40E0S	Pelican Lake*
Level 8			3	6		40E0S 8, 9; 1054E 19-24, 14-19	Pelican Lake*
Level 9						40S0E 9	none
Level 10a	2, 3, 4		5	7, 9	6, 7, 8	40E0S 10(1-6)	Quartzite artifacts**
Level 10b	5		6	9	9	40E0S 10(6-12)	Quartzite artifacts**
Level 10c	6		7	10	10	40E0S 10(12-18)	Quartzite artifacts**
Level 10d	7, 8	1		11	11	40E0S 10(18-24)	Quartzite artifacts**

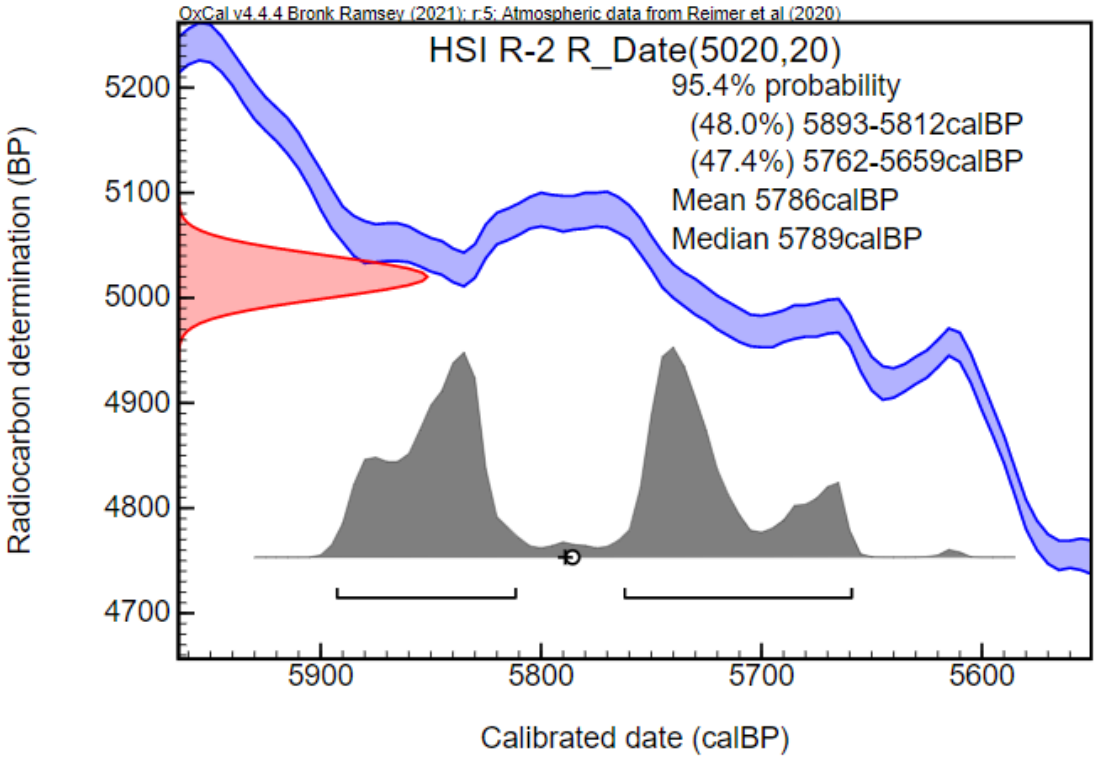
*Notes say it was assigned Pelican Lake, rather than claiming that they found any specific point type

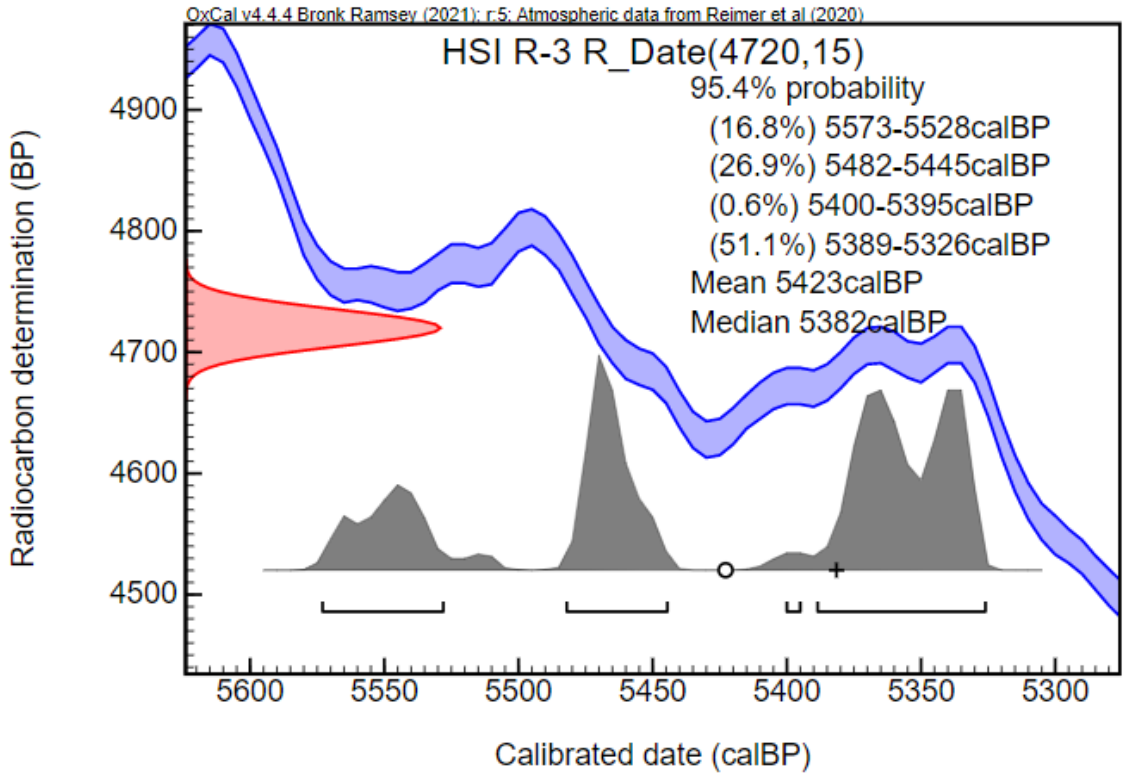
**Later determined to be Mummy Cave in Reeves (1978)

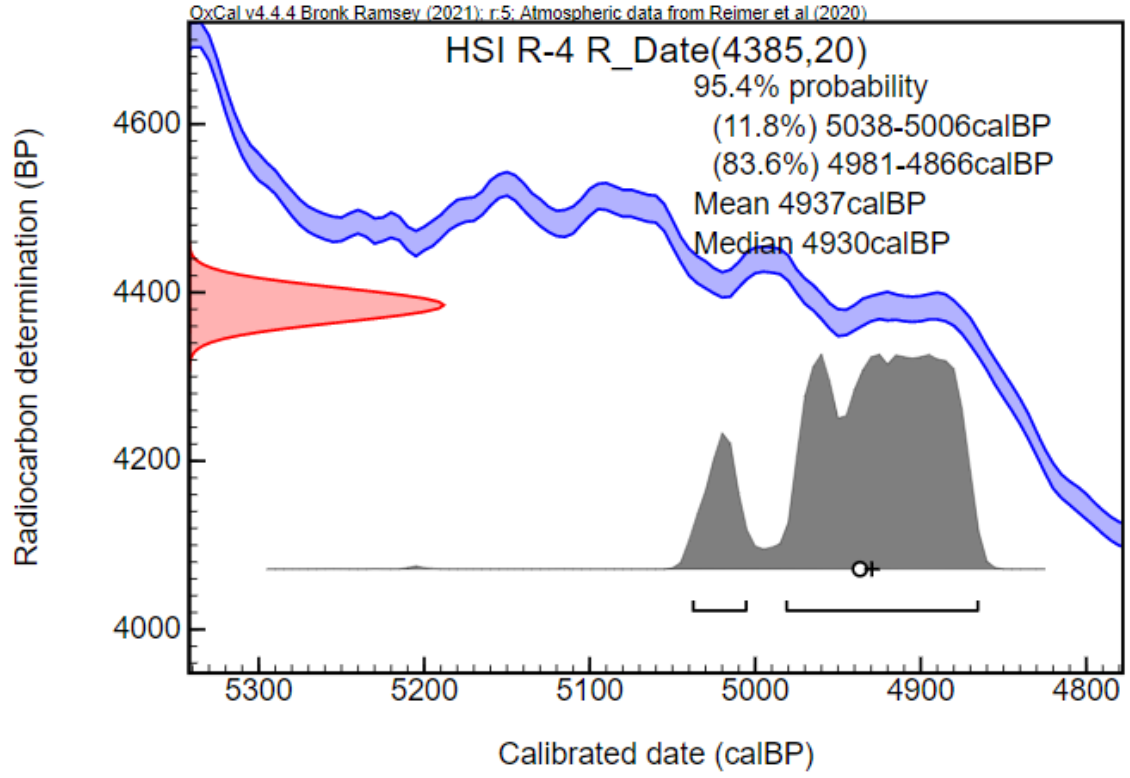
Appendix 2

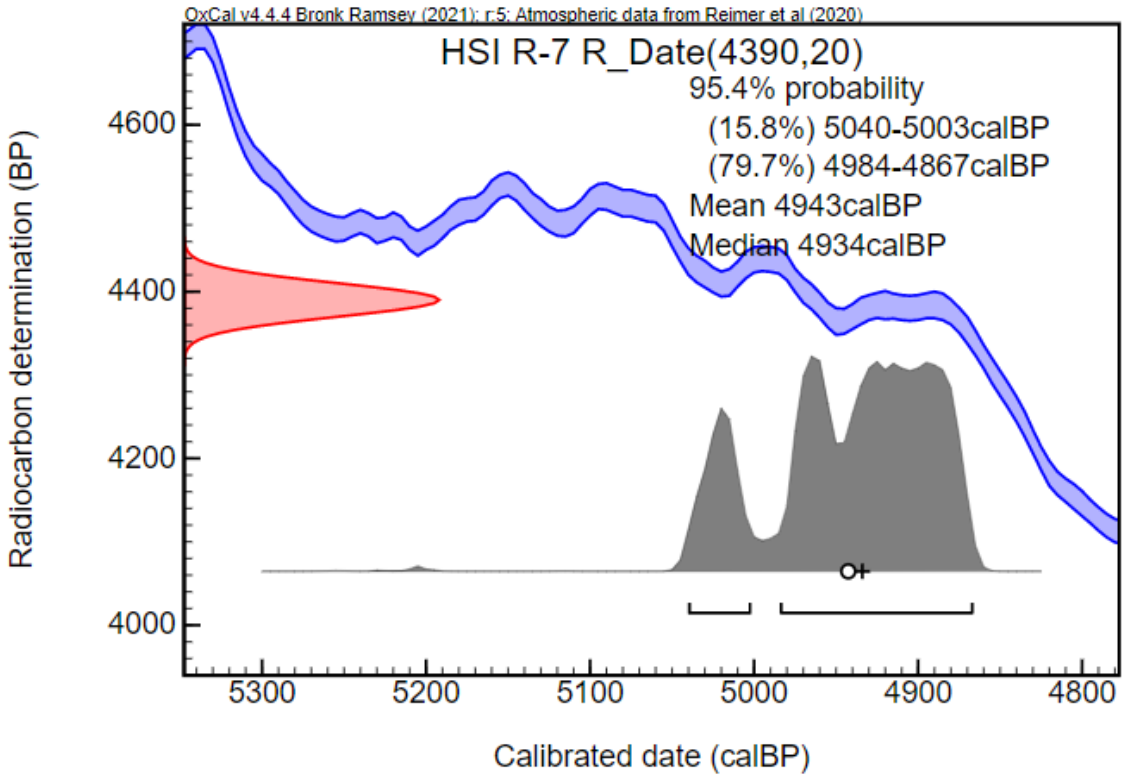
The following are the calibration curves for the new AMS radiocarbon dates from the HSIBJ kill site.

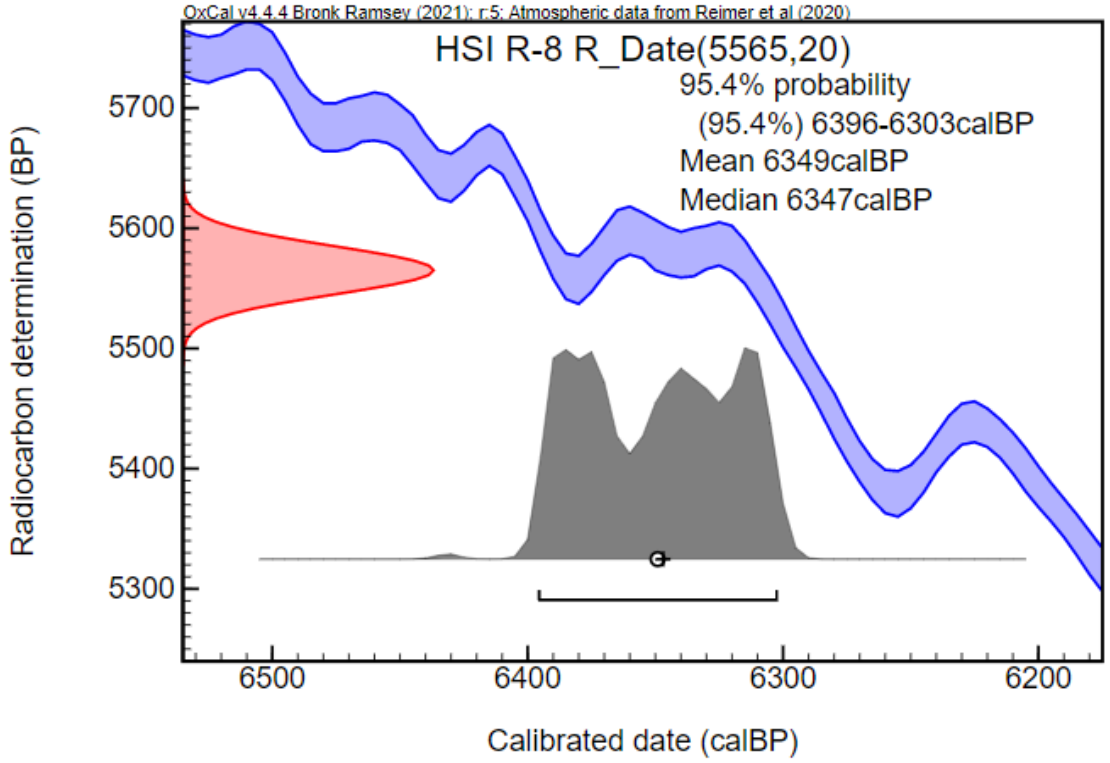


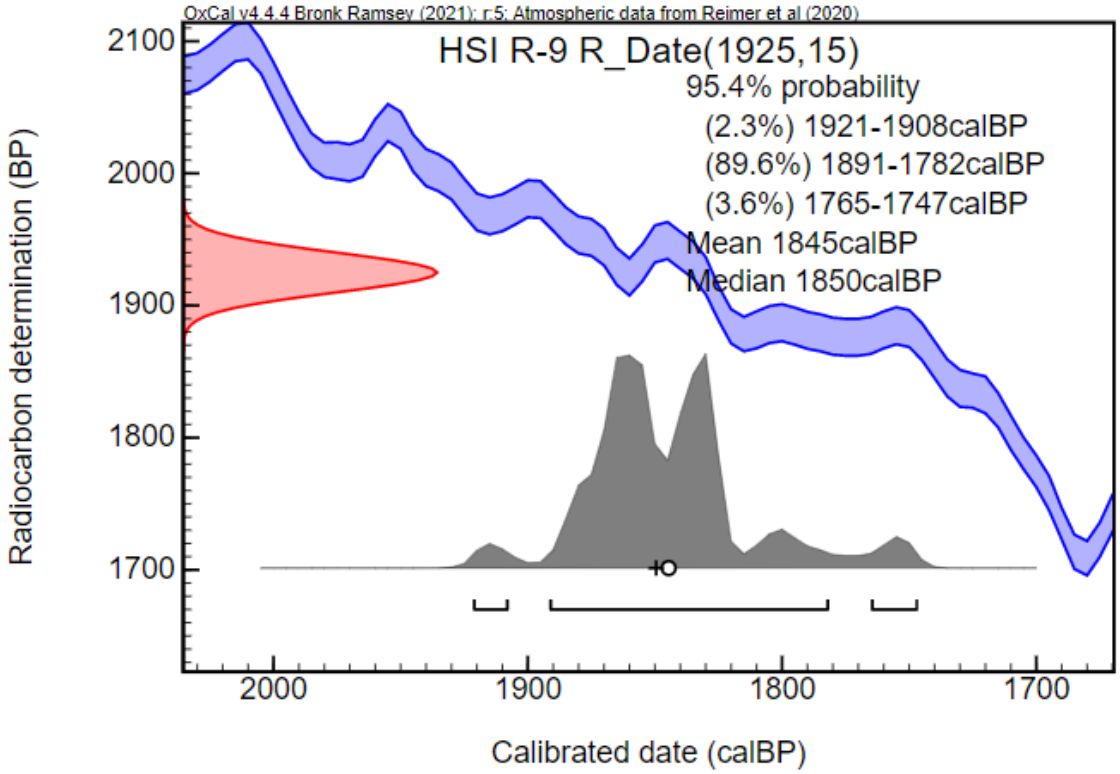

OxCal v4.4.4 Bronk Ramsey (2021); r:5; Atmospheric data from Reimer et al (2020)
HSI R-2 R_Date(5020,20)
95.4% probability
(48.0%) 5893-5812calBP
(47.4%) 5762-5659calBP
Mean 5786calBP
Median 5789calBP
Radiocarbon determination (BP)
5200
5100
5000
4900
4800
4700
5900
5800
5700
5600
Calibrated date (calBP)

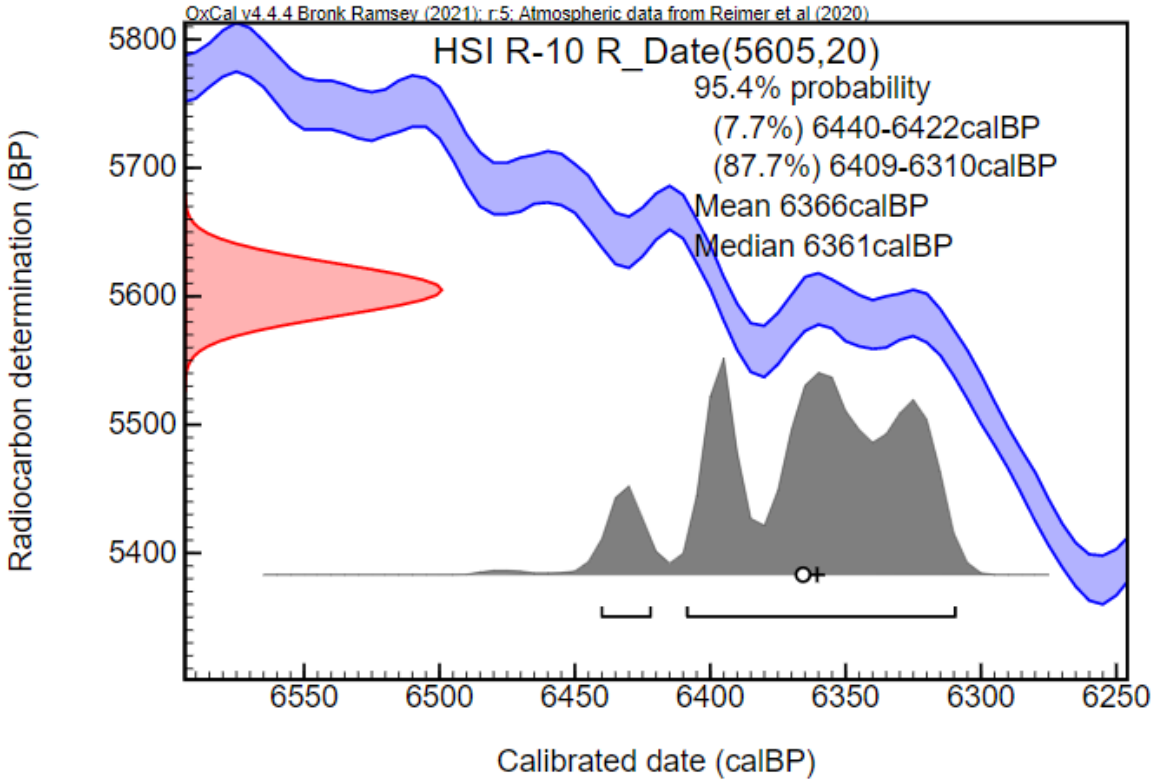

OxCal v4.4.4 Bronk Ramsey (2021); r:5; Atmospheric data from Reimer et al (2020)
HSI R-3 R_Date(4720,15)
95.4% probability
(16.8%) 5573-5528calBP
(26.9%) 5482-5445calBP
(0.6%) 5400-5395calBP
(51.1%) 5389-5326calBP
Mean 5423calBP
Median 5382calBP
Radiocarbon determination (BP)
4900
4800
4700
4600
4500
5600
5550
5500
5450
5400
5350
5300
Calibrated date (calBP)

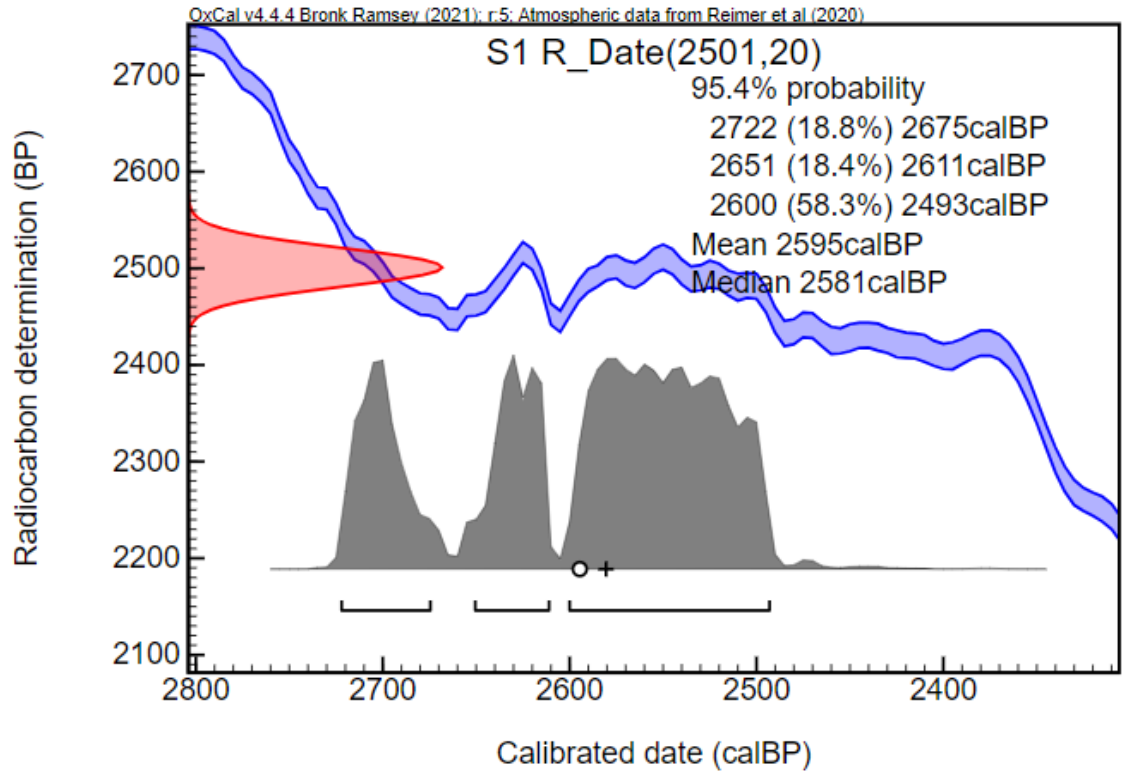

OxCal v4.4.4 Bronk Ramsey (2021); r:5; Atmospheric data from Reimer et al (2020)
HSI R-4 R_Date(4385,20)
95.4% probability
(11.8%) 5038-5006calBP
(83.6%) 4981-4866calBP
Mean 4937calBP
Median 4930calBP
Radiocarbon determination (BP)
4600
4400
4200
4000
5300
5200
5100
5000
4900
4800
Calibrated date (calBP)

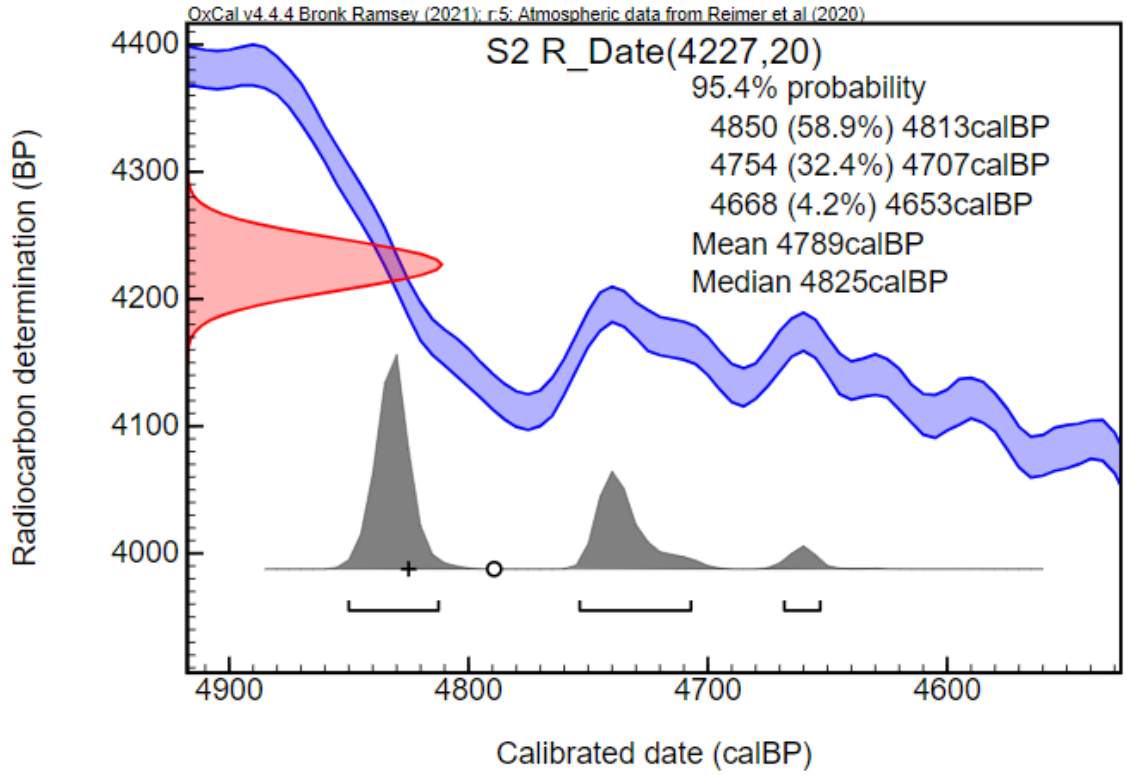

OxCal v4.4.4 Bronk Ramsey (2021); r:5; Atmospheric data from Reimer et al (2020)
HSI R-7 R_Date(4390,20)
95.4% probability
(15.8%) 5040-5003calBP
(79.7%) 4984-4867calBP
Mean 4943calBP
Median 4934calBP
Radiocarbon determination (BP)
4600
4400
4200
4000
5300
5200
5100
5000
4900
4800
Calibrated date (calBP)

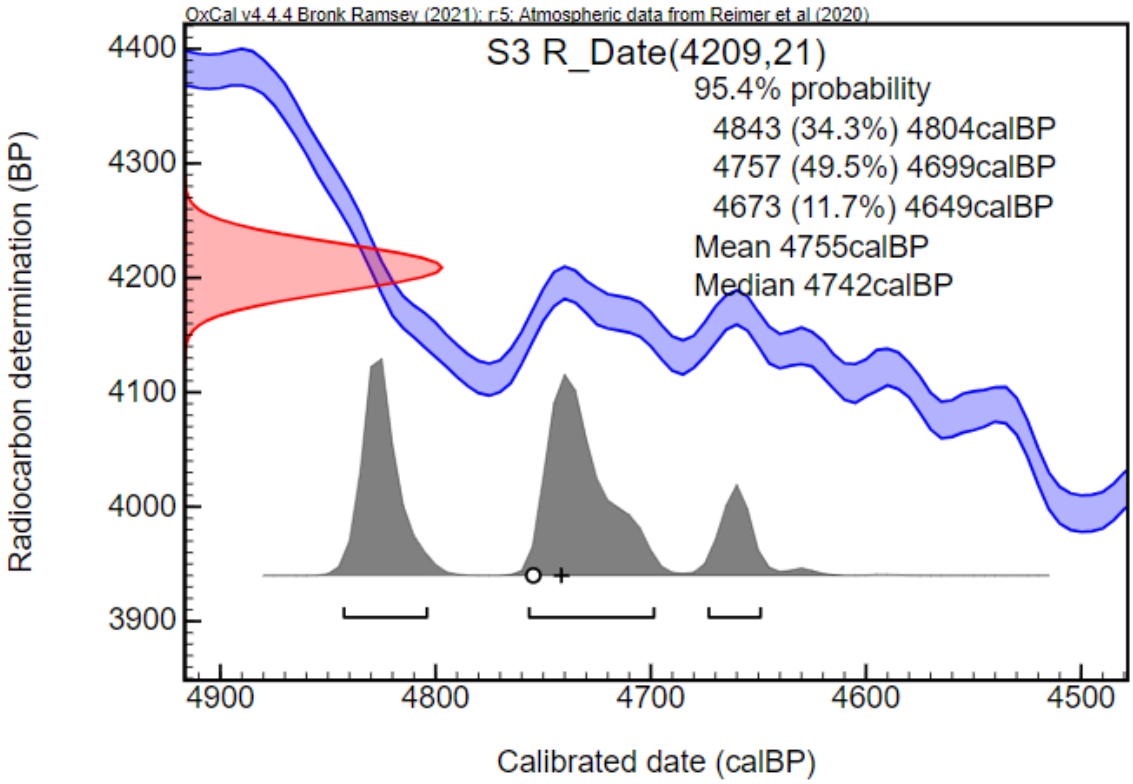

OxCal v4.4.4 Bronk Ramsey (2021); r:5; Atmospheric data from Reimer et al (2020)
HSI R-8 R_Date(5565,20)
95.4% probability
(95.4%) 6396-6303calBP
Mean 6349calBP
Median 6347calBP
Radiocarbon determination (BP)
5700
5600
5500
5400
5300
6500
6400
6300
6200
Calibrated date (calBP)

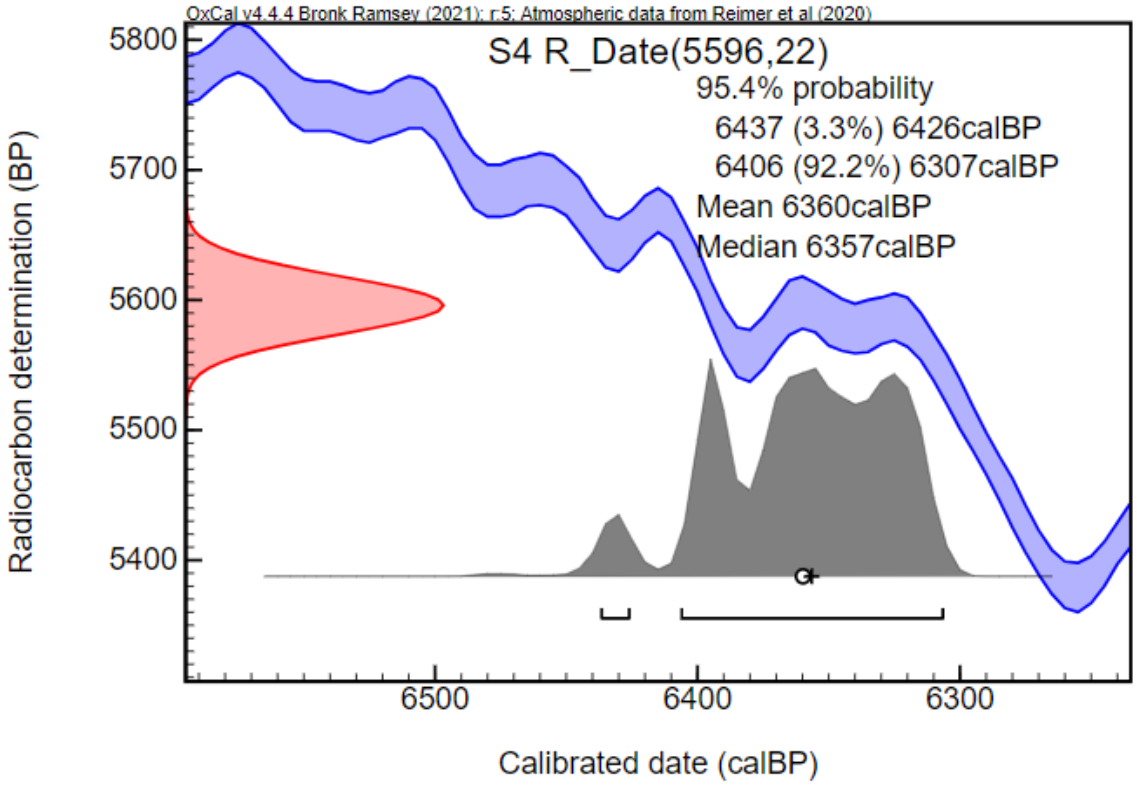

OxCal v4.4.4 Bronk Ramsey (2021); r:5; Atmospheric data from Reimer et al (2020)
HSI R-9 R_Date(1925,15)
95.4% probability
(2.3%) 1921-1908calBP
(89.6%) 1891-1782calBP
(3.6%) 1765-1747calBP
Mean 1845calBP
Median 1850calBP
Radiocarbon determination (BP)
2100
2000
1900
1800
1700
2000
1900
1800
1700
Calibrated date (calBP)

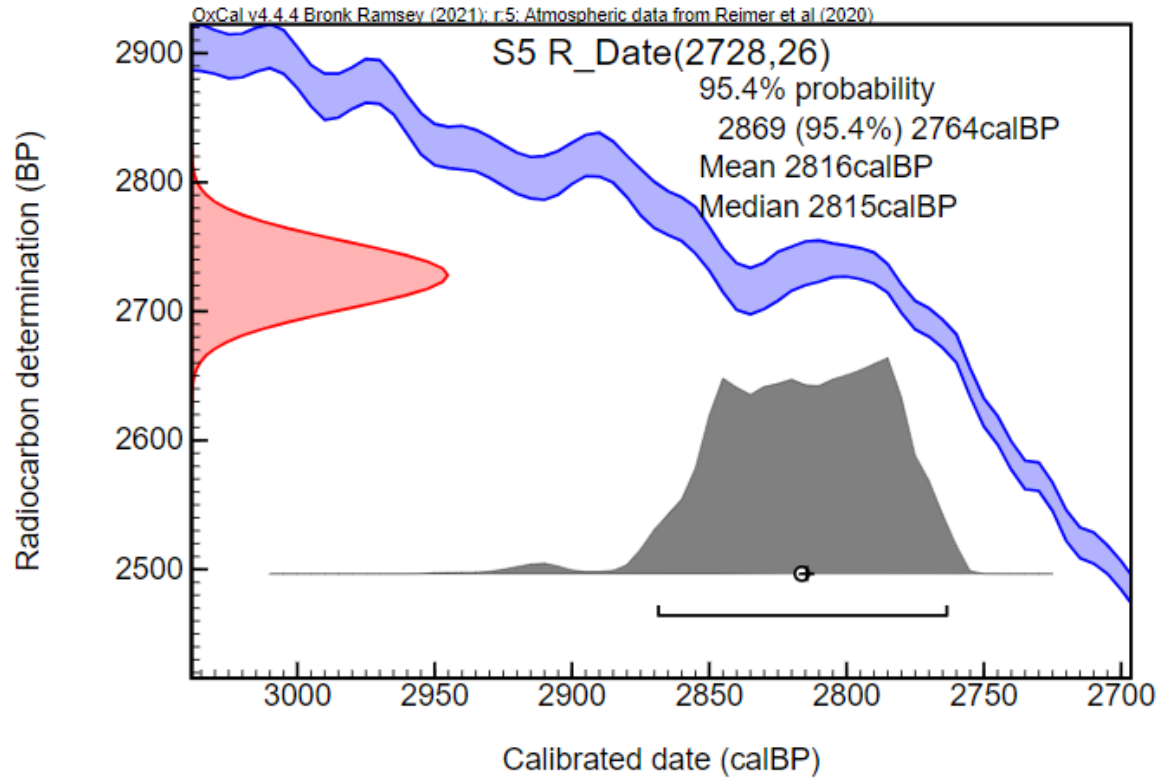

OxCal v4.4.4 Bronk Ramsey (2021); r:5; Atmospheric data from Reimer et al (2020)
HSI R-10 R_Date(5605,20)
95.4% probability
(7.7%) 6440-6422calBP
(87.7%) 6409-6310calBP
Mean 6366calBP
Median 6361calBP
Radiocarbon determination (BP)
5800
5700
5600
5500
5400
6550
6500
6450
6400
6350
6300
6250
Calibrated date (calBP)

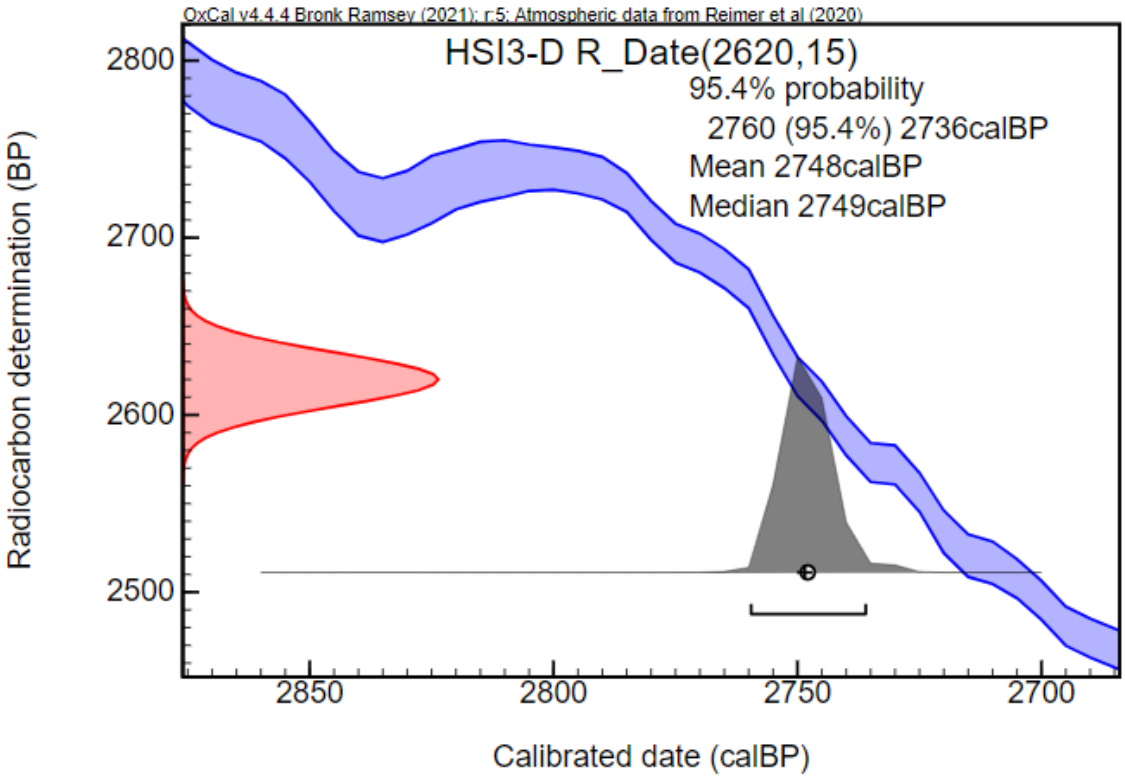

OxCal v4.4.4 Bronk Ramsey (2021); r:5; Atmospheric data from Reimer et al (2020)
S1 R_Date(2501,20)
95.4% probability
2722 (18.8%) 2675calBP
2651 (18.4%) 2611calBP
2600 (58.3%) 2493calBP
Mean 2595calBP
Median 2581calBP
Radiocarbon determination (BP)
2700
2600
2500
2400
2300
2200
2100
2800
2700
2600
2500
2400
Calibrated date (calBP)


OxCal v4.4.4 Bronk Ramsey (2021); r:5; Atmospheric data from Reimer et al (2020)
S2 R_Date(4227,20)
95.4% probability
4850 (58.9%) 4813calBP
4754 (32.4%) 4707calBP
4668 (4.2%) 4653calBP
Mean 4789calBP
Median 4825calBP
Radiocarbon determination (BP)
4400
4300
4200
4100
4000
4900
4800
4700
4600
Calibrated date (calBP)


OxCal v4.4.4 Bronk Ramsey (2021); r:5; Atmospheric data from Reimer et al (2020)
S3 R_Date(4209,21)
95.4% probability
4843 (34.3%) 4804calBP
4757 (49.5%) 4699calBP
4673 (11.7%) 4649calBP
Mean 4755calBP
Median 4742calBP
Radiocarbon determination (BP)
4400
4300
4200
4100
4000
3900
4900
4800
4700
4600
4500
Calibrated date (calBP)


OxCal v4.4.4 Bronk Ramsey (2021); r:5; Atmospheric data from Reimer et al (2020)
S4 R_Date(5596,22)
95.4% probability
6437 (3.3%) 6426calBP
6406 (92.2%) 6307calBP
Mean 6360calBP
Median 6357calBP
Radiocarbon determination (BP)
5800
5700
5600
5500
5400
6500
6400
6300
Calibrated date (calBP)


OxCal v4.4.4 Bronk Ramsey (2021); r:5; Atmospheric data from Reimer et al (2020)
S5 R_Date(2728,26)
95.4% probability
2869 (95.4%) 2764calBP
Mean 2816calBP
Median 2815calBP
Radiocarbon determination (BP)
2900
2800
2700
2600
2500
3000
2950
2900
2850
2800
2750
2700
Calibrated date (calBP)


OxCal v4.4.4 Bronk Ramsey (2021); r:5; Atmospheric data from Reimer et al (2020)
HSI3-D R_Date(2620,15)
95.4% probability
2760 (95.4%) 2736calBP
Mean 2748calBP
Median 2749calBP
Radiocarbon determination (BP)
2800
2700
2600
2500
2850
2800
2750
2700
Calibrated date (calBP)

Appendix 3

Head-Smashed-In Buffalo Jump Zooarchaeological Report

The following section is a summary of Smith's (1980) report.

North Area

Mummy Cave

Demographics and seasonality

10a:

- MNI: Nine based on nine right astragali
- Ages based on mandibles: one at 0-2.5, one at 1.5-2.5, one late adolescence [3.5-4.5 years], three "early maturity", two "mature"
- Normal cow-calf herd
- Sex and age based on astragalus: one immature female, four as mature female and/or immature male, and three as mature male
- No seasonality indicators

10b:

- MNI: six based on six right astragali
- one at 3.5-4.5 years (late adolescence), one at full maturity (5.5-9.5 years), and one in old age at 9.5-13.5 years [based on mandibular teeth], one at less than 1.5 years [based on proximal phalanges]
- one male and one female individual [based on phalanges]
- one immature female, three mature female/immature male and one mature male [based on astragali] [they add that the one mature male is based on large fragments, not a whole astragalus] [it could be *Bison antiquus occidentalis*]
- No seasonality indicators

10c:

- MNI: 12 based on aged mandible teeth
- two immature individuals (one at 0-1.5 years and one at 1.5-2.5 years); one individual at 2.5-3.5 years (early adolescence); three at late adolescence at 3.5-

4.5 years; two nearly maturity (4.5-5.5 years); two at full maturity (5.5-9.5 years); and, two in old age (9.5 years or more)

- normal cow-calf herd
- eight mature females and/or immature males (66.7%) and one immature female (8.3%) (based on astragali) + two mature males (16.7%) based on astragali and metapodials
- Unable to determine seasonality

10d:

- MNI: 4 based on aged mandible teeth
- One individual is immature at 1.5-2.5 years, one in late adolescence at 3.5-4.5 years, one in early maturity at 4.5-5.5 years, and one is mature at 5.5-9.5 years.
- normal cow-calf herd
- Unable to determine seasonality

Mummy Cave Processing Analysis

Head:

- Representation of the skull and mandible is “low-moderate”
- evidence for removal of brain, tongue, nasal gristle, mandible marrow

Axial skeleton:

- Few vertebral body fragments discarded after trunk segmentation
- A few mostly proximal rib fragments discarded after rib cage removal

Front limb:

- few scapula fragments
- scapula “likely transported to this secondary processing station in articulation with the humerus and the front limb for subsequent segmentation”
- humerus common, distal fragments most frequent, marrow production
- radius moderately represented, proximal end removed, marrow processing
- ulna fragments low-moderately represented
- carpus moderately common, discarded during processing
- metacarpal moderately common in 10a/b/d and fragmented, 10c minimally or unbutchered

Hind limb:

- little-to-no pelvis fragments, these indicate fragmentary remains brought to the processing station after the meat was stripped elsewhere
- femur moderately common, most fragments from proximal end, marrow processing
- tibia same or less common than the femur, proximal end removed, marrow processing
- patella removed
- tarsal very common, discarded during butchering
- metatarsal rarer than metacarpal/approximately equal to femur/tibia. Marrow processing except in 10c
- phalanges moderately common, discarded during butchering

Summary

- interpreted as a secondary processing area focused on limbs, most meat striped at the kill/primary butchering site
- Most Mummy Cave remains are in N1, N3, N4, N5

Pelican Lake

Unit 8:

- MNI: two based on left cuneiform pes tarsal
- At least one greater than 5 years
- Seasonality undeterminable

Unit 7:

- MNI: six based on right cuneiform carpal and mandibular teeth
- Two at 1.5-2.5 years, one early adolescence, one late adolescence, two were in early maturity
- Normal cow/calf herd
- Seasonality undeterminable but summer suggested due to lack of very young elements [why not fall?]

Unit 6:

- MNI: 13 based on ageable mandibular and maxillary teeth
- One 0-2.5 years, two early adolescence, four late adolescence, three early maturity, one fully mature, two over 9.5 years
- 1 immature female/2 mature males [based on astragalus]
- Normal calf/cow herd
- Seasonality undeterminable

Unit 5:

- MNI: six based on left astragali
- one in early adolescence, one in late adolescence, one in early maturity, and one fully mature [based on mandible teeth]
- 1 bull astragalus

Unit 4:

- MNI: four based on left astragali
- One individual was immature at 0-2.5 years of age, one was in late adolescence (3.5-4.5 years), and one individual was in early maturity at 4.5-5.5 years of age.
- Seasonality undeterminable

Pelican Lake Processing Analysis

Head:

- Skull fragments only in unit 5, skull chopped at temporal region
- Mandible (unit 5) smashed for marrow

Axial:

- Very low vertebrae frequency in all units
- Almost no ribs in all units

Front limbs:

- Moderate-high humerus frequency – ends removed, chopped through distal condyles for disarticulation, proximal end removed for marrow
- Radius moderately common, proximal fragments, marrow extraction
- Some ulna fragments
- Carpals discarded after butchering
- Metacarpal moderate frequency except in 8 [where it is absent], sometimes but not commonly used for marrow production

Hind limbs:

- Lower frequency than front limbs
- Pelvis not processed (thus, meat removed and bones discarded near kill)
- Femur frequency varies (33.3%-11.5%), proximal end removed, marrow processing
- Tibia moderate frequency, ends removed (mostly distal), marrow processing
- No patella
- Tarsals discarded
- Metatarsal fragments suggest marrow processing
- Phalanges moderate frequency but hoof retained

Summary

- Secondary processing area for limbs/marrow
- Mostly represented in Levels N4 and N5

Pelican Lake to Besant Transition Component

Unit 3:

- MNI: 36 based on maxilla and mandible teeth ageing
- Four immature individuals with one individual from 0-6 months, one individual from 0.5-1.5 years, and two individuals from 0-2.5 years of age; four individuals in early adolescence (2.5-3.5 years); five individuals in late adolescence (3.5-4.5 years); 12 individuals in early maturity (4.5-5.5 years); nine individuals at full maturity (5.5-9.5 years); and two individuals in the old age classification (9.5-13.5 years)
- One immature female, two to four mature males and 10-12 mature female and/or immature male
- “predominant” calf/cow herd composition
- fall occupation based on teeth from 6-month-old bison

Processing

Head:

- horn sheaths, skull fragments rare
- mandible low frequency, marrow extraction
- skull frags indicate possible evidence of brain extraction via smashing basio-occipital

Axial:

- Vertebrae have low frequency, fragments represent mess from primary butchering area elsewhere

Front limbs:

- Moderate limb bone frequency
- No scapula thus, meat removed elsewhere
- Humeri moderate frequency, distal shaft sections/tubes, marrow removal
- Radius moderate frequency, nearly all frags proximal, marrow production
- Ulna fragments rare
- Carpals moderate frequency
- Metacarpal moderate frequency, proximal frags, carnivore gnawing

Hind limbs:

- One pelvis fragment
- Femur rare, marrow processing evident
- Tibia low-moderate frequency, all fragmented
- Tarsal moderate-high frequency, often damaged
- One patella
- Phalanges rare

Summary

- Secondary processing, mostly for marrow
- Represented in units 40E/OS, 40E/2.55, 15E/OS, N-3, N-4 and N-5
- Similar late North Area Avonlea and Old Women’s

South Area

Mummy Cave

16a:

- MNI: five based on right distal tib and two other bones that are less than 6 months old
- One individual is very immature (0-0.5 years), three individuals are over five years (three distal right mature tibiae at full maturity), and one individual is less than four years (immature distal metapodials, distal radii and tibiae)
- One bull
- Summer seasonality due to one individual that is less than 6-month-old

16b:

- MNI: two based on one mature and one immature metapodials
- One mature male based on astragali
- Seasonality undetermined

16c:

- MNI: three
- Ageable mandibular teeth indicate two fully mature individuals (5.5-9.5 years) and one individual in early adolescence (2.5-3.5 years)
- Astragali indicates one mature male and two mature female and/or immature male.

Level 16 Processing Analysis

Head:

- No skulls
- Mandibles in 16b, evidence for marrow and tongue extraction

Axial:

- Vertebrae low-moderate frequency, mostly vertebral bodies, no ribs

Front limb:

- Scapula frags moderate frequency (leftover from initial disarticulation)
- Humeri moderate frequency, head or distal frag, marrow
- Radius common, mostly distal frags and some proximal, marrow processing
- Ulna moderate frequency
- Carpals rare

- Metacarpal varies from very common to absent, no marrow processing

Hind limb:

- Pelvis frags common (brought when stuck to femur)
- Femur moderate frequency, mostly proximal frags and some distal
- Tibia moderate-high frequency, distal frags, marrow processing
- Tarsus high frequency in 16a and low-moderate otherwise
- Astragali and Navicular-Cuboids damage were chopped
- Metatarsal high- moderate frequency, no marrow processing in 16a [but yes in b/c?]
- Phalange moderate frequency

Summary: all of Unit 16

- Secondary butchering for limb marrow

Unknown Culture Unit X, Levels 8b, 9, 10 and 11

Unit 15:

- MNI: five
- Two mandibular teeth were recovered, indicating one individual at 0-1.5 years of age (immature) and one individual at 2.5-3.5 years of age (early adolescent).
- Summer-early fall (one right metatarsal aged 6 month or less)
- Other elements suggest the herd composition was primarily of an age less than five years (immature vertebrae, immature distal radii, olecranon of ulna, distal metapodials, proximal and distal tibia)
- One big male (one big ulna and one big metacarpal)
- Astragali suggest two males/rear second phalanx suggest one male

Processing Analysis

Head:

- Skull moderate frequency, horn core suggesting brain removal via frontal smashing
- Mandible marrow extraction

Axial:

- Vertebrae far more common than in later occupations indicating primary processing.
- Ribs rare (taken to campsite?)

Front limb:

- Scapula frags common
- Humeri common, distal shaft present/proximal end absent
- Radius very frequency, few whole/proximal frags with many distal frags, marrow removal
- Ulna moderate frequency
- Carpals low frequency
- Metacarpals low frequency, some whole, end fragments, no marrow processing

Hind limbs:

- Pelvis moderate frequency
- Femur moderate frequency, mostly proximal frags, some tubes. Marrow removal either happening here or wasted?
- Tibia high frequency, end frags, thus tube gone for marrow processing
- Tarsal moderate-high frequency
- Phalanges moderate frequency, like in later times hoof removed

Summary:

- Secondary processing but closer to the primary processing area
- Season is late spring to late summer

Pelican Lake

Unit 14:

- MNI: 12 based on right astragali
- A t least one individual is fully mature, one is in early adolescence, and one is in late adolescence according to identifiable teeth. At least three individuals are over four years, as determined by fused proximal right radii (n=3)
- Sexing of astragali indicates one female individual and four males. Sexing of rear medial phalanges indicates two immature females, five mature female and/or immature males, and two mature males
- Late summer/rutting season.

Processing Analysis

Head:

- No skull, mandibles rare, tongue removal evident

Axial:

- Vertebrae very rare, one rib fragment thus not primary processing locality

Front limbs:

- Scapula fragments low frequency
- Humeri low frequency, end fragments thus shaft removed elsewhere
- Radii mod frequency, end fragments thus shaft removed elsewhere
- Carpals mod frequency
- Metacarpal end fragments mod frequency thus shaft removed for marrow

Hind limbs:

- No pelvis fragments
- Femur proximal fragments thus shaft removed for marrow
- Tibia distal fragments thus shaft removed for marrow
- Tarsus high frequency thus hind limb segmented here
- Metatarsal [no info provided]
- Phalanges common

Summary

- Moderate use of the South Area, specifically Unit X, Level 7 (6-12in)
- Secondary processing
- Summer utilization

Unit 13c:

- MNI: seven based on right astragali
- One individual under 4.5 years, at least four over 3.5 years

Processing Analysis

Head:

- No skull or mandible

Axial:

- Vertebrae very rare, no ribs

Front limbs:

- No scapula frags
- Humerii distal frags only, common thus marrow production
- Radii proximal frags, moderate frequency, shaft removed for marrow
- Ulna low frequency
- Carpals very frequency
- Metacarpal moderate frequency, distal frags thus shaft removed for marrow

Hind limbs:

- No pelvis
- Femur high frequency, marrow production
- Patella mod frequency
- Tibia high frequency, marrow production
- Tarsal high frequency
- No metatarsals (some metacarpals above may be metatarsals), may be removed marrow extraction or left behind at the cliff base
- Phalanges moderate-high frequency, hoof retained

Summary:

- Secondary processing, no seasonality determined

Unit 11
Unit 11a:

- MNI: three based on right navicular cuboid
- One over 5 years old, two over 3 years old

Unit 11b:

- MNI: 1
- Over 4 years old

Unit 11g:

- MNI 1

Processing Analysis

Unit 11 a/b/g:
Head:

- No skull
- Mandible rare, marrow processing

Axial:

- Vertebrae rare, no ribs

Front limbs:

- Front fragments rare
- Humeri distal fragments
- Radii end fragments
- No ulna
- Carpal/metacarpal very rare

Hind limbs:

- Rare
- No pelvis
- Femur low-moderate frequency
- No tibia
- Tarsus varied
- Metatarsal rare but complete
- Phalanges mod frequency, hoof retained

Summary:

- Secondary processing
- The site distribution shows 11A present in Unit Z, Level 7, 11b in Unit A, Level 13 (6-12 inches), and 11g in Unit A, Level 13 (36-42 inches).
- Probably not summer seasonality