University of Alberta

AGATE BASIN ARCHAEOLOGY IN ALBERTA AND SASKATCHEWAN, CANADA

by

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A thesis submitted to the Faculty of Graduate Studies and Research
in partial fulfillment of the requirements for the degree of

Master of Arts

Department of Anthropology

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ABSTRACT

This thesis documents Agate Basin archaeological remains in the provinces of Alberta and Saskatchewan. By extension, it examines the context of the rapidly changing Late Pleistocene/Early Holocene environment. A database of information on Agate Basin sites in the study area is assembled. Site analysis allowed for the examination of Agate Basin adaptations based on radiocarbon chronology, landform use, mobility, resource use, projectile point production and climate and environmental context. The results confirm that Agate Basin producing peoples within Alberta and Saskatchewan displayed variability concerning projectile point production, landscape use, resource extraction, and hunting practice. It appears that Agate Basin producing people within Alberta and Saskatchewan practiced a predominantly broad-based strategy for procuring resources. No evidence exists to support a model of large-scale communal hunting. Likely, the strongest influence on the particular adaptive behaviours of Agate Basin producing people in Alberta and Saskatchewan can be summarized as environmental.

AKNOWLEDGEMENTS

The production of any work is always due to an array of people along with the author. This thesis is the result of a collaborative effort and a great deal of support. Much of the work here could not have been accomplished without the aid of many people.

I would like to start by acknowledging the help I received from Joan Damkjar from the Alberta Archaeological Survey and Nathan Friesen from the Saskatchewan Heritage Resources Branch. Their contribution in the compilation of the Agate Basin database for Alberta and Saskatchewan used here was crucial. I would similarly like to thank Bob Dawe and Jack Brink at the Royal Alberta Museum for taking the time to give me access to the collections on many occasions, and the interest and support they gave to this project. Likewise, I would like to thank Dr. Evelyn Siegfried and Ian Brace of the Royal Saskatchewan Museum for taking time out of their schedule to show me the Saskatchewan collections that were invaluable to this thesis. I would also like to thank Dr. David Meyer for the correspondence, advise, extensive knowledge and access to Agate Basin material housed at the University of Saskatchewan.

I would especially like to thank my supervisors, Dr. Charles Schweger and Dr. Alwynne Beaudoin. They have contributed knowledge, time, effort and patience in making this thesis possible. I would also like to thank my committee members, Dr. John Ives and Dr. Duane Froese for their time, conversations and valuable feedback for this thesis. Their insight greatly improved the contribution I was able to make.

Most importantly, I would like to thank the three most important people of my life. My parents, John and Joyce, who gave me unconditional support over the years in all that I have chosen to do. And to Nisha, you have been an anchor and a light. I could not have done it without you.

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Chapter 1 - Introduction

1.0 Introduction

The late Pleistocene/early Holocene was a time of unique climate patterns without a modern day analogue (Beaudoin and Oetelaar 2003; Schweger and Hickman 1989). This is documented in northern latitudes, such as in the provinces of Alberta and Saskatchewan. The earth's orbital variations in the late Pleistocene/early Holocene resulted in significant changes in the annual insolation budget. This, in turn, affected the climate and environment. The late Pleistocene/early Holocene climate was characterized by extreme continentality[1], warmer summers and colder winters than present. How the unique late Pleistocene/early Holocene climate may have influenced the adaptations[2] of prehistoric hunter/gatherers remains an open question.

Agate Basin archaeology spans the late Pleistocene and early Holocene in Alberta and Saskatchewan. This archaeological record affords an opportunity to examine the adaptations prehistoric people may have made to climate and environments that were rapidly changing and unique when compared to the remainder of the Holocene. This thesis will primarily document the presence of Agate Basin material remains in the provinces of Alberta and Saskatchewan. Second, it will summarize the context of the late Pleistocene/early Holocene environment and draw correlations between environmental context and Agate

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[1] Not to be confused with seasonality, continentality is a measure of how the climate of a place is affected by its remoteness from the oceans and oceanic air. The average temperatures prevailing in January and July are most often quoted as an indicator of this.

[2] Adaptation refers to patterns of behaviour that enable a culture to cope with its surroundings. Bennet describes this as," strategic behaviour…the rational or purposive manipulation of the social and or natural environments" (Bennet 1976:2).

Basin adaptations. To accomplish the above, a database of information on Agate Basin sites in the study area will be assembled from published and public sources as well as from grey literature and private collections. Data from paleoenvironmental sites, climate models and faunal remains are used to create the environmental context during Agate Basin occupation.

Agate Basin archaeology is identified by the presence of the Agate Basin projectile point, one of the many projectile point typologies[3] knapped by prehistoric occupants of Alberta and Saskatchewan. Archaeology is rich in discussion on what projectile points mean in terms of the concept of culture. Broadly, culture refers to a set of learned beliefs, values and behaviours shared by members of a group[4]. While projectile points were produced by people, it is uncertain how far the archaeologist can go in establishing evidence of a distinct culture based on a single material attribute such as the projectile point. This thesis will adopt a pragmatic approach and recognize Agate Basin producing people (ABPP) as a culture, small "c" as opposed to Agate Basin Culture, which carries the connotation of culture beyond the projectile point type, to being a complete and distinct entity. Here, Agate Basin refers to a projectile point; ABPP refers to the people who produced that point typology and who loosely demonstrate shared behaviours at some level.

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[3] Typology refers to a classification of a series of artifacts based upon the consideration of qualitative and quantitative attributes, usually based on an idealized 'type' specimen.

[4] A classical definition of culture offered by Rappaport is as follows,"... a part of the distinctive means by which a local population maintains itself in an ecosystem and by which a regional population maintains and coordinates its groups and distributes them over the available land" (1968:233). The focus on the ecosystem and distribution find particular relevance here given the nature of this thesis. Material culture is considered to be part of the 'means' mentioned in this definition.

A contextual approach to the archaeological record will be followed here. This approach looks at material culture, environmental context and patterns of behaviour exhibited in resource procurement and use, and landform use. Karl Butzer explains this as," Contextual archaeology … which aims to stimulate holistic research by calling attention to the complex systematic interactions among cultural, biological, and physical factors and processes" (1985,7).

1.1 The Agate Basin Typology and Agate Basin Adaptation

Agate Basin falls into the paleoindian plains typological sequence of the Great Plains of Canada and the United States (Holliday 2000; Vickers 1986). The typological sequence as described in the Northern Plains from oldest to youngest is as follows: 1. Clovis/Basally Thinned Triangular; 2. Folsom; 3. Agate Basin/Hell Gap; and 4. Alberta/Cody Complex (Vickers 1986). This sequence is not perfect, as has been demonstrated (Holliday 2000; Sellet 2001). Radiocarbon dates indicate an overlap in time of Agate Basin material culture with Hell Gap and Cody Complex material culture (Holliday2000; Sellet 2001); however, it is possible that this is a product of the nature of radiocarbon dates being statistical probabilities rather than discrete certainties. Regardless ABPP do have an observable temporal and spatial range.

Like many other prehistoric lanceolate projectile points in Alberta and Saskatchewan, Agate Basin projectile points are mostly surface finds. Consequently, much of the chronology and many assumptions about the culture and economy of the people who produced Agate Basin projectile points in Alberta and Saskatchewan come from sites excavated and interpreted in the United States, specifically at the Agate Basin site in Wyoming. As Rod Vickers explains, "Plano points are cross-dated according to sequences developed in the United States … the sequence of Agate Basin/Hell Gap is projected directly from American data" (1986, 36). Given the scarcity of intact stratified archaeological sites found within the boundaries of my study area, Vickers' statement is no less true today. However, the prevailing understanding of Agate Basin adaptations developed in the United States may not necessarily apply to the Agate Basin archaeological remains found within the study area.

Traditional concepts of Agate Basin developed in the United States (Agogino and Frankforter 1960; Frison 1984, 1991; Frison and Stanford 1982; Roberts 1961) come from the well-stratified and documented Agate Basin site in Wyoming. This is the type-site for the Agate Basin typology (Agogino and Frankforter 1960; Frison 1984, 1998, 1991; Frison and Stanford 1982; Roberts 1961). Here, one stratum is characterized by Agate Basin projectile points in association with a bone bed yielding extinct bison (*Bison antiquus*) (Frison and Stanford 1982, 264). The bone bed containing Agate Basin points, "…reflects the main feature of the Agate Basin component" (Frison and Stanford 1982, 79).

The extent of the bone bed suggests that the Agate Basin component at this site reflects processing of a large number of now-extinct *Bison sp.* following a communal hunt. It has been suggested that this activity may have produced more food than could be initially utilized (Frison and Stanford 1982). Evidence of this kind has been found at numerous paleoindian sites in the Great Plains (Hill et al.

2008). According to Frison and Stanford (1982), all the evidence from this site suggests that ABPPs were plains-adapted communal bison hunters.

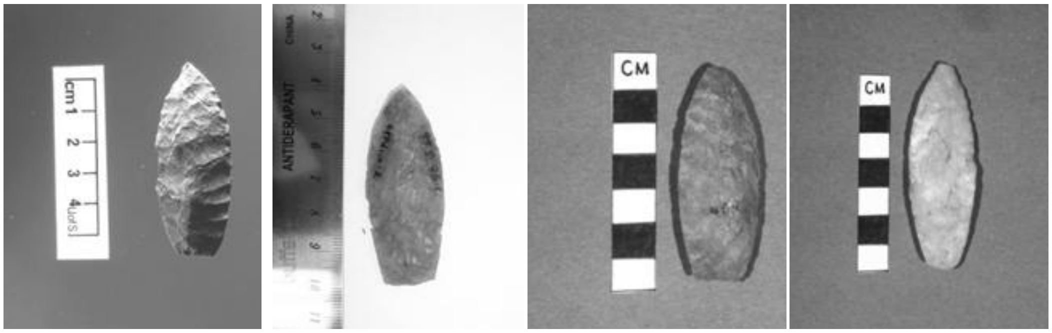
More recently, excavations at the Allen site, located along the Medicine Creek in Southern Nebraska, have shown the use by ABPP of a variety of animal resources including bison, deer, pronghorn, jackrabbit, cottontail, prairie dog and fresh water mussels, and no evidence of communal hunting (Bamforth 2007). The list of animal remains at the Allen site indicates a focus on a much greater dietary breadth as compared to the Agate Basin site.

The archaeological record provides evidence of *Ovis sp.* hunting by ABPP (Fedje 1986; Fedje et al. 1995; Frison 1992, 2004; Gryba 1983). Yet the only evidence of large-scale communal hunting by any paleoindian people of *Ovis* are the remains of a large net (50-65 meters long, 1.5-2.5 meters tall) found in the Wyoming foothills, thought to be used for trapping *Ovis sp.* (Frison 2004, 165). The large size of the net indicates a communal venture, as a large number of people would be required to use the net as a trap. The net dates to approximately 9800 cal years BP (8800 ^{14}C years BP), but is not associated with ABPP, nor does it fall within the study area.

All of these sites allow for comparisons with the Agate Basin archaeological record within the study area. However, the particular Agate Basin archaeological record within the study area has no evidence for communal kill events like those found at the type site (Table 3.1). Rather, the archaeological record within the study area shows regionally specific adaptations by ABPP.

1.2 The Agate Basin Typology

First described during a symposium of the 1964 Annual meeting of the



1. FgOc-6 (2) **1. GfPd-1 (99.5)** **3. Phenix Collection (no # C)** **4. Phenix Collection (636)**

Figure 1.1 Four Agate Basin Projectile Point Specimens From the Study Area

American Anthropological Association and subsequently published by Agogino et al. (1964), the Agate Basin typology is defined as an unstemmed lanceolate point of medium to large size, with a lenticular blade and a straight to convex base (Figure 1.1; Appendix 6).

Agate Basin appears in a large range of environments over its' time range and is associated with concentrations of *Bison* and *Ovis* in Alberta and Saskatchewan (Ebell 1980; Fedje 1986; Fedje et al. 1995; Gryba 1983), as well as a variety of other species found outside the study area (Bamforth 2007).

1.3 Distribution

Agate Basin is a tool typology that is spread over a large expanse of North America. Its northern border resides in the north of Alberta and Saskatchewan. It has been argued that it extends into the North West Territories (NWT) and Nunavut (Wright 1976), northeastern British Columbia (BC) (Fladmark 1975), and Alaska (Kunz et al. 2003). The relatively young dates retrieved from Agate

Basin-like sites in NWT and Nunavut compared to Agate Basin sites elsewhere makes this point typology either distinctive, or a late variant of Agate Basin.

To the west, Agate Basin has been found in the foothills and Rocky Mountains from Alberta and BC to as far south as Utah and Colorado (Fedje et al. 1995; Fladmark 1975; Gryba 1983; Kornfeld and Frison 2000). Agate Basin's southern borders reach as far as New Mexico (Hester 1972) and as far east as Manitoba (Pettipas 2005).

1.4 Agate Basin in Time

The dating of Agate Basin material remains is still limited in quality and quantity. Radiocarbon (^{14}C) dates associated with Agate Basin projectile points have been obtained from only a small number of sites (Ahler et al. 2004; Bamforth 2007; Fedje et al. 1995; Frison 1991; Frison and Stanford 1982; Gryba 1983; Holliday 2000; Kulle 1998; Landals 2002). ^{14}C dates collected for this thesis largely fall within the range from 12,800 to 10,800 cal years BP (see section 4.0.3). Detailed results and discussions regarding Agate Basin ^{14}C dates will be addressed later (see sections 3.1 and 4.0).

1.5 Climate and Environment

The study area climate during the late Pleistocene/early Holocene exhibited extreme seasonality and continentality (Beirle and Smith 1998; Hickman and Schweger 1991, 1993; Schweger and Hickman 1989; van Geel et al. 1999). Further, the seasonality and continentality would have been greater at northern latitudes (Kaufman et al. 2004; Kutzbach and Webb 1993; Kutzbach et al. 1998; Milankovitch 1941; Schweger and Hickman 1989; van Geel et al. 1999).

In the study area, the late Pleistocene/early Holocene was a time of dramatic climate and ecological change that resulted in unique environments compared to the present day. One can hypothesize that this may have led to unique adaptations of ABPPs.

Based on the work of Milankovitch (1941), Kutzbach and Webb (1993) and Kutzbach et al. (1998), the Northern Hemisphere radiation budget during the early late Pleistocene/early Holocene would have been distinctly different to the modern radiation budget. This was due to the perihelion—the point where the earth's orbit is closest to the sun—occurring in July, and the axial tilt of the earth being exaggerated to 24 ½ degrees[5]. The net effect would be greater solar radiation in summer months and less radiation in winter months as compared to the present. Many lines of evidence document that orbitally induced climate changes influenced the hydrology, flora and fauna of the study area (Kutzbach and Webb 1993; Kutzbach et al. 1998). Climate, hydrology, and flora and fauna make up the context for ABPP's adaptations.

Debate exists on the extent and timing of climatic and environmental change in the study area. According to Schweger and Hickman (1989), the late Pleistocene/early Holocene appears to be a time of drier conditions in the interior plains of Alberta and Saskatchewan. However, other evidence suggests that this may not be the case (Reeves and Dormaar 1972). Cooler, moister conditions are evidenced by a paleosol dated to before 9500 cal years BP (8500 ^{14}C years BP) (Beaudoin and Oetelaar 2003, 199). These two different lines of evidence may

[5] At present, the perihelion is in January and the axial tilt of the Earth is 23½ degrees.

reflect either regional or sub-regional variability and/or decadal and centennial climatic variability. As Beaudoin and Oetelaar explain, "The lack of agreement between climatic interpretations based on different lines of evidence sharply highlights the relatively limited knowledge of this critical interval and perhaps reflects underlying regional variability in climate" (2003, 200).

The late Pleistocene ice-cover quickly disappeared under the influence of high summer radiation and warming. The newly emerged late Pleistocene/early Holocene landscape was colonized by plant and animal species. As time progressed, the pioneering grass-herb and shrub communities in central Alberta and Saskatchewan were replaced by forests (Beaudoin and Oetelaar 2003; MacDonald and Case 2001; Sauchyn and Sauchyn 1991), although tree species would have varied depending on the specific environment—mountains versus plains, for example.

The fauna of the region was influenced by variable carrying capacities, geomorphology, and ecology. Larger species of mammals found in the study area include: elk (*Cervus elaphus*), mountain sheep (*Ovis canadensis*), bison (*Bison sp.)*, deer (*Odocoileus sp*.), bear (*Ursus sp*.), mountain lion (*Felis concolor*), wolf (*Canis lupus*), coyote (*Canis latrans*), hare (*Lepus sp*.), beaver (*Castor sp*.), mammoth (*Mammuthus sp*.), horse (*Equus sp*.), Caribou (*Rangifer sp*.) and waterfowl (Beaudoin and Oetelaar 2003) (Table 3.7). ABPPs would have been witness to some of these species and would have adapted their behaviour accordingly.

1.6 Organization

This thesis consists of five chapters. Chapter 1 introduces the study. Chapter 2 provides a detailed account of the methods employed in the research. Chapter 3 presents results of the analyses conducted, including a review of radiocarbon dates, site distribution, landform analysis, resource use, lithic analysis, and a review of climate and environment of the study area. The results of the study are discussed in Chapter 4. Chapter 5 renders relevant conclusions and suggests recommendations for future research.

Chapter 2 - Methods

2.0 Study Area

The study area consists of the provinces of Alberta and Saskatchewan, allowing for a large regional analysis. It also places practical limitations on the scope of this thesis considering the expansive distribution of the Agate Basin typology. Data from recorded Agate Basin sites in Alberta and Saskatchewan was assembled in order to create a database for this thesis.

2.1 Archaeological Site Definition

Archaeological sites selected for this study were identified by the presence of Agate Basin projectile points. Some sites that had been designated Agate Basin archaeological sites by sources were not used for two reasons. First, if the projectile points do not fit the morphological definition described here (see section 2.5) the site was rejected. Second, if only the distal tip or an insufficient amount of the basal (proximal) end of the projectile point was present (less than 50% intact) the site was rejected. These fragments were considered unreliable for the Agate Basin designation (see Appendix 7 for a listing of rejected Agate Basin sites and the reasoning for the rejections). However, if the projectile point or projectile point fragment was 50% or more intact from the basal end and displayed Agate Basin traits, it was designated an Agate Basin projectile point and was considered to indicate an Agate Basin site.

Sites were compiled from published and unpublished sources. Most sites were compiled from unpublished sources, as described through Cultural Resource Management (CRM) reports and reports from the provincial archaeological records of Alberta and Saskatchewan[6]. Project PAST[7] (Boag 1989) and Project TRACE[8] (Hjermstad 1991) site information was used extensively for Alberta.

The majority of Agate Basin sites found in the study area lack good contextual data, such as stratigraphic context and radiocarbon dating. For this reason, a hierarchy of sites based on their analytic quality was created in order to differentiate the quality of sites for analysis. The site quality was rated between site class 1 (best) and site class 5 (worst) and has the following characteristics: site class 1. Stratified sites with radiocarbon dates; site class 2. Stratified sites with no radiocarbon dates; site class 3. Stratified sites from test pits alone; site class 4. Surface find through survey; and site class 5. Surface find by private collectors, which may lack provenience and other data.

2.2 Chronology and Radiocarbon Dates

For standardization and comparisons, all radiocarbon dates used in this thesis were calibrated using OxCal v.4.1 (Ramsey 2009. Oxford *Radiocarbon Accelerator Unit*, accessed 2009). All radiocarbon dates will be presented in radiocarbon years before present (^{14}C years BP) and calibrated years before present (cal years BP). The calibration curve used here is IntCal09: Northern Hemisphere (Reimer et al. 2009). All calibrated radiocarbon dates are presented

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6 Only sites compiled from the Alberta and Saskatchewan Archaeological Surveys up to November 2009 were used in this thesis, including CRM site reports.

7 Project PAST was a project in which private landholders were encouraged to allow researchers to document their lithic collections. The project documented the Parkland between the North Saskatchewan and Red Deer rivers between1984-1989. Basic location information and photographs were catalogued and stored at the Royal Alberta Museum (Boag 1989).

8 Project TRACE, a sister project to Project PAST, was a project in which private landholders were encouraged to allow researchers to document their lithic collections. This project was focused on the region from Sundre to the Saskatchewan border between the Red deer and Oldman River drainages, and was undertaken in 1991. Basic location information and photographs were catalogued and stored at the Royal Alberta Museum (Hjermstad 1991).

at one sigma. All Agate Basin calibrated dates are rounded to the closest five-year interval. The radiocarbon dates obtained for this thesis come from secondary sources that are referenced (Appendix 2, 3 and 4). Radiocarbon dates related to Agate Basin archaeology are designated as reliable or unreliable based on potential contamination and sources of error. All radiocarbon dates designated as unreliable will be discussed in detail in section 4.0.

2.3 Distribution

The locations of Agate Basin sites are plotted using basic GIS (ArcView GIS 3.2). All geographic co-ordinates are plotted in decimal latitude and longitude and converted if the co-ordinates are given in another system.[9]

Maps of provincial boundaries, human population, legal land descriptions, roads, and railways were retrieved from the Earth Science Sector (ESS) of Natural Resources Canada (2002, *Welcome to Geogratis.* Natural Resources Canada, accessed 2004) and compiled with ArcView 3.2. Quaternary landform data for central and southern Alberta was retrieved from the Alberta Geological Survey (2005, *Alberta Geological Survey.* Alberta Geological Survey, accessed 2010).

2.4 Landform Data

Landform data associated with site location are derived from four main sources. The first are site reports and site form records from the two provincial Archaeological Surveys. Most of these data were the results of CRM reports. The second are published sources. The third is records from Project TRACE and Project PAST. The fourth source came from Quaternary landscape data from the

[9] The conversion program used may be found online (Cosmas, Tom. 1999. *Lat-Long Converter*, accessed January, 2009).

Alberta Geological Survey (2005, *Alberta Geological Survey*. Alberta Geological Survey**,** accessed 2010)**.** These landform records are plotted on topographical maps. Many of the sites had only partial information to offer the landform analysis. Therefore, analysis of specific landform components will involve a different percentage of the total number of sites collected.

Five landform categories were created for the analysis (Figure 2.1). First,

Landform Type 1 Shore | **Landform Type 2 River Valley** | **Landform Type 3 Crest/Prominence** | **Landform Type 4 Crest/Midslope** | **Landform Type 5 Flat Terrain**

Figure 2.1 Five Landform Types

the shore category (Type 1) is defined as sites that are or were located within 20 meters of a standing body of water such as a lake or pond. One major limitation with this category is that old drainages, shorelines of dry lakes, or other bodies of water are not always recorded or recognized by the authors of these sources. Second, the river valley landform category (Type 2) is comprised of sites along past or present river valleys. Third, the crest and prominence category (Type 3) is comprised of high points on relatively lower-lying surrounding terrain. It is made up of hills and knolls that may be moraines. Fourth, the crest and midslope category (Type 4) refers to sites found on the slope of a crest or prominence, or located directly at the base of the slope. Fifth, the flat terrain category (Type 5) consists of sites located on landforms with no noted discernable features.

The aspect (direction) of a slope was recorded when available. The proximity of archaeological sites to potable water was also documented. Unfortunately, past bodies of water such as lake basins and springs may not have been identified in source material, and small water bodies were not always noted. Further, it may not be known if certain water bodies were fresh water or saline at this time. Despite this, the known data were compiled and recorded based on the closest present or past body of water cited by the author.

All imperial measurements (yards, miles) reported from sources have been converted to metric units (meters, kilometres), significant up to two decimal places.

2.5 Typology and Lithic Data Base

The definition of Agate Basin used in this thesis comes from the official definition given at the 1964 annual meeting of the American Anthropological Association:

> The form of the Agate Basin type is defined as medium to large, unstemmed, and lanceolate. It has a long and slender or short blunt tip and a narrow, straight to convex base. The blade is flat, lenticular in longitudinal section, and lenticular to sometimes diamond shape in cross-section. All or most of the faces bear parallel, horizontal flaking which can be narrow and shallow (ribbon-like) or broad and medium-deep and runs from the lateral edges to the midline. In a few cases, parallel, oblique ribbon scars oriented from upper right (tip) to lower left (base) occur on one face together with parallel, horizontal flake scars. Lateral edges are minutely retouched and basal edges are thinned by removal of flakes longitudinally from base to tip or transversely just above the base on both faces. Lateral edges are usually ground at the proximal end for a distance of one-quarter to one-half of the total length of the point (Agogino et al. 1964, 1351).

Identification of the Agate Basin projectile points for many of the sites was based on photographs and written descriptions. Projectile point measurements are listed in Tables 3.3, 3.4, 3.5, and Appendix 1. Photographed projectile points were measured by the author when available. All other projectile point measurements used were taken from the original author. The projectile points described in the reports were compared to this definition as well as samples described in the type-site report (Frison and Stanford 1982, 80). The definition focuses on qualitative aspects of the Agate Basin type.

Metric measurements of length (cm), width (cm), and thickness (cm) were taken with sliding callipers and measured to the nearest tenth of a millimetre (Figure 2.2). Agate Basin projectile points that were greater than 95% intact, and where any damage sustained appeared to have little to no impact on three metric measurements, were used for the metric analysis.

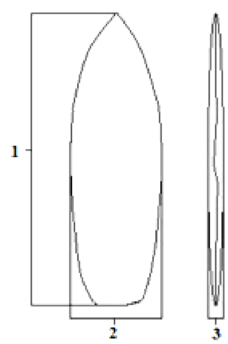

Figure 2.2 Lithic Measurements: 1. Maximum Length 2. Maximum Width 3. Maximum Thickness

Lithic raw material type was recorded and described by either myself or the author of a source. Like the metric characteristics, lithic raw material type is defined by the author of the original report. The majority of sources described raw material types based on visual analysis and not based on petrographic or other scientific analysis. All other attempts made for identification of lithic material type was done by visual identification alone. No further analysis was attempted.

Evidence of reworking of Agate Basin projectile points is documented[10]. Therefore, a reworking category was created based on the potential reshaping of a dull or broken projectile point for reuse as either a projectile point or other tool type. The criterion used to determine whether a projectile point is reworked was a deviation of the outline morphology from the ideal form indicated by a truncated distal portion. Because of the qualitative nature of this category, reworking was listed as likely reworked, not reworked, or indeterminate.

2.6 Climate and Ecology Data

Palaeoclimate reconstruction is based on the recovery and interpretation of palaeoclimate proxy data from palaeoenvironmental sites, as well as biome maps adapted from Dyke (2004). All palaeoclimate data were compiled from published sources. Palaeoenvironmental sites were chosen from published sources providing they were in the time frame covered in this thesis and had reliable ^{14}C dates. Paleoenvironmental sites that had problematic or contaminated radiocarbon dated were rejected. Palaeoenvironmental sites needed to be within or directly adjacent to the study area for selection (Figure 3.23, Table 3.6).

All palaeoenvironmental site locations are listed in decimal latitude and longitude, and were converted to this coordinate system if they were originally given in an alternate coordinate system.[11] All maps of palaeoenvironmental site locations were created using Arcview 3.2. Data for map creation was obtained from Natural Resources Canada (2002, *Welcome to Geogratis.* Natural Resources

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[10] Noting angled invasive resharpening of Agate Basin projectile points as a determinant of reworking is not attempted in this thesis. For details of this method see Buchanan 2006 and Buchanan and Collard 2010.

[11] The conversion program used can be found online (Cosmas, Tom. 1999. *Lat-Long Converter,* accessed January, 2006).

Canada, accessed 2004). Maps of glaciation, glacial retreat and biomes were adapted from Dyke et al. (2004) and Dyke (2004, 2005).

Chapter 3 – Results

3.0 Site Collection and Analysis

Data from one hundred and thirty-nine Agate Basin archaeological sites in the

#	Borden	Site Name	Site Class	Province	# Of Agate Basin Points	Aspect	Water Body Type	Distance to Water	Land-form Type	^{14}C Dates	Faunal Evidence	Reference
1	FiPo-200		4	AB	1	N/A	River	1km	Flat Terrain (5)	N/A	N/A	Ronaghan 1982
2	DhPg-8	Wally's Beach	3	AB	N/A	N/A	River	10m	Shore (1)	3	N/A	Tolman 2001
3	FgQj-7		3	AB	1	South	Creek	<50m	Crest Midslope (4)	N/A	N/A	Wondrasek 1998; Reeves 2001
4	DhPh-51	St Mary's Reservoir	4	AB	1	South	River	50m	River valley (2)	N/A	*Bison*, unid.	Meyer 2001
5	DhPh-87	St Mary's Reservoir	2	AB	1	N/A	River	1.5 km	Flat Terrain (5)	N/A	N/A	Meyer 2001
6	DgOp-15	Bad Waters	4	AB	1	N/A	Creek	900 m	Flat Terrain (5)	N/A	N/A	Reeves 1976
7	FiPp-26		3	AB	1	South	Lake	400m	Crest Prominence (3)	N/A	N/A	Wright 1979
8	GdOo-16	Duckett	3	AB	1	N/A	Lake	0m	Shore (1)	N/A	Unid. bone fragments	Fedirchuk and McCullough 1986
9	IkOs-1	Leland Lake	2	AB	3	N/A	Lake	<50m	Shore (1)	N/A	N/A	Pollock 1977
10	IcPx-1		2	AB	1	N/A	River	<50m	River valley (2)	N/A	N/A	Donahue 1975
11	GcOm-18		3	AB	2	N/A	Creek	200m	Crest Prominence (3)	N/A	Unid bone	Fedirchuk1980a Fedirchuk 1980b.
12	FdOq-9		3	AB	1	N/A	River	2km	Crest Prominence (3)	N/A	Unid. bone	Fedirchuk 1980a, 1980b
13	EePl-215		2	AB	1	N/A	River	<50m	River valley (2)	N/A	Unid. bone	Rogers1979; Wood 1998.
14	GfPp-2		3	AB	1	West	River	300m	River valley (2)	N/A	N/A	Cloutier 2006
15	FkOo-8		3	AB	1	Southwest	River	<50m	River valley (2)	N/A	N/A	Gruhn 1965

16	FiPn-36		4	AB	1	N/A	Lake	2km	Crest Prominence (3)	N/A	N/A	Damp 1981
17	EkPj-4	Kievers Lake; Kiever Lake	4	AB	1	N/A	Lake	100m	Crest/ Midslope (4)	N/A	N/A	Hjermstad 1991
18	EhPj-2	Hutterite Colony	4	AB	2	N/A	N/A	N/A	N/A	N/A	N/A	Hjermstad 1991
19	EhPi-4	Goose Track Hill	4	AB	1	N/A	Creek	250m	Crest/ Midslope (4)	N/A	N/A	Hjermstad 1991
20	EeOn-16	Project Past	5	AB	1	N/A	N/A	N/A	N/A	N/A	N/A	Boag 1989
21	ElOw-3	Project Past	5	AB	1	N/A	N/A	N/A	N/A	N/A	N/A	Boag 1989
22	ElOw-4	Project Past	5	AB	1	N/A	N/A	N/A	N/A	N/A	N/A	Boag 1989
23	ElOx-7	Project Past	5	AB	1	N/A	N/A	N/A	N/A	N/A	N/A	Boag 1989
24	FiOq-17	Project Past	5	AB	1	N/A	N/A	N/A	N/A	N/A	N/A	Boag 1989
25	FcPd-2	Project Past	5	AB	1	N/A	N/A	N/A	N/A	N/A	N/A	Boag 1989
26	FdPg-23	Project Past	5	AB	1	N/A	Lake	200m	Crest Prominence (3)	N/A	N/A	Boag 1989
27	FdPr-5	Project Past	5	AB	1	N/A	N/A	N/A	N/A	N/A	N/A	Boag 1989
28	FePg-19	Project Past	5	AB	1	East	River	0m	Crest/ Midslope (4)	N/A	N/A	Boag 1989
29	FgPl-4	Project Past	5	AB	1	N/A	N/A	N/A	N/A	N/A	N/A	Boag 1989
30	FhPm-9	Project Past	5	AB	1	N/A	Creek	30m	Crest Prominence (3)	N/A	N/A	Boag 1989
31	FhPm-10	Project Past	5	AB	1	N/A	Creek	500m	Crest Prominence (3)	N/A	N/A	Boag 1989
32	FhPm-24	Project Past	5	AB	1	N/A	N/A	N/A	N/A	N/A	N/A	Boag 1989
33	EjPo-135	Project Trace	5	AB	1	N/A	N/A	N/A	N/A	N/A	N/A	Hjermstad 1991
34	EfPi-9	Three Boulder Blow (PT)	5	AB	1	N/A	N/A	N/A	N/A	N/A	N/A	Hjermstad 1991

35	EhPi-9	Sandhill (PT)	5	AB	1	N/A	N/A	N/A	Crest Prominence (3)	N/A	N/A	Hjermstad 1991
36	EiPi-10	Pointed Knife Blow (PT)	5	AB	1	Southwest	Spring Slough	0m	Crest/ Midslope (4)	N/A	N/A	Hjermstad 1991
37	EiPh-6	Gas Cap Hill (PT)	5	AB	1	South	Spring Slough	0m	N/A	N/A	N/A	Hjermstad 1991
38	EiPi-16	Rooster Blow (PT)	5	AB	1	N/A	Spring Slough	0m	N/A	N/A	N/A	Hjermstad 1991
39	EkPj-10	Allingham Highway (PT)	5	AB	1	N/A	N/A	N/A	N/A	N/A	N/A	Hjermstad 1991
40	EiPj-5	Spike Blow (PT)	5	AB	1	N/A	N/A	N/A	N/A	N/A	N/A	Hjermstad 1991
41	EjPj-19	Walking Crow (PT)	5	AB	1	N/A	N/A	N/A	N/A	N/A	N/A	Hjermstad 1991
42	FaPk-11	Headless Mouse (PT)	5	AB	1	N/A	N/A	N/A	N/A	N/A	N/A	Hjermstad 1991
43	ElPn-5	Moose Blowout (PT)	5	AB	1	N/A	N/A	N/A	N/A	N/A	N/A	Hjermstad 1991
44	EgPh-19	Milnesand Blowout (PT)	5	AB	1	N/A	N/A	N/A	N/A	N/A	N/A	Hjermstad 1991
45	EjPj-23	Blue Nitro Hill (PT)	5	AB	1	N/A	N/A	N/A	N/A	N/A	N/A	Hjermstad 1991
46	FiPl-19	Project Trace	5	AB	1	N/A	N/A	N/A	N/A	N/A	N/A	Hjermstad 1991
47	FlPf-26	Project Trace	5	AB	1	N/A	N/A	N/A	N/A	N/A	N/A	Hjermstad 1991
48	EjPa-8	Project Trace	5	AB	1	N/A	N/A	N/A	N/A	N/A	N/A	Hjermstad 1991
49	EkPn-6	Project Trace	5	AB	1	N/A	N/A	N/A	N/A	N/A	N/A	Hjermstad 1991
50	EjOu-7	Project Trace	5	AB	1	N/A	N/A	N/A	N/A	N/A	N/A	Hjermstad 1991
51	FbOo-2	Project Trace	5	AB	1	N/A	N/A	N/A	N/A	N/A	N/A	Hjermstad 1991

52	EjPa-9	Project Trace	5	AB	1	N/A	N/A	N/A	N/A	N/A	N/A	Hjermstad 1991
53	EjPa-14	Project Trace	5	AB	1	N/A	N/A	N/A	N/A	N/A	N/A	Hjermstad 1991
54	EjPf-52	Project Trace	5	AB	1	N/A	N/A	N/A	N/A	N/A	N/A	Hjermstad 1991
55	EkPi-1	Project Trace	5	AB	1	South	N/A	N/A	Crest Prominence (3)	N/A	N/A	Hjermstad 1991
56	EjPj-32	Project Trace	5	AB	1	South	Creek	0m	Crest/ Midslope (4)	N/A	N/A	Hjermstad 1991
57	EdPk-45	Project Trace	5	AB	1	N/A	N/A	N/A	N/A	N/A	N/A	Hjermstad 1991
58	ElPl-10	Rosebud Hill, East (PT)	5	AB	1	South	Creek	20m	Crest Prominence (3)	N/A	N/A	Hjermstad 1991
59	FdPl-14	Project Trace	5	AB	1	N/A	N/A	N/A	N/A	N/A	N/A	Hjermstad 1991
60	ElPm-8	Project Trace	5	AB	1	N/A	N/A	N/A	N/A	N/A	N/A	Hjermstad 1991
61	EjPo-141	Project Trace	5	AB	1	N/A	N/A	N/A	N/A	N/A	N/A	Hjermstad 1991
62	EjPo-144	Project Trace	5	AB	1	N/A	N/A	N/A	N/A	N/A	N/A	Hjermstad 1991
63	EhOo-2	Project Trace	5	AB	1	N/A	Lake	10m	Shore (1)	N/A	N/A	Hjermstad 1991
64	EiOr-2	Project Trace	5	AB	1	N/A	N/A	N/A	N/A	N/A	N/A	Hjermstad 1991
65	EiOx-11	Project Trace	5	AB	1	N/A	N/A	N/A	N/A	N/A	N/A	Hjermstad 1991
66	EkOt-6	Project Trace	5	AB	1	N/A	N/A	N/A	N/A	N/A	N/A	Hjermstad 1991
67	EkOx-19	Project Trace	5	AB	1	N/A	N/A	N/A	N/A	N/A	N/A	Hjermstad 1991
68	EaPg-30	Project Trace	5	AB	1	N/A	N/A	N/A	N/A	N/A	N/A	Hjermstad 1991
69	EaPh-13	Trail Hill Blowout (PT)	5	AB	1	N/A	N/A	N/A	N/A	N/A	N/A	Hjermstad 1991

70	EaPh-24	Project Trace	5	AB	1	N/A	N/A	N/A	N/A	N/A	N/A	Hjermstad 1991
71	EbPh-5	Big Rock Blowout (PT)	5	AB	1	N/A	N/A	N/A	N/A	N/A	N/A	Hjermstad 1991
72	EbPh-7	Project Trace	5	AB	1	N/A	N/A	N/A	N/A	N/A	N/A	Hjermstad 1991
73	EgPi-9	Caruso Hill (PT)	5	AB	1	N/A	N/A	N/A	N/A	N/A	N/A	Hjermstad 1991
74	EfPf-15	Project Trace	5	AB	1	N/A	N/A	N/A	N/A	N/A	N/A	Hjermstad 1991
75	GdPf-3	Project Trace	5	AB	1	N/A	Lake	20m	Shore (1)	N/A	N/A	Hjermstad 1991
76	EfPn-7	Project Trace	5	AB	1	N/A	N/A	N/A	N/A	N/A	N/A	Hjermstad 1991
77	EdPc-219		4	AB	1	N/A	Creek	40m	Crest Prominence (3)	N/A	N/A	Green 2002
78	EgPr-2	Sibbald Creek	1	AB	4	South	River	<50m	River valley (2)	1	*Bison antiquus, Ovis*	Gryba 1983
79	GfPd-1		5	AB	1	N/A	N/A	N/A	N/A	N/A	N/A	Stored at University of AB, no Report.
80	DjPn-50		3	AB	1	N/A	Creek	20m	River valley (2)	N/A	Unid. bone	Reeves 1985
81	EiOq-1	Johnston Locality 19	4	AB	1	N/A	N/A	N/A	Flat Terrain (5)	N/A	N/A	Wormington, and Forbis 1965
82	EePs-25	Orchid Creek	3	AB	1	N/A	Creek	10m	River valley (2)	N/A	N/A	Brink 1978
83	EhPu-1	Lake Minne-wanka	1	AB	1	N/A	Lake	10m	Shore (1)	2	*Bison* and *Ovis*	Landals 2002, 2000
84	FiPo-264		4	AB	1	N/A	N/A	N/A	N/A	N/A	N/A	Gryba 1982
85	FiPp-27		3	AB	1	N/A	N/A	N/A	Crest Prominence (3)	N/A	N/A	Gryba 1977

86	FfQh-27		1	AB	1	South	Creek	20m	River valley (2)	1	1 unid. calcine bone fragment	Fedirchuk and McCullough 1998; Kulle, 1998
87	GfPa-6		2	AB	1	N/A	Spring Slough	20m	Crest Prominence (3)	N/A	Unid. bone fragments	Ball 2006
88	GgQt-10		3	AB	1	N/A	Spring Slough	50m	Flat Terrain (5)	N/A	N/A	Gorham 1996
89	HiOw-38		3	AB	1	N/A	Creek	100m	River valley (2)	N/A	N/A	Clarke 2001
90	IeOs-5		3	AB	2	N/A	Lake	300m	Crest Prominence (3)	N/A	N/A	Bereziuk 2007
91	IlOw-7	Projectile Find Spot	4	AB	1	N/A	River	500m	Flat Terrain (5)	N/A	N/A	Pollock 1977
92	EhPv-8	Vermillion Lakes	1	AB	3	South	River	<50m	River valley (2)	4	*Ovis canadensis*, unid. ungulate	Fedje 1986; Fedje et al. 1995.
93	DkNv-2	Napao Site	2	SK	1	N/A	Spring Slough	40m	Flat Terrain (5)	N/A	charred and fragmentary unid. bone.	Watson 1987
94	DiMu-3		3	SK	1	N/A	Creek	50m	Flat Terrain (5)	N/A	N/A	Light 1998
95	FiNk-8	Forest Shatilla Site (PA8)	4	SK	1	N/A	Spring Slough	20m	Flat Terrain (5)	N/A	bison bone fragments	Krozner and Playfield 2000
96	FiNh-4	Kosowan II	4	SK	1	N/A	River	1.8km	Flat Terrain (5)	N/A	N/A	Frey 1994
97	EgNq-18	Coteau Beach D	4	SK	2	N/A	Lake	20m	Shore (1)	N/A	Unid. bone	Stevenson 1989.
98	FeOf-2		5	SK	1	N/A	River	1.5km	Flat Terrain (5)	N/A	N/A	Carlson 1993

99	FeOf-3	Gibbon	5	SK	1	N/A	River	3.0km	N/A	N/A	N/A	Carlson 1993
100	FgOc-6	Tait Site A	5	SK	1	N/A	Lake	3.0km	Flat Terrain (5)	N/A	N/A	Carlson 1993
101	FgOe-10	La Clare A	5	SK	1	N/A	Creek	1.5km	N/A	N/A	N/A	Carlson 1993
102	FgOh-8	Foster B	5	SK	2	N/A	Creek	1.0km	N/A	N/A	N/A	Carlson 1993
103	FhOg-13	Furman B	5	SK	1	South west	River	500m	Crest Prominence (3)	N/A	N/A	Carlson 1993
104	FhOg-4		5	SK	1	N/A	River	2.0km	Crest Prominence (3)	N/A	N/A	Carlson 1993
105	IgOg-4		4	SK	1	N/A	Lake	200m	Shore (1)	N/A	N/A	Site Form
106	IgOg-3		4	SK	1	N/A	Lake	200m	Shore (1)	N/A	N/A	Site Form
107	FiNj-5	Bachur #2	5	SK	1	South west	River	160m	River valley (2)	N/A	N/A	Site Form
108	FiNj-6	Bachur #1	5	SK	1	South west	River	200m	River valley (2)	N/A	N/A	Site Form
109	FiNj-10	Bachur Collection	5	SK	1	South	River	160m	River valley (2)	N/A	N/A	Site Form
110	FgMx-3	Armley Site	5	SK	1	N/A	N/A	N/A	N/A	N/A	N/A	Spurling 1983
111	FgMx-4	Allchin (Campbell A-4)	5	SK	1	N/A	River	3.5km	Flat Terrain (5)	N/A	N/A	Spurling 1983
112	EgNq-7	Coteau Pasture #2	5	SK	3	N/A	Lake	0m	Shore (1)	N/A	N/A	Johnson 1984
113	EgNo-41	Debra's Walk	3	SK	1	N/A	Lake	5m	Shore (1)	N/A	1 unid. bone fragment	Saylor 1993
114	EdNi-6		5	SK	1	N/A	Lake	750m	Flat Terrain (5)	N/A	N/A	Balcom 1990
115	EdNg-10		4	SK	1	N/A	Spring Slough	810m	N/A	N/A	N/A	Hjermstad and Paquin 2002
116	FgOe-14		5	SK	1	N/A	River	500m	N/A	N/A	N/A	Carlson 1993
117	FgOe-16		5	SK	1	N/A	River	600m	N/A	N/A	N/A	Carlson 1993
118	FhOd-2		5	SK	2	N/A	Lake	1.9 km	Flat Terrain (5)	N/A	N/A	Carlson 1993

119	FjOi-13		5	SK	1	N/A	Spring Slough	500m	Crest Prominence (3)	N/A	N/A	Carlson 1993
120	FgOg-4		5	SK	1	North west	Creek	500m	Crest Prominence (3)	N/A	N/A	Carlson 1993
121	EgNk-7	Righetti #4	5	SK	1	N/A	Creek	200m	Flat Terrain (5)	N/A	N/A	Light 1998
122	EkNd-3	Lorienz Site	5	SK	1	N/A	Spring Slough	300m	Flat Terrain (5)	N/A	N/A	Novekosky 2002
123	EkNd-4	Burt Pumford Site	4	SK	1	N/A	Spring Slough	50m	N/A	N/A	N/A	Novekosky 2002
124	EbNj-4	Parkhill Site	4	SK	7	N/A	Creek	50m	Crest Prominence (3)	N/A	numerous id bone fragments	Ebell 1980
125	EaNb-3		4	SK	1	N/A	N/A	N/A	Crest Prominence (3)	N/A	N/A	German 1985
126	EbNj-9	Ernie Doyle	3	SK	1	N/A	Spring Slough	800m	Crest Prominence (3)	N/A	N/A	Ebell 1975
127	EjNb-1	Blue Hill	4	SK	1	N/A	Spring Slough	250m	Crest Prominence (3)	N/A	N/A	Novecosky 2002
128	ElMw-8	Bill Kereluke	3	SK	1	N/A	Creek	200m	Flat Terrain (5)	N/A	N/A	Novecosky 2002
129	ElMq-1	Riverside Farm Site	3	SK	1	N/A	River	200m	River valley (2)	N/A	N/A	German 1985
130	FdMt-9	Aron Site	4	SK	1	N/A	N/A	N/A	N/A	N/A	N/A	Finnegan and Gibson 1997
131	FdMv-25	Base Site	4	SK	1	N/A	N/A	N/A	N/A	N/A	N/A	Finnegan and Gibson 1997
132	FeMv-14	John McCormack Site	4	SK	1	N/A	N/A	N/A	N/A	N/A	N/A	Finnegan and Gibson 1997

133	FfMv-13		4	SK	1	N/A	N/A	N/A	N/A	N/A	N/A	Finnegan and Gibson 1997
134	FfNj-1	Fenton Ferry	2	SK	10	N/A	Spring Slough	100m	Crest Prominence (3)	N/A	N/A	Meyer and Freeman 2006; Site Form
135	EbOa-19		3	SK	1	N/A	Spring Slough	1.0km	Crest Prominence (3)	N/A	N/A	Thomas and German 1991
136	EcOi-2	Jean Wilk	3	SK	1	N/A	Spring Slough	100m	Flat Terrain (5)	N/A	N/A	Anonymous 1989
137	EgNr-8	Girl Guides' Camp Site	3	SK	1	N/A	Lake	0m	Shore (1)	N/A	N/A	Stevenson 1989
138	EgNr-2	Camp Rayner	2	SK	1	N/A	River	1.0km	Crest Prominence (3)	N/A	N/A	Stevenson 1989
139	FcOh-3	Anna Site	4	SK	1	N/A	Lake	0m	Shore (1)	N/A	N/A	Hanson and Weinbender 2004

Table 3.1 Agate Basin Archaeological Site Listing Including Borden Number, Site Name, Site Class, Province, # of Agate Basin Points, Site Aspect, Site Water Body Type Association, Site Landform Type Association, Radiocarbon Dates, and Site Faunal Evidence (see Appendix 8 for decimal latitude and longitude listings for each site)

study area were compiled (Table 3.1). This forms the basis of which all subsequent analysis was derived. Site distribution, site type, landform use, resource use and lithic data are all acquired from data from these sites (see appendix 8 for locational information).

3.1 Chronology and Radiocarbon Dates

Twenty radiocarbon dates from nine sites provide the chronologic control of Agate Basin material remains (Figure 3.1, Figure 3.2, Table 3.2, and Appendix 3).

#	Site	LAB #	Material Dated	Uncorrected Age (^{14}C)	Range of Calibrated Ages (Cal BP) *	Cultural Association	Reliable	Reference
1	Agate Basin (WY)	RL-557	Calcine Bone Fragments	10430 ± 570	12785-11310	Agate Basin	yes	Frison and Stanford 1982; Holliday 2000
2	Agate Basin (WY)	O-1252	Bulk Charcoal	9300 ± 450	11205-9920	Agate Basin	no	Frison and Stanford 1982; Holliday 2000
3	Agate Basin (WY)	M-1131	Calcine Bone Fragments	9990 ± 225	11965-11220	Agate Basin	yes	Frison and Stanford 1982; Holliday 2000
4	Hell Gap (WY)	I-167	Charcoal (burned soil)	10850 ± 550	13355-12000	Agate Basin	no	Frison 1991; Holliday 2000
5	Frazier (CO)	SMU-316	Soil Humates	9550 ± 130	11100-10705	Agate Basin	no	Holliday 2000
6	Allen (NE)	TX-6596	Charcoal	10260 ± 360	12525-11405	Agate Basin	yes	Bamforth 2007; Holliday 2000
7	Allen (NE)	TX-6594	Bulk Charcoal	10600 ± 620	13120-11410	Agate Basin	no	Bamforth 2007; Holliday 2000
8	Vermilion Lakes (AB)	RIDDL 75	Charred Wood	9570 ± 150	11135-10715	Agate Basin	yes	Fedje et al. 1995

9	Vermilion Lakes (AB)	RIDDL 83	Bone Collagen	9700 ± 130	11235-10790	Agate Basin	yes	Fedje et al. 1995
10	Vermilion Lakes (AB)	RIDDL 77	Bone Collagen	9840 ± 200	11710-10870	Agate Basin	yes	Fedje et al. 1995
11	Vermilion Lakes (AB)	RIDDL 82	Charred Wood	10010 ± 180	11825-11245	Agate Basin	yes	Fedje et al. 1995
12	Sibbald Creek (AB)	GX-8808	Bulk Charcoal	9570 ± 320	11315-10310	Agate Basin	no	Gryba 1983
13	FfQh-27 (AB)	Beta - 104738	Organic Stain Sediment	11270 ± 50	13235-13115	Agate Basin	no	Kulle 1998
14	Lake Minnewanka (AB)	TO-9256	Mountain Sheep bone	10250 ± 60	12105-11825	Plano	yes	Landals 2002
15	Lake Minnewanka (AB)	TO-9257	Bison incisor	10110 ± 60	11960-11505	Plano	yes	Landals 2002
16	Lake Minnewanka (AB)	TO-9258	Mountain Sheep bone	10220 ± 50	12050-11825	Plano	yes	Landals 2002
17	Beacon Island (ND)	SR-6231	*Bison antiquus* Bone fragment	10330 ± 45	12375-12050	Agate Basin	yes	Ahler et al. 2004
18	Beacon Island (ND)	SR-6232	*Bison antiquus* M1	10305 ± 45	12370-11990	Agate Basin	yes	Ahler et al. 2004
19	Beacon Island (ND)	ETH-26780	charred wood, *Salix sp.*	10371 ± 82	12390-12095	Agate Basin	yes	Ahler et al. 2004
20	Beacon Island (ND)	ETH-26781	charred wood, *Salix sp.*	9911 ± 105	11600-11220	Agate Basin	yes	Ahler et al. 2004

Table 3.2 Calibrated Radiocarbon Dates of Agate Components from Archaeological Sites (*1 sigma, IntCal09 calibration curve, OxCal 4.1)

Radiocarbon dates on strata containing Agate Basin projectile points within the study area are available from only four sites; the Vermilion Lakes site (Fedje 1986; Fedje et al. 1995), the Sibbald Creek site (Gryba 1983), FgQh-27

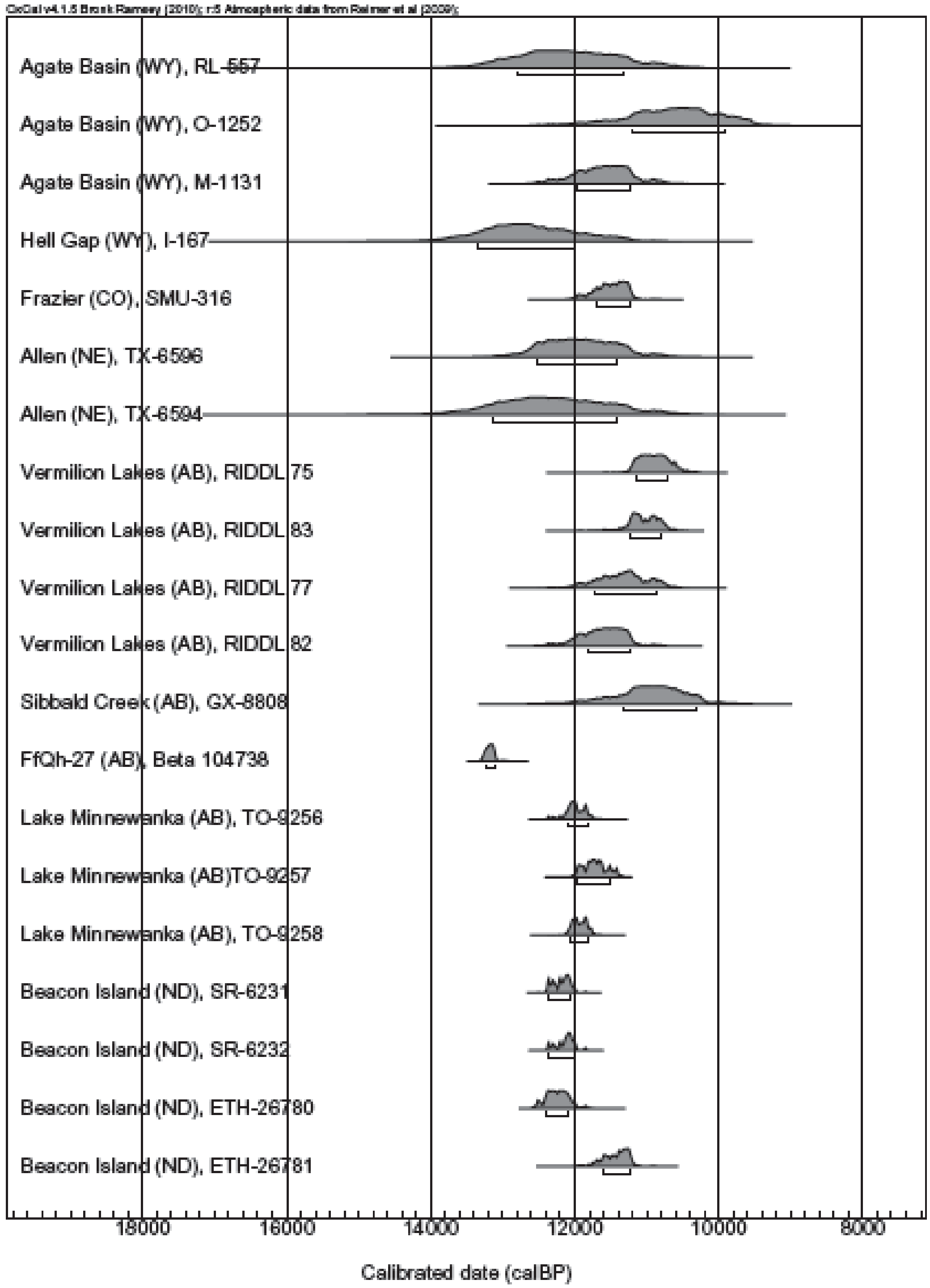


Figure 3.1 Agate Basin Calibrated Radiocarbon Dates within the Study Area and in the U.S.A. (IntCal09 calibration curve and one sigma range is shown, OxCal 4.1)

(Fedirchuk and McCullough 1998; Kulle 1998) and Lake Minnewanka[12] (Landals 2002) (Table 3.1). All four sites are located in southwestern Alberta and therefore only represent a small portion of the study area ABPP utilized. Regardless, they represent the only sample available for temporal comparison. The dates are listed with the qualifier of either being reliable or unreliable. The calibrated radiocarbon dates illustrated in Figure 3.1 from within and outside the study area fall within a large range based on the one sigma ranges presented. Further discussion regarding the date ranges will be presented in section 4.0.

3.2 Site Distribution and Site Class

The majority of sites (56.8%) are of site class 5. Only four Agate Basin sites 2.9%) are classified as site class 1 – stratified with ^{14}C dates (Figure 3.2, 3.3, Table 3.1). 139 Agate Basin sites in the study area are distributed throughout the provinces of Alberta and Saskatchewan with the majority of sites located in the southern halves of these two provinces (Figure 3.3). These sites vary considerably in the amount and quality of data recorded about or associated with them. Out of 139 Agate Basin sites located within the study area, 133 are located in the(southern half of Alberta and Saskatchewan (Figure 3.3). Only six sites are located in the north of Alberta (IkOs-1, IcPx-1, HiOw-38, and IeOs-5) and the north of Saskatchewan (IgOg-3 and IgOg-4).

[12] It is debatable as to whether Lake Minnewanka represents the Agate Basin projectile point typology or another paleoindian projectile point typology; however the dates are used here. See discussion in section 4.2.4.

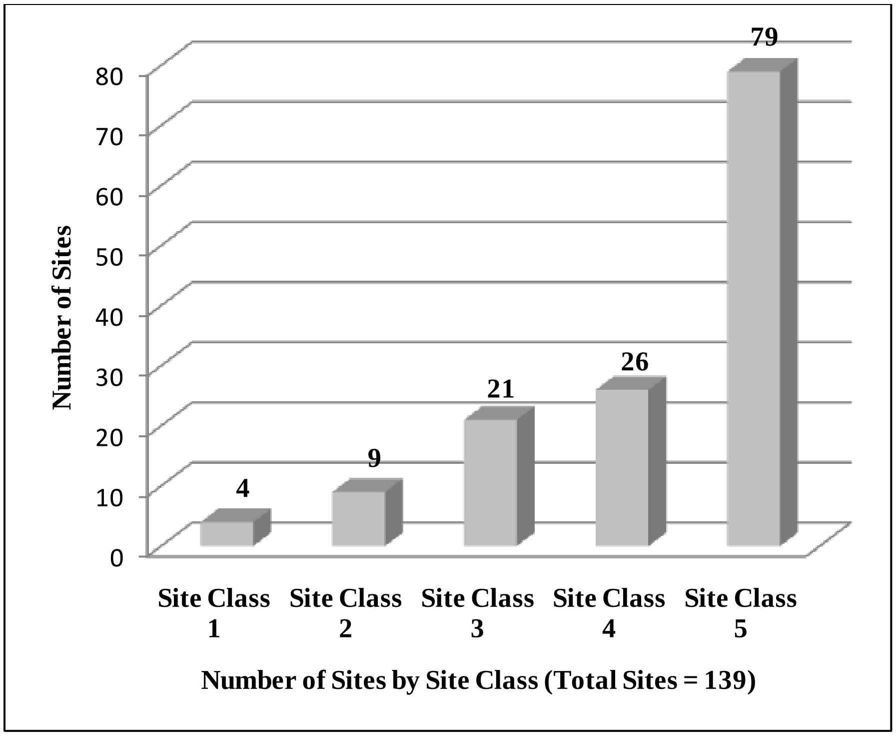


Figure 3.2 Agate Basin Archaeological Sites in the Study Area Differentiated by Site Class

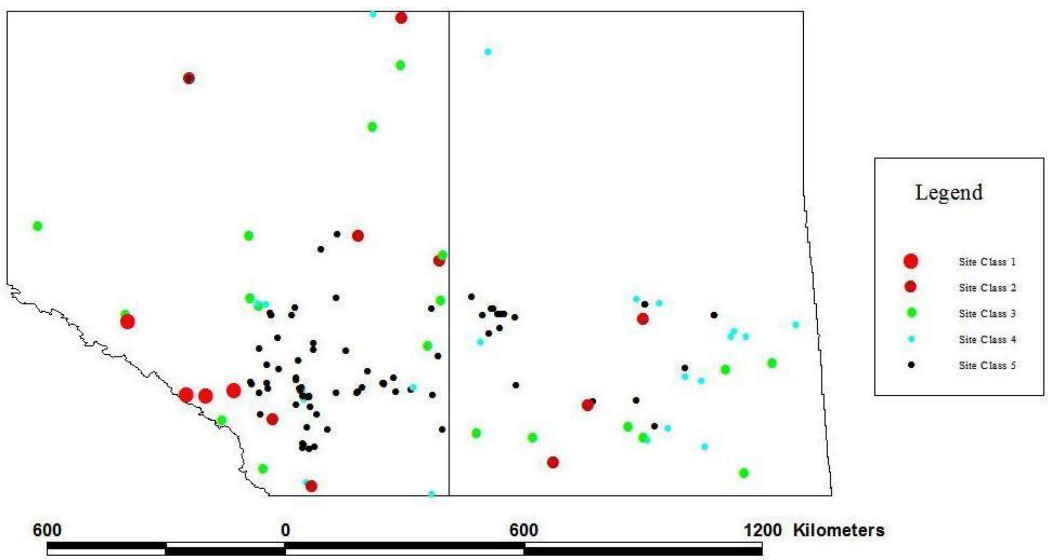


Figure 3.3 Distribution of One hundred and thirty-nine Agate Basin Sites Differentiated by Site Class

3.2.1 Relationship Between Site Locations and Present Human Population

There appears to be a relationship between Agate Basin site locations, major roadways (Figure 3.4), railways (Figure 3.5), and developed land (Figure

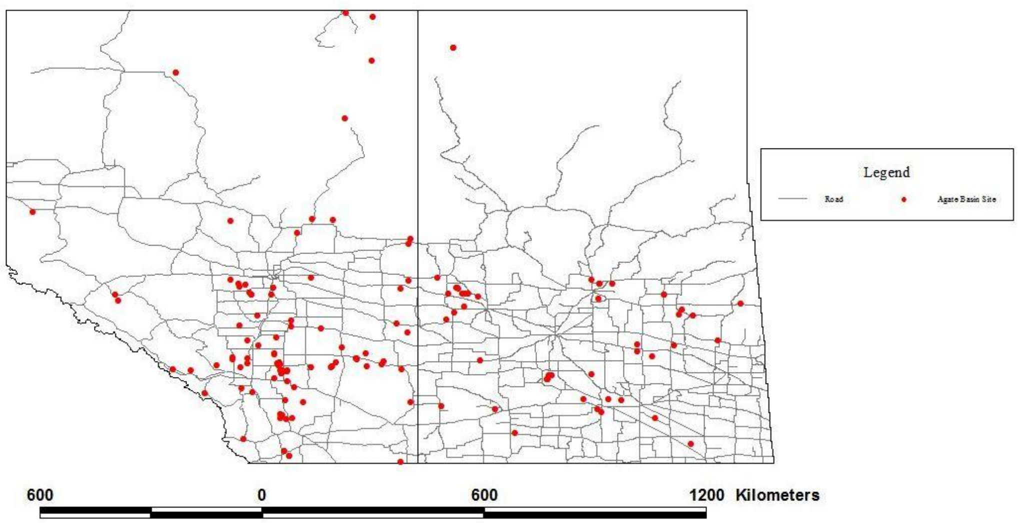


Figure 3.4 Agate Basin Archaeological Sites Compared with Major Roadways of Alberta and Saskatchewan

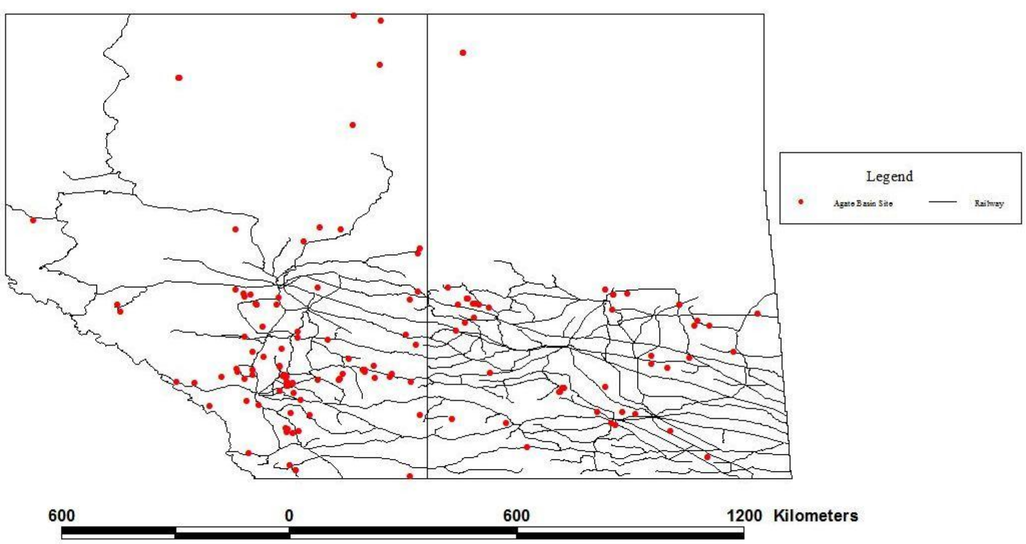


Figure 3.5 Agate Basin Archaeological Sites Compared with Major Railways of Alberta and Saskatchewan

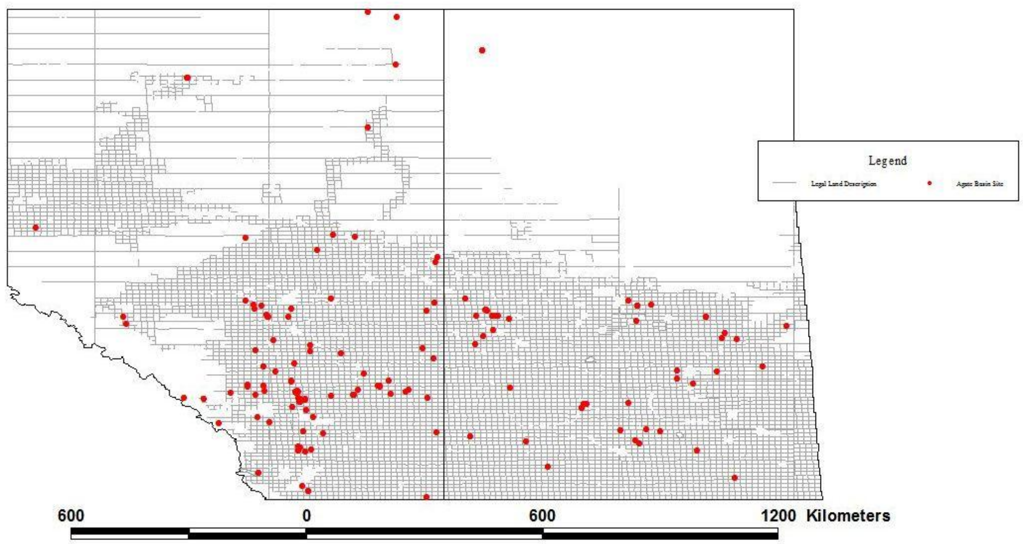


Figure 3.6 Agate Basin Archaeological Sites Compared with Legal Land Descriptions of Alberta and Saskatchewan)

3.6). Agate Basin sites within areas of Alberta and Saskatchewan covered by detailed legal land description[13] represent surveyed, settled and developed land, largely agricultural development, according to the Earth Science Sector (ESS) of Natural Resources Canada (NRCan) (Figure 3.6). Legal land description reflects the majority of developed and occupied land.

These types of development act as proxy indicators of a larger pattern of settlement and land development in the study area. It is clear that the majority of Agate

Basin sites in the study area are located in areas of greatest modern population impact. Human activity such as infrastructure, settlement, and agriculture leads to site discovery. Because of this, any discussion of Agate Basin settlement and adaptation will be biased towards sites located in the southern halves of Alberta and Saskatchewan.

[13] Legal land description refers to a method of locating or describing land in relation to public land survey.

3.3 Agate Basin Landform Use

A total of 77 sites reported sufficient information to be placed in one of the five landform categories. The shore landform category (Landform Type 1) consists of 13 sites (17% of the total) located within 20 meters of an existing body of water (Figure 3.7). Since dry lake basins or ponds are not always identified and

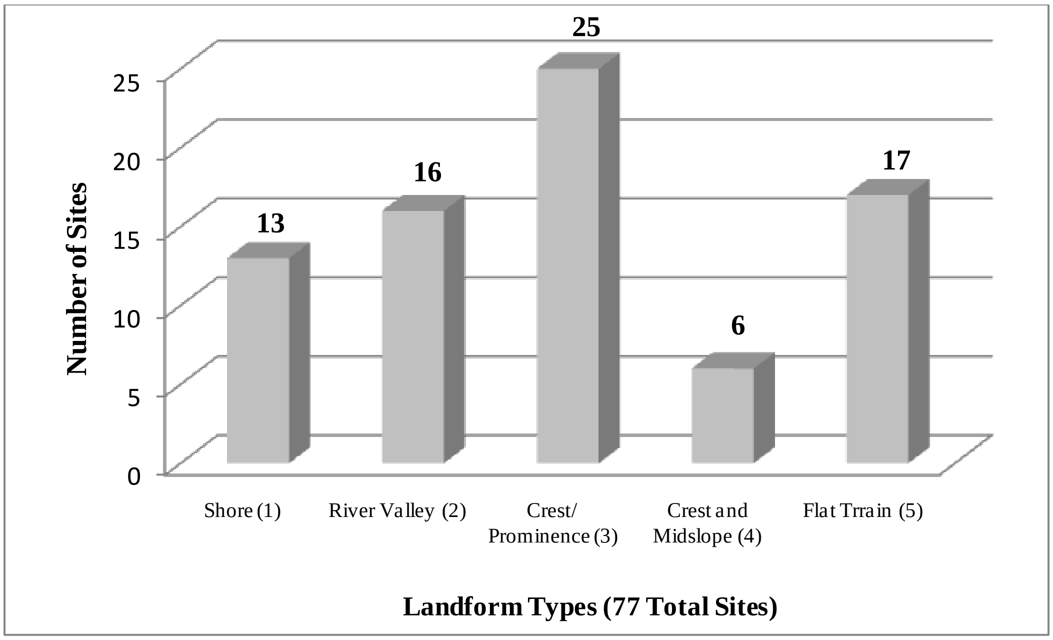


Figure 3.7 Landform Types Associated with Agate Basin Sites in Alberta and Saskatchewan

recorded, this landform category may include more sites especially in the arid and semiarid portions of the study area.

River valley sites (Landform Type 2) consists of 16 sites (21% of the total). This landform class provides the most detailed archaeological remains of Agate Basin. The Vermilion Lakes and the Sibbald Creek sites are shore/midslope sites and contain intact stratigraphy and radiocarbon dates (site class 1). 25 sites (32% of the total) fall into the crest and prominence category (Landform Type 3). This landform type refers to features elevated on relatively low-lying terrain such as moraines, knolls and other features. Six sites (8 % of the total) fall into the crest and mid-slope category (Landform type 4). These are sites found on slopes or at the base of a crest or prominence, and make up the smallest category of sites. 17 sites (22% of the total) fall into the flat terrain category (Landform Type 5). These sites contain no recorded land features.

A further attempt was made to find associations of landform types and Agate Basin site frequencies. Detailed Quaternary landform maps were downloaded from the Alberta Geological Survey (2005. *Alberta Geological Survey*, accessed 2010) and compared to Agate Basin sites found in the same area as the quaternary landforms are documented. This duplicates a similar study undertaken in Alberta area regarding paleoindian fluted points (Ives 2006).

85 Agate Basin sites in central and southern Alberta are compared to Quaternary landform features. The percentage of the 85-site sample was compared with the percentage that each of the Quaternary landforms occupy as a total area in central and southern Alberta. This was done in order to discern if there were any discrepancies between the two frequencies. For example, if there are a significantly higher percentage of sites located on moraines than what moraines make up as a percentage on the total landscape, then this indicates an ABPP preference for choosing to locate sites on this landscape feature. The results of this comparison illustrate some discrepancies between the frequency of ABPP site selection and the frequency of certain Quaternary landforms (Figure 3.8).

Three Quaternary landform categories that initially stand out as preferred

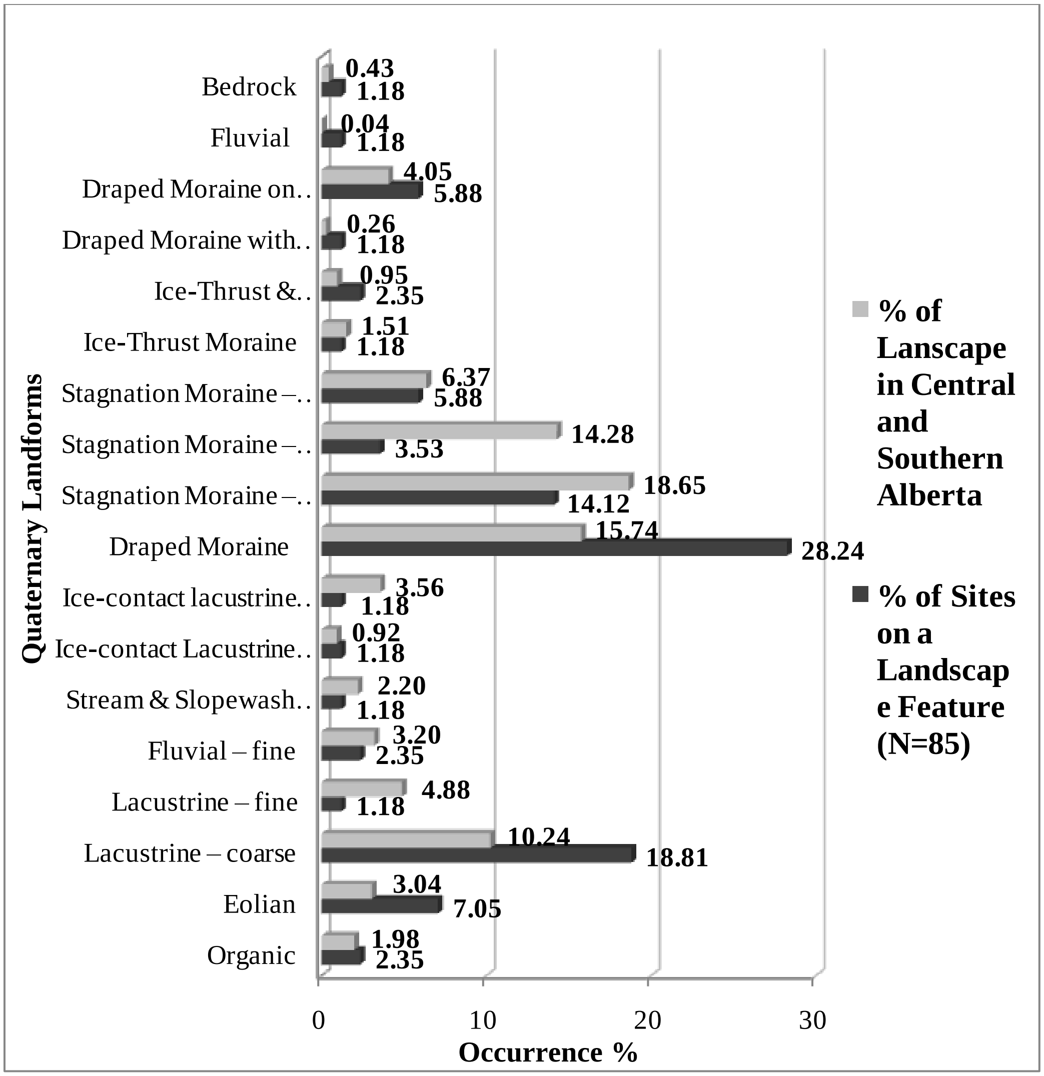


Figure 3.8 Percentage of Agate Basin Archaeological Sites Found on each of the Quaternary Landforms in Central and Southern Alberta, plotted with the % of the Landscape each Quaternary Landform Occupies

landforms for Agate Basin site selection are the Draped Moraine, the Lacustrine-coarse and the Eolian Quaternary landform categories. Conversely, the Stagnation Moraine seems to have been avoided by ABPP for site selection based on this comparison.

3.3.1 Agate Basin Sites and Water Sources

The proximity of 82 Agate Basin sites to known water bodies indicates that the plurality of sites, 39 (47.5%), are situated within 100 meters of a water source (Figure 3.9). 62 sites (75.6%) occur within 500 meters, while a total of 20

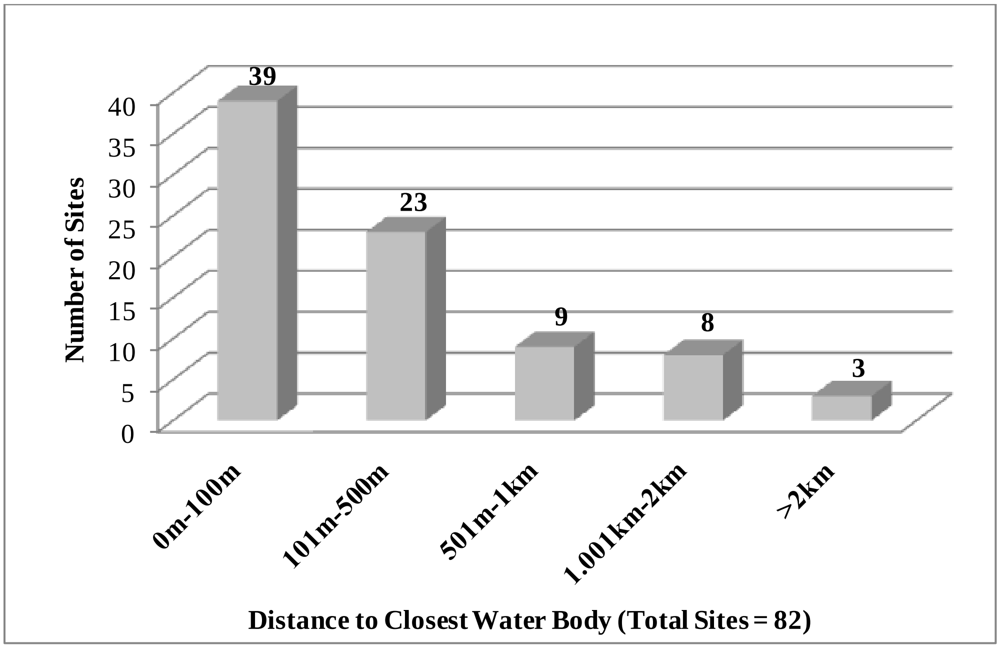


Figure 3.9 Proximity 82 Agate Basin Sites to Known Water Sources

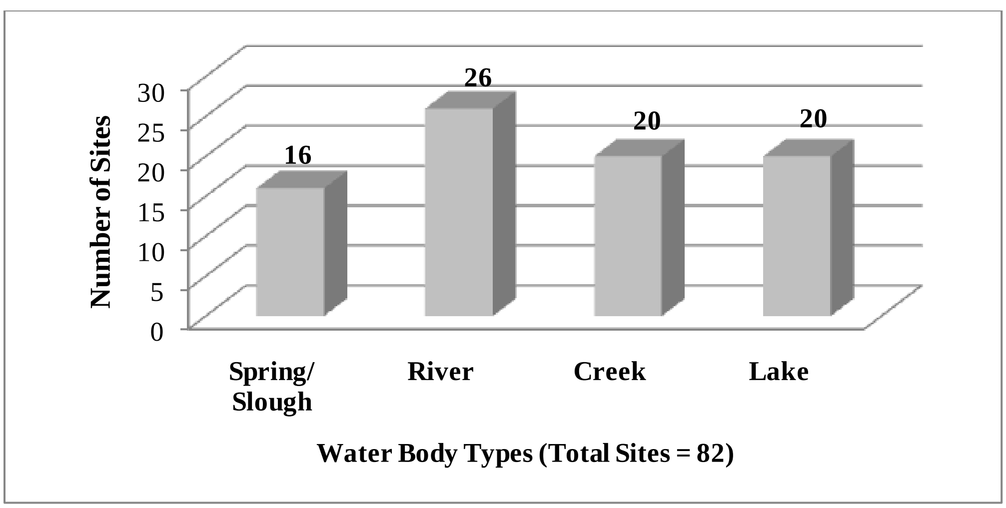


Figure 3.10 Site Associations with Different Water Body Types

sites (24.4%) occur at a distance of greater than 500m from a known water source. The frequency of sites declines with increased distance to water.

The site locations relative to water body type are relatively evenly divided between spring/slough, creek, river valley and lake, although springs and sloughs have the lowest frequency of association with Agate Basin sites, while rivers have the highest frequency of association (Figure 3.10).

3.3.2 Site Aspect

The aspects of 19 sites on slopes were examined to determine preference

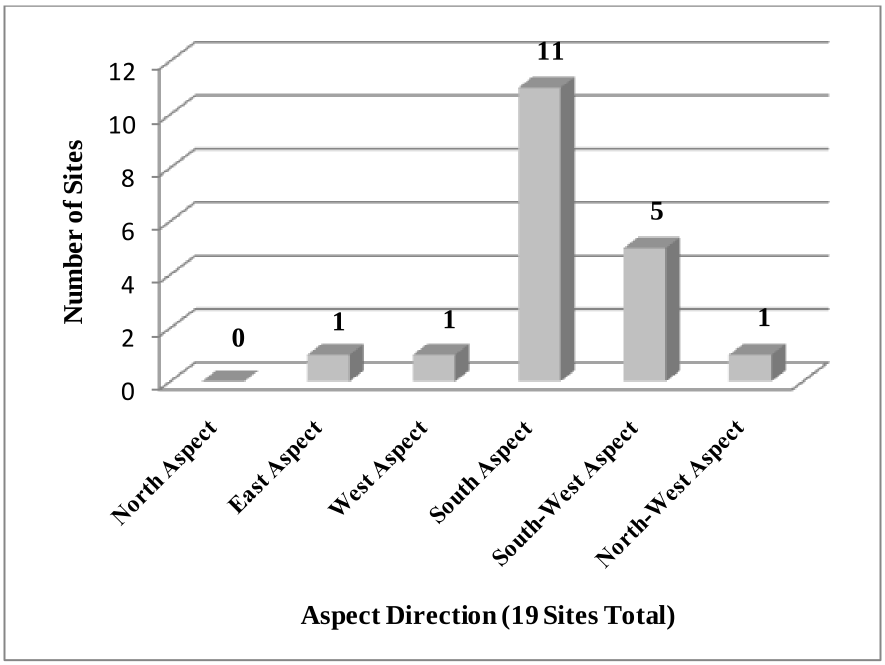


Figure 3.11 Slope Facing Direction of Relevant Agate Basin Sites

in site location for a particular slope facing direction (Figure 3.11). The majority of these sites are associated with south and southwest facing slope directions. These directions account for 84.2% (16 sites) of the sites with this information (Figure 3.12). Three other slope facing directions are represented by one site each: east, west and northwest.

3.4 Projectile Point and Lithic Analysis

The morphology of projectile points and the type and source of lithic material used in artifact production remain central for demonstrating the adaptations of Agate Basin projectile producing people. The following are results of the analyses of Agate Basin projectile points from inside and outside the study area.

3.4.1 Alberta and Saskatchewan Agate Basin Projectile Point Measurements

Length, width and thickness measurements of intact Agate Basin projectile points were recorded and the results are as follows (Table 3.3, Table 3.4, and Appendix 1).

3.4.1.1 Agate Basin Projectile Point Metric Measurements

38 Agate Basin projectile points from Alberta were measured (Table 3.3). 29 Agate Basin projectile points from Saskatchewan were measured (Table 3.4).

#	Site/ Collection	Accession Number	Province	Length (cm)	Width (cm)	Thickness (cm)
1	GfPd-100 (GfPd-1)	99.5	Alberta	5.93	2.08	0.73
2	DhPh-87	87.3	Alberta	6.6	2.36	0.78
3	GfPa-6	92	Alberta	7.15	2.19	0.79
4	FiPo-264	1	Alberta	5.15	1.82	0.61
5	IlOw-7	1	Alberta	6.4	2.45	0.84
6	FiPp-27	995	Alberta	11.8	3.86	1.36
7	FiPp-27	1200	Alberta	7.78	3.17	0.97
8	IkOs-1	113	Alberta	5.9	2.1	1
9	IeOs-5	18	Alberta	10.1	3.24	1.14
10	IeOs-5	7	Alberta	9.09	5.41	1.43
11	EhPu-1, Surface Find	349R12E1.1	Alberta	6.77	1.95	0.76
12	EgPr-2	7717	Alberta	4.1	2.03	0.59
13	Vermilion Lakes	153Rd	Alberta	7.4	2.2	0.9
14	Vermilion Lakes	153Re	Alberta	5.35	1.9	0.6
15	Vermilion Lakes	520Ra	Alberta	4.75	2.21	0.6

16	GdOo-16	4793	Alberta	5.3	2.21	0.61
17	Derdrich Collection	H97.89.55	Alberta	4.05	1.75	0.6
18	Derdrich Collection	H97.89.19	Alberta	3.99	2.24	0.68
19	Scriver Collection	H90.142.10	Alberta	3.9	1.96	0.87
20	Light Collection	H88.118.2	Alberta	3.9	1.97	0.81
21	Johnson Collection	60.2.561	Alberta	5.39	2.17	0.73
22	Wichender Collection	56.2.45	Alberta	7.79	2.32	0.95
23	Unnamed Collection (Tray E-22)	H67.354.347	Alberta	7.09	2.38	1.18
24	Unnamed Collection (Tray D-22)	H67.354.1	Alberta	7.08	2.32	1.05
25	Unnamed Collection (Tray G-22)	H73.13.22	Alberta	6.01	2.02	0.58
26	Unnamed Collection (Tray W26)	H03.15.216	Alberta	4.8	2.06	0.6
27	Unnamed Collection (Tray W26)	H03.15.197	Alberta	6.23	1.74	0.73
28	Unnamed Collection (Tray G-22)	H.68.4.73	Alberta	6.11	2.48	0.86
29	Dzurko Collection	H05.78.27	Alberta	5.8	2.3	0.55
30	Dzurko Collection	H05.78.43	Alberta	6.4	0.94	0.46
31	Dzurko Collection	H05.78.46	Alberta	5.42	1.89	0.8
32	Dzurko Collection	H05.78.91	Alberta	4.26	1.9	0.79
33	Robinson Collection	H78.24.3	Alberta	6.12	1.88	0.96
34	Howard Collection	61.1.26	Alberta	5.99	2.38	0.99
35	Howard Collection	61.4.658	Alberta	4.25	2.2	0.61
36	Howard Collection	61.4.785	Alberta	5.56	1.9	0.69
37	McKay Collection	H88.139.58	Alberta	6.09	2.23	0.9
38	McKay Collection	H88.139.60	Alberta	4.76	2.22	0.58
			Average	**6.07**	**2.27**	**0.81**

Table 3.3 Alberta Agate Basin Projectile Point Measurements

***Private collections donated to and stored at the Royal Alberta Museum**

#	Site/ Collection	Accession Number	Province	Length (cm)	Width (cm)	Thickness (cm)
1	FgOe-10	1	Saskatchewan	6.35	2.6	1.8
2	FgOe-16	2	Saskatchewan	4.35	2	0.7
3	FjOi-13	5	Saskatchewan	6	2.2	0.9

4	FgOc-6, Larry Iverson Collection	2	Saskatchewan	6.1	2.4	1.9
5	FgOe-10, Leclare Collection	1	Saskatchewan	5.4	1.9	0.6
6	FhOg-14	1	Saskatchewan	4.4	1.9	0.8
7	FhOg-4, Cooper Collection	5	Saskatchewan	8.1	2.85	0.9
8	EgNo-41	3	Saskatchewan	6.5	2.2	0.9
9	EbNj-4, Parkhill Site	2	Saskatchewan	7.65	2.45	0.8
10	EbNj-4, Parkhill Site	3	Saskatchewan	6.4	2.7	0.85
11	EbNj-4, Parkhill Site	6	Saskatchewan	8.5	2.65	0.7
12	EbNj-4, Parkhill Site	7	Saskatchewan	5.75	2.2	0.65
13	EbNj-4, Parkhill Site	12	Saskatchewan	5.76	2.11	0.7
14	EbNj-4, Parkhill Site	604	Saskatchewan	4.01	1.96	0.96
15	EbNj-4, Parkhill Site	431	Saskatchewan	5.21	2.12	0.51
16	Phenix Collection	AS2	Saskatchewan	6.9	2.82	0.93
17	Phenix Collection	COA	Saskatchewan	5.26	2.39	0.93
18	Phenix Collection	321	Saskatchewan	6.33	2.51	0.74
19	Phenix Collection	633	Saskatchewan	5.56	2.55	0.73
20	Phenix Collection	470	Saskatchewan	6.81	2.79	1.11
21	Phenix Collection	No # (a)	Saskatchewan	5.59	2.19	0.82
22	Phenix Collection	No # (b)	Saskatchewan	5.83	2.41	0.9
23	Phenix Collection	No # (c)	Saskatchewan	6.51	2.52	0.82
24	Phenix Collection	636	Saskatchewan	7.4	2.81	0.98
25	Phenix Collection	637	Saskatchewan	5.45	2.39	0.92
26	Phenix Collection	320	Saskatchewan	5.41	2.52	0.76
27	Phenix Collection	459	Saskatchewan	6.31	2.41	0.9
28	Phenix Collection	497	Saskatchewan	7.56	2.98	0.99
29	Phenix Collection	455	Saskatchewan	13.31	3.6	0.92
			Average	**6.37**	**2.45**	**0.9**

Table 3.4 Saskatchewan Agate Basin Projectile Point Measurements

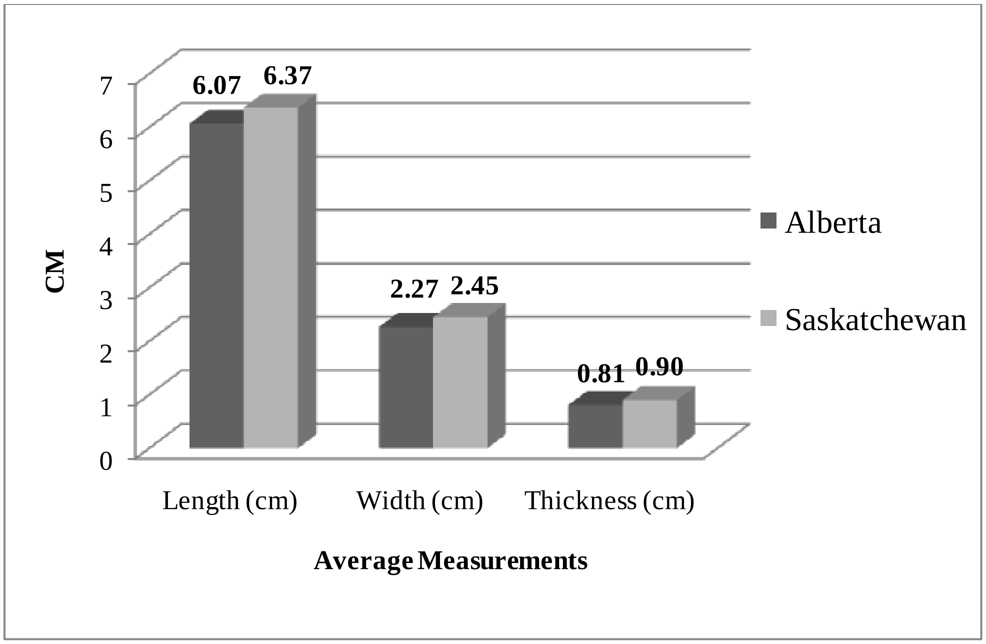


Figure 3.12 Average Metric Measurements of Agate Basin Projectile Points from the Alberta and Saskatchewan Samples Compared

Saskatchewan points are on average longer, wider and thicker than those from Alberta are (Figure 3.12). However, the differences in these average metric measurements are marginal.

3.4.1.2 Agate Basin Projectile Point Raw Material Type

The lithic composition of 38 Agate Basin points from Alberta was

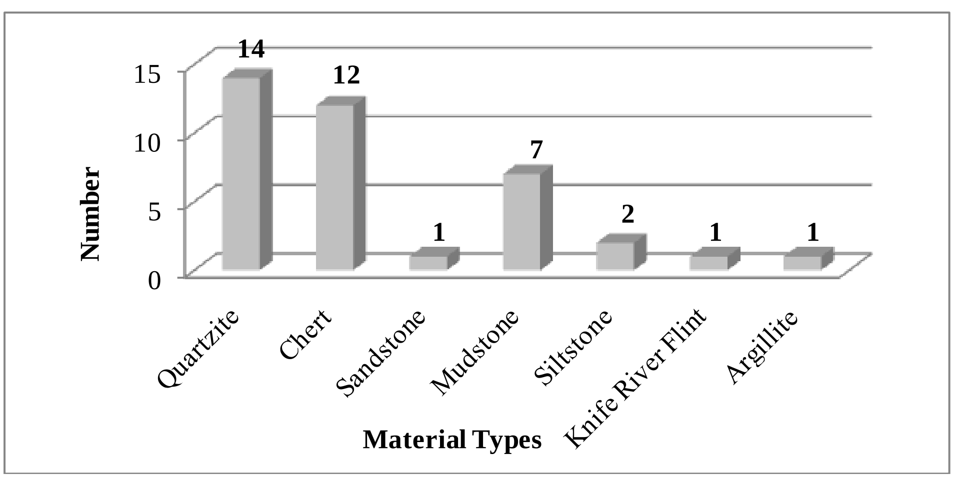


Figure 3.13 Raw Material Types of Agate Basin Projectile Points, Alberta (Total 38)

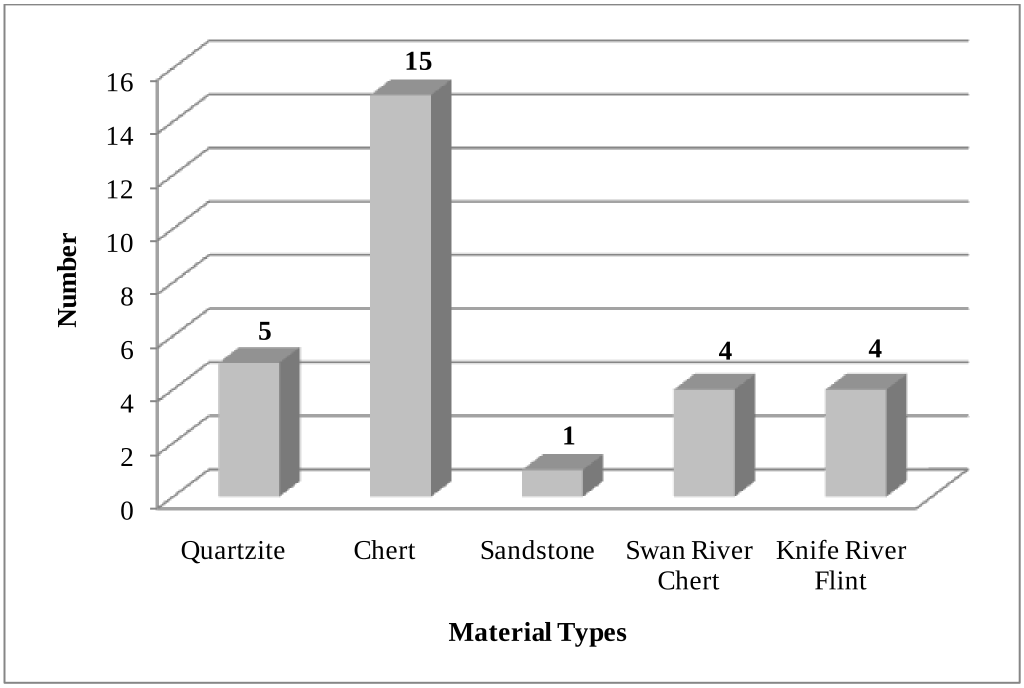


Figure 3.14 Raw Material Types of Agate Basin Projectile Points, Saskatchewan (Total 29)

determined (Figure 3.13, Appendix 1). Cherts account for 34%, while quartzite accounts for 37%. Other material types account for 29% of the total sample.

29 Agate Basin points from Saskatchewan were examined (Figure 3.14, Appendix 1). Swan River Chert (SRC), and Knife River Flint (KRF) account for 26% of the total sample and other cherts account for 52% of the total sample. Other materials account for only 22% of the total sample. The Saskatchewan sample has only one example of a sedimentary material type (sandstone) while the Alberta sample has significant quantities of sedimentary material types (26%). Of importance to note is that the Saskatchewan sample is made up of a much greater percentage of both cherts (52%) and distinctive raw materials such as SRC and KRF (28%).

3.3.1.3 Lithic Reworking of Agate Basin Projectile Points

19 Agate Basin projectile points within the study area sample were

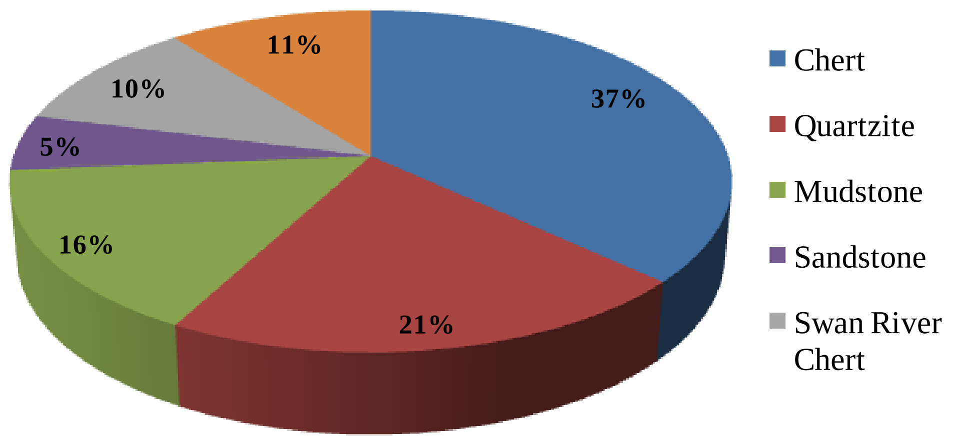


Figure 3.15 Material Type Frequencies for Reworked Agate Basin Projectile Points in Alberta and Saskatchewan (Total = 19)

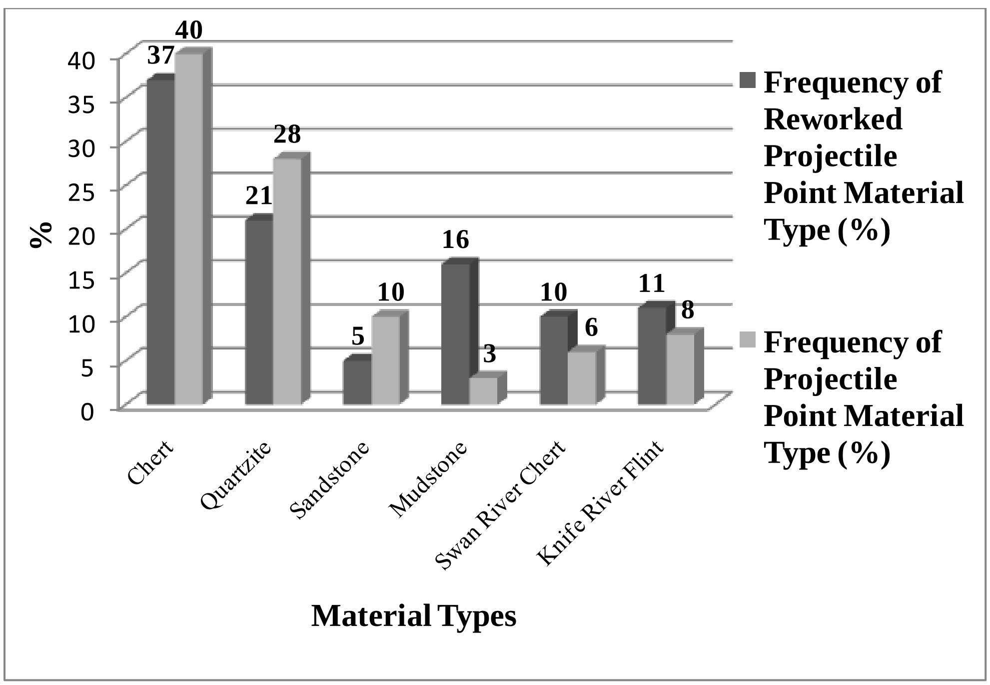
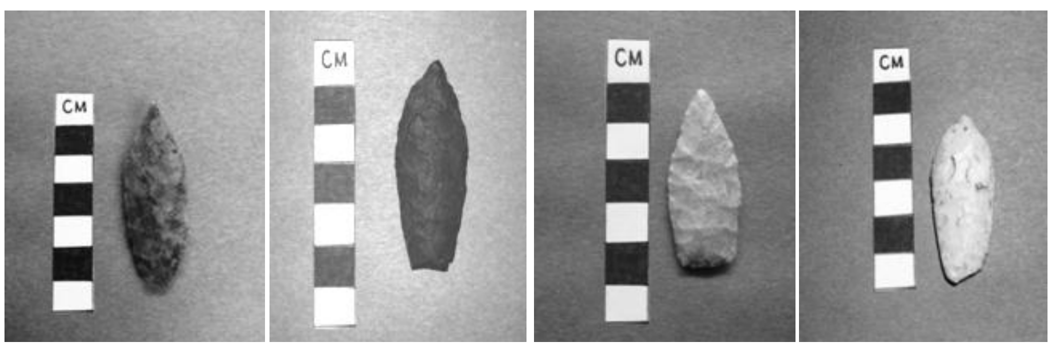


Figure 3.16 Agate Basin Projectile Points: Raw Material Type Compared to Reworking Frequency

diagnosed to be reworked (Figure 3.15, Appendix 1, Appendix 6). Cherts and diagnosed materials, such as SRC and KRF, make up the majority of projectile point material types that appear to have been reworked. The frequency of the material type of the total sample of projectile points was also compared to the frequency of the material type of the reworked projectile points (Figure 3.16). This comparison shows that certain material types have an abnormally low frequency of reworking compared to their overall frequency of material type in the total sample. For example, mudstone only makes up 3% of the total projectile point material type sample, whereas it makes up 16% of the reworked material type sample.

Figure 3.17 illustrates four samples documented within the study area that demonstrate reworking. The criterion used to determine whether a projectile point had been reworked was a deviation of the outline morphology from the ideal



1. IkOs-1 (113) **2. Dzurko Collection (H05.78.27)** **3. Howard Collection (61.4.658)** **4. Phenix Collection (497)**

Figure 3.17 - Four Samples of Reworked Projectile Points from the Study Area (see Appendix 1, Appendix 6)

form. The projectile points appear to have a truncated distal end, likely due to being reshaped after wear and breakage. These projectile points likely represent the end of use life.3.4.2 Comparisons with the Agate Basin Type Site, Wyoming.

3.4.2.1 Morphometric Comparisons between the Study Area and the Type Site

Length, width and thickness measurements of 41 Agate Basin projectile points from the Wyoming type site (Table 3.5) have been published by Frison and

#	Specimen	Length (cm)	Width (cm)	Thickness (cm)
1	2.48a	11.15	2.00	0.62
2	2.48b	10.50	2.20	0.60
3	2.48c	11.90	2.60	0.68
4	2.48e	7.80	2.40	0.87
5	2.48f	8.80	2.20	0.70
6	2.48g	6.70	1.80	0.60
7	2.48h	5.50	2.00	0.62
8	2.48i	8.40	1.90	0.70
9	2.48j	7.80	1.90	0.59
10	2.48k	7.00	2.00	0.69
11	2.48l	2.00	5.75	0.61
12	2.48m	5.90	2.50	0.74
13	2.49d	6.70	2.40	0.87
14	2.49e	6.30	1.50	0.62
15	2.49f	5.70	1.60	0.61
16	2.49k	6.80	2.40	0.71
17	2.49m	10.30	2.40	0.89
18	2.50a	7.10	1.80	0.82
19	2.50g	4.20	1.75	0.69
20	2.50i	9.50	2.50	0.81
21	2.50p	4.95	1.70	0.59
22	2.51a	8.00	2.40	0.76
23	2.51b	9.60	2.30	0.61
24	2.51e	7.90	2.60	0.74
25	2.51g	13.90	2.10	0.70
26	2.51h	5.40	1.90	0.73
27	2.51i	8.40	2.50	0.73
28	2.51l	5.50	1.70	0.54
29	2.51m	7.80	2.45	0.90
30	2.52b	11.05	2.50	0.80

31	2.52d	8.30	2.30	0.78
32	2.52f	5.75	2.00	0.69
33	2.52h	7.00	1.60	0.61
34	2.52i	7.40	1.80	0.61
35	2.52k	8.95	2.70	0.75
36	2.53c	6.50	1.60	0.55
37	2.53n	7.82	2.31	0.78
38	2.53o	8.43	2.20	0.88
39	2.56a	10.11	2.52	0.75
40	2.56j	10.03	2.35	0.69
41	2.56k	7.91	2.11	0.71
	Averages	**7.82**	**2.23**	**0.71**

Table 3.5 Metric Measurements of Projectile Points from the Agate Basin Site, Wyoming (from Frison and Stanford 1982)

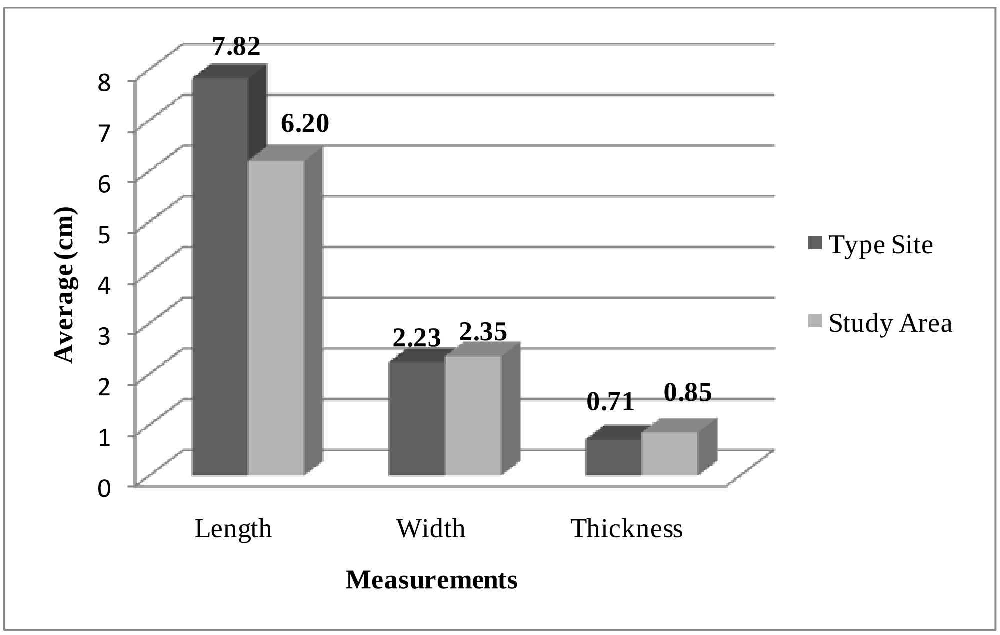


Figure 3.18 Comparisons of Average Metric Measurements Between the Study Area Projectile Point Sample and Type Site Projectile Point Sample

Stanford (1982). Comparisons with the study area projectile point sample indicate notable differences. Type site projectile points tend to be longer (1.6 cm), narrower (0.12 cm) and thinner (0.14 cm) than the sample compiled from the study area (Figure 3.18).

3.3.2.2 Comparison of Raw Material Types Between the Study Area and the Type Site

The study area projectile point material types are represented by a wide

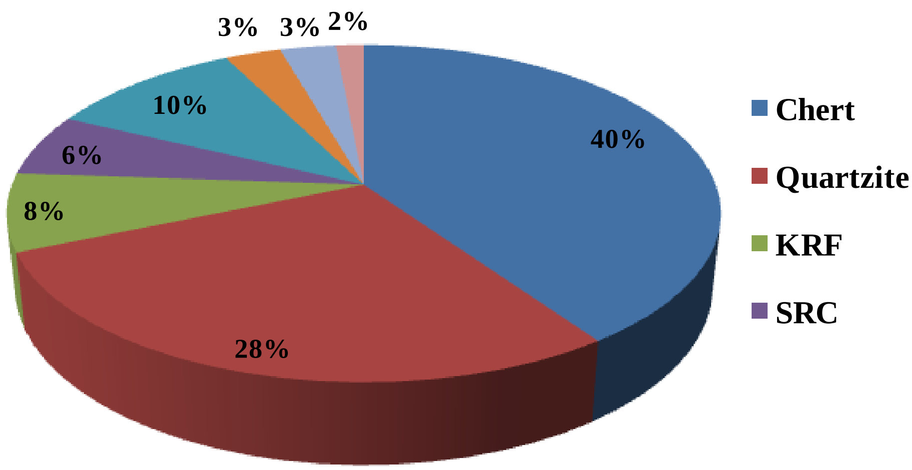


Figure 3.19 Raw Material Types of 67 Agate Basin Projectile Points from the Study Area (KRF=Knife River Flint, SRC=Swan River Chert)

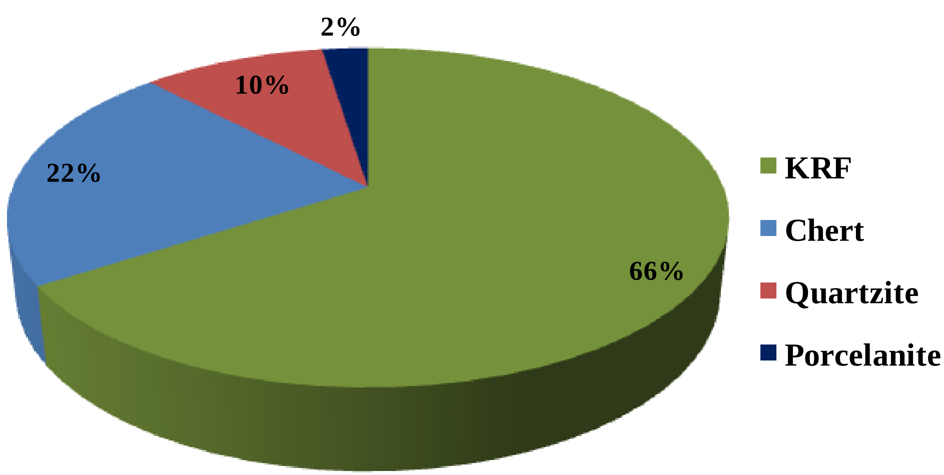


Figure 3.20 Raw material types of 41 Agate Basin Projectile Points from the Type Site (KRF=Knife River Flint)

array of source materials. Of the 67 projectile points analyzed, the largest material type represented consists of chert (40%), with diagnosed cherts such as SRC and KRF making up another 14%. Quartzite represents 28% of the total sample, while the remainder of material types represents 18% (Figure 3.19). This is in sharp contrast to the raw materials recovered from the Agate Basin type site. KRF makes up 66% of the type site lithologies. In total, chert accounts for 88% of the type site lithologies (see Figure 3.20).

3.3.2.3 Comparison of Reworking between the Study Area and the Type Site

Study area projectile points exhibit higher frequencies of reworking than those from the type site (Figure 3.21, Appendix1). Approximately 28% of all specimens in the study area have likely been reworked, compared with

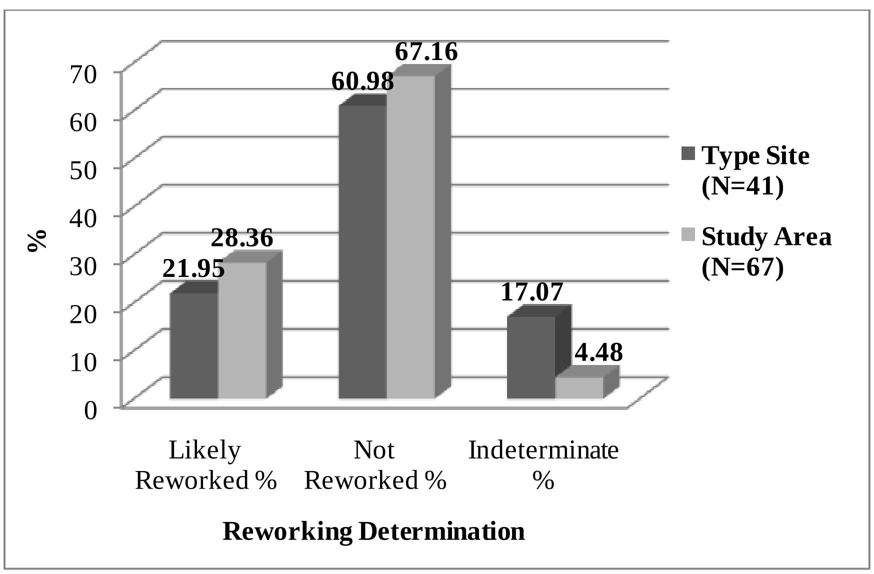


Figure 3.21 Comparison of Reworking Frequency between the Study Area and the Type Site

approximately 22% of the type site specimens. This explains part of the discrepancy in average length between the two groups.

3.5 Climate and Ecology of the Late Pleistocene/Early Holocene

One objective of this thesis is to contextualize ABPP within the unique late Pleistocene/early Holocene palaeoenvironment. For this purpose, a subset of 15 palaeoenvironmental sites have been assembled and reviewed, 13 of which are within the study area (see methods) (Table 3.6, Figure 3.22).

The palaeoenvironmental sites are scattered over the study area are confined to the southern halves of Alberta and Saskatchewan (Figure 3.22). Seven of the palaeoenvironmental sites are located in the Rocky Mountains and adjacent foothills while the remainder represent the plains region. Two sites from the

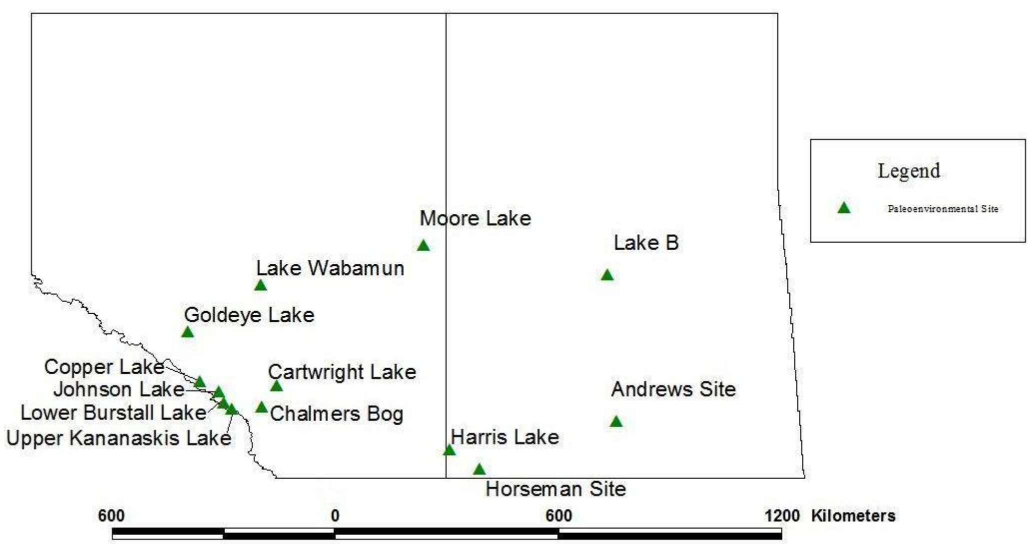


Figure 3.22 Palaeoenvironmental Site Locations in Alberta and Saskatchewan

U.S.A. are also referenced because of their close proximity to the study area and thus have relevant data.

General trends of warming and increasing aridity are documented throughout the late Pleistocene/early Holocene based on proxy evidence of ecological changes. Different regions express these changes differently within the

#	Site	Time frame (Cal years BP)	Location	Summary of Records	Reference
1	Upper Kananaskis Lake	pre 10.5	Rocky Mountains, SW Alberta	Glacial runoff was at a minimum indicating glacial retreat and/or an absence of glacial melt-water runoff, likely due to steadily increasing temperatures.	Beierle and Smith 1998
2	Lower Burstall Lake	10.4-10.2	Rocky Mountains, SW Alberta	Glacial runoff was at a minimum indicating glacial retreat and/or an absence of glacial melt-water runoff, likely due to steadily increasing temperatures.	Beierle and Smith 1998
3	Copper Lake	12.5-10.7	Rocky Mountains, SW Alberta	Glacial runoff was at a minimum indicating glacial retreat and/or an absence of glacial melt-water runoff, likely due to steadily increasing temperatures.	Beierle and Smith 1998
4	Johnson Lake	11.1-10.4	Rocky Mountains, SW Alberta	Glacial runoff was at a minimum indicating glacial retreat and/or an absence of glacial melt-water runoff, also likely due to increased temperatures.	Beierle and Smith 1998
5	Cartwright Lake	11.5-10.5	Alberta Foothills, SW Alberta	Deglaciation of Rocky Mountain foothills suggesting warmer temperatures and possibly less winter precipitation	Beierle and Smith 1998
6	Goldeye Lake	13.4-10.4	Alberta Foothills, SW Alberta	By 10,400 cal years BP a freshwater planktonic assemblage had replaced the previous saline assemblage, indicating increased freshwater input.	Hickman and Schweger 1993
7	Chalmers Bog	pre 9.5	Alberta Foothills, SW Alberta	Characterized by decreasing values of non-arboreal pollen, such as Artemisia. Increasing amounts of *Pinus*, *Betula* and Salix occur at the same time. This indicates increasing landscape stability, along with increased temperatures.	Mott and Jackson 1982
8	Moore Lake	12.3-10.2	East Central Alberta	Moore Lake was initially fresh water, but became saline at roughly 11,000 ca yr BP and remained as such well past 10,200 cal years BP. This implies a period of either increased temperature, decreased precipitation, or some combination of the two. Up to 11,000 cal years BP the core retrieved is dominated by *Picea* pollen. Artemisia, Cyperaceae, and Gramineae decline in abundance, while Salix and *Populus* reach their maximum values. This open-forest environment has no modern analogue. Based on a sharp increase in the abundance of *Betula* and *Pinus*, along with a decrease of *Picea* and *Populus* starting at roughly 10,900 cal yr BP formed open mixed forest communities.	Hickman and Schweger 1993, 1996

9	Lake Wabamun	11.6-10.7	Central Alberta	Lake Wabamun was eutrophic throughout the early Late Pleistocene/early Holocene based on decreased diatom numbers and increased levels of salinity throughout the early Late Pleistocene/early Holocene , indicating increased aridity/temperatures.	Hickman and Schweger 1991; Schweger and Hickman 1989; Hickman et al. 1984
10	Harris Lake	11.1-9.9	SW Saskatchewan Cypress Hills	The most abundant pollen at this time is *Populus* along with Chenopodiaceae/Amaranthaceae. *Pinus* and *Picea* pollen remains relatively low but are increasing in frequency during this period. This complex is called the *populus* forest grassland-shrub mosaic (Sauchyn and Sauchyn 1991,20). This mosaic likely varies from other areas at this time due to the elevation of Harris Lake and the surrounding area, which is approximately 400 m. The climate was relatively warm and dry because the pollen indicates the area consisted of an aspen forest with minimal *Picea* and a significant complex of shrubs and herbs.	Last and Sauchyn 1993; Porter et al. 1999; Sauchyn and Sauchyn 1991; Sauchyn 1990
11	Horseman Site	12.2-10.6	SW Saskatchewan Cypress Hills	Area was dominated by sage and grasses, but some deciduous and coniferous trees were present in the region, roughly from 12,200 – 10,600 cal years BP.	Klassen 1994
12	Lake B	12.4-11.7	Central Saskatchewan	This period is dominated by *Picea* pollen and encompasses a spruce peak. Spruce pollen accounts anywhere from 90%–50% of total pollen.	Mott 1973
13	Andrews Site	12.3-11.4	SW Saskatchewan	Presence of *Picea glauca* and wet meadow herbs indicates spruce forest vegetation likely occupied the area at 12,000 cal yr BP. This was replaced by a deep water pond and deciduous parkland environment from 11,500 cal yr BP.	Yansa 2006
14	Moon Lake	12.8-10.7	East North Dakota, U.S.A	Between 12,800 and 10,700 cal years BP , salinity increased, interrupted by at least one relatively short-lived freshwater event (Laird et al. 1996, 1998). Further, the pollen record indicates that the area was relatively cool and moist until approximately 11,200 cal yr BP, as evidenced by spruce forest. After this, deciduous parkland and increased water salinity indicate a changing climate of the area, from wetter and cooler conditions preceding 10.3 kya to warmer and drier conditions increasing until after 9.2 kya	Laird et al. 1996, 1998
15	Guardipee Lake	12.4-9.9	Montana, U.S.A.	High nonarboreal percentages and small amounts of *Juniperus*, *Salix* and *Populus* pollen in sediments deposited between ca. 12,200 and ca. 9300 cal years BP suggest temperate grassland with shrubs growing locally in mesic settings. (Barnosky 1989, 57). This was accompanied by drier and hotter conditions at 9400 cal years BP, and there was little to no tree cover throughout the 12,400-year history illustrated by the core.	Barnosky 1989

Table 3.6 Palaeoenvironmental Site Data Summary

study area due to numerous factors such as geographic position, elevation, and the time transgressive influence of the retreating Laurentide ice sheet. This is expanded upon in Chapter 4 (Sections 4.2, 4.4 and 4.5).

Depending on the particular location within the study area, a pattern of environmental change occurred, time transgressively, from spruce forest to white spruce parkland forest to deciduous parkland forest and finally grassland (Yansa 2006, 2007). However, it must be emphasized that each specific region of the study area followed a unique pattern of environmental change based on numerous locally specific factors (Figure 3.6).

Fauna position and frequency likely changed in response to the environmental changes occurring at this time. Wally's Beach Site (DhPg-8), located in southern Alberta by the St. Mary reservoir, has yielded numerous faunal remains, including *Bison antiquus* (bison), *Bootherium bombifrons* (helmeted musk ox), *Rangifer tarandus* (caribou), *Erethizon* (porcupine), *Lepus* (hare), *Ursus* (bear), and *Canis lupus* (wolf) and mammoth tracks. This paleontological fauna is ca. 12,900 to 12,000 cal years BP (10,500-11,000 ^{14}C years ago), well within the ABPP time frame in the study area (McNeil et al. 2004).

Numerous reports dating faunal remains from the study area have been compiled here. Dates that fall between approximately 13,400-10,500 cal years BP are assembled (Table 3.7). *Bison* dominates this assemblage, although beaver, mammoth, wapati, caribou, camel and horse are notable additions. It must be pointed out that Agate Basin material remains have never been associated with

Species	Lab #	Material Dated	Uncorrected Age	Range of Calibrated Ages (cal years BP) *	Reference
Castor sp. (beaver)	AECV-1620C	beaver-gnawed wood	9730 ± 110	11252-10806	Beaudoin et al. 1996
Castor sp. (beaver)	AECV-1596C	Wood	10,150 ± 140	12055-11408	Harington 2003
Mammuthus imperator (Mammoth)	S-232	Femur	10,600 ± 140	12670-12223	Agenbroad 1984
Mammuthus sp. (Mammoth)	GX-2918-D	Tibia	10,240 ± 325	12418-11405	Graham et al.1987
Cervus elaphus (wapati)	AECV-272C	Rib	9920 ± 220	11995-11163	Churcher 1984
Bison priscus (steppe bison)	GSC- 2865	2 tibiae	9880 ± 130	11607-11186	Driver 1998
Bison occidentalis (western Bison)	GSC-612	not reported	10,760 ± 160	12875-12545	Wilson and Churcher 1984
Bison occidentalis (western Bison)	I-8579	Ribs	9670 ± 160	11219-10780	Shackleton and Hills 1977
Bison occidentalis (western Bison)	GSC-1894	Bison bone Collagen	9630 ± 300	11395-10502	Shackleton and Hills 1977, Lowdon and Blake 1979
Bison sp.(unknown species)	I-3118	not reported	10,210 ± 100	12108-11652	Morlan 1993
Bison sp.(unknown species)	GSC-3065	Skull	10,200 ± 280	12378-11404	Jackson and Pawson 1984
Bison sp.(unknown species)	AECV-439C	not reported	10,080 ± 150	11965-11358	Beaudoin 1988
Bison sp.(unknown species)	GSC-1205	2 tibiae	10,000 ± 160	11767-11246	Lowdon and Blake 1979
Bison sp.(unknown species)	CAMS-13192	not reported	9990 ± 150	11750-11250	Harington 2003
Bison sp.(unknown species)	CAMS-12913	not reported	9930 ± 60	11593-11240	Harington 2003
Bison sp.(unknown species)	I-8483	Tibia, Metatarsal, Metacarpal	9860 ± 140	11613-11156	Westgate et al.1978
Bison sp.(unknown species)	TO-2999	Metacarpal	9750 ± 80	11250-10901	Beaudoin et al. 1996
Castor sp. (beaver)	AECV-1620C	beaver-gnawed wood	9730 ± 110	11252-10806	Harington 2003
Castor sp. (beaver)	AECV-1596C	Tibia	10,150 ± 140	12005-11408	Harington 2003
Cervus elaphus (wapiti)	AECV-272C	Rib	9920 ± 220	11955-11163	Harington 2003

Bison priscus (steppe bison)	GSC- 2865	2 tibiae	9880 ± 130	11607-11186	Harington 2003
Bison occidentalis (western bison)	I-8579	Rib	9670 ± 160	11389-10787	Harington 2003
Bison occidentalis (western bison)	GSC-1894	Rib	9630 ± 300	11395-10502	Harington 2003
Bison sp.(unknown species)	CAMS-12913	Rib	9930 ± 60	11593-11240	Harington 2003
Bison sp.(unknown species)	I-8483	Tibia, Metatarsal, Metacarpal	9860 ± 140	11613-11156	Harington 2003
Bison sp.(unknown species)	TO-2999	Metacarpal	9750 ± 80	11250-10901	Harington 2003
Bootherium bombifrons	TO-7691	3rd Cervical Vertebrae	10,980 ± 80	12955-12709	Tolman 2001
Bison bison antiquus	TO-7693	Maxilla fragment	11,130 ± 90	13133-12897	Tolman 2001
Equus conversidens	TO-7696	Rib Fragment	11,330 ± 70	13279-13144	Tolman 2001
Rangifer tarandus	TO-8972	Antler	11,350 ± 80	13299-13148	Tolman 2001
Unidentified Bone Fragment	GSC-613	Unidentified Bone Fragment	11,370 ± 170	13417-13095	Stalker 1968
Bison sp.(unknown species)	RL-757	Tibia	11,300 ± 290	13445-12852	Wilson and Churcher 1984
Bison sp.(unknown species)	TO-7694	Cranium	11,290 ± 280	13430-12859	Wilson et al. 2008
Unidentified Bone Fragment	GSC-989	Unidentified Bone Fragment	11,100 ± 160	13136-12786	Stalker 1968
Unidentified Bone Fragment	GSC-612	Unidentified Bone Fragment	10,760 ± 160	12875-12545	Lowdon and Blake 1979
Bison sp.(unknown species)	GSC-3065	Cranium	10,200 ± 280	12378-11585	Wilson 1983
Bison sp.(unknown species)	TO-7695	Cranium	10090 ± 70	11944-11406	Wilson et al. 2008
Camelops hesternus	BGS 2143	not reported	10708 ± 100	12708-12550	Burns 2009
Mammuthus sp.	BGS 2141	not reported	10743 ± 100	12728-12565	Burns 2009

Table 3.7 ^{14}C Dates Retrieved from or Associated with Faunal Remains from the Study Area (*1 sigma, IntCal09 calibration curve, OxCal 4.1)

mammoth remains in any context. The mammoth dates within the Agate Basin time frame presented here is pointed out to be inclusive to the data, and no association is being drawn between ABPP and mammoth either at Wally's Beach or elsewhere. None-the-less, these dated remains fall within the Agate Basin time frame in the study area and were thus added.

Chapter 4 – Discussion

4.0 Radiocarbon Dates

4.0.1 Overlapping Chronologies

Plains chronologies demonstrate that the Agate Basin time frame overlaps with other Plains typologies such as Hell Gap and Cody Complex (Fiedel 1999; Holliday 2000; Sellet 2001). This reflects the stretched nature of the ^{14}C calibration curve during the late Pleistocene/Early Holocene (Beaudoin and Oetelaar 2003; Fiedel 1999). It also may reflect that ABPP and other cultural groups represented by other projectile point typologies overlapped in time and space.

Known paleoindian kill localities such at the Agate Basin type site in Wyoming yield a clear type of projectile point, the Agate Basin projectile point typology. This represents that paleoindian projectile point typologies represent some form of cultural idiosyncrasy. Yet Sellet explains that,"…how such patterns are related to cultural differences remains unclear." (2001, 61). What is clear is that there is no archaeological evidence to suggest that Agate Basin occupation is earlier or contemporaneous with Clovis or Folsom manifestations.

4.0.2 Radiocarbon Dating Discussed

Standardized calibration curves must be used to calibrate radiocarbon dates. This is necessary, as the ^{14}C content of the atmosphere has varied through time. Therefore, there is not a one-to-one ratio between radiocarbon years and calendrical years (Chiu et al. 2007; Reimer et al. 2009).

The interval between the late Pleistocene and early Holocene exhibits significant ^{14}C perturbations that is evident as plateaus or abrupt jumps in age (Beaudoin and Oetelaar 2003; Fiedel 1999). As a result, ^{14}C dates between 12,500 to 10,000 cal years BP must be acknowledged as stretched (Beaudoin and Oetelaar 2003; Chiu et al. 2007; Fiedel 1999; Reimer et al. 2009).

When plants fix atmospheric carbon dioxide (CO_2) into organic material during photosynthesis they incorporate a quantity of ^{14}C that matches the level of this isotope in the atmosphere. After plants die or they are consumed by animals the ^{14}C fraction of this organic material declines at a fixed exponential rate due to the radioactive decay of ^{14}C. Comparing the remaining ^{14}C fraction of a sample to that expected from atmospheric ^{14}C allows the age of the sample to be calculated. Because there are numerous sources of 'dead' carbon (^{14}C deficient) that may mix with a sample and affect the estimated age, archaeologists must be careful to avoid potential sources of contamination that lead to dating errors. All ^{14}C dates must therefore be scrutinized and interpreted before being presented.

4.0.3 Sources of Error in ^{14}C Dating

Any source of old ^{14}C encountering a sample destined for ^{14}C dating is a potential source of error. However, there are certain sources of ^{14}C error that are of particular relevance to archaeologists. In the case of organic sediments, such as soils, contamination can occur because younger and/or older inputs of carbon are constantly added to the soil matrix (Bradley 1992; Wilson 1993).

Younger sources of contamination can arise from root penetration and bioturbation through a soil/sediment profile (Bradley 1992; Wilson 1993).

Contamination by older forms of carbon in organic sediments can occur in a number of ways, such as sources of old carbon in bedrock, the incorporation of old carbon in rootlets and roots of organisms and concentrations of $CaCO_3$ in soils (Bradley 1992; Lowe and Walker 1997; Wilson 1993).

The reservoir effect occurs when bodies of water frequently exhibit $^{14}C/^{12}C$ ratios that dramatically differ from that of the atmosphere. Modern reservoirs that tap old formation waters or ^{14}C 'dead' waters have extremely low percentages of ^{14}C. This can contaminate materials with old carbon, giving inaccurate dates (Bradley 1992; Wilson 1993).

A source of contamination in the study area is lignite, which mimics charcoal in appearance and consistency on areas of deglaciated landscapes. This could potentially affect all dates within the study area that are conducted on non-culturally specific bulk charcoal samples (Wilson 1993). In the areas of northern Alberta and Saskatchewan, dates can easily be contaminated with trace amounts of bitumen that can produce anomalously old dates (Wilson 1993).

In the case of bone, carbon exchange after death is always possible. Bone may incorporate old or new carbon sources depending on the particular environment where it is found. To limit the potential contamination of the sample, it is always advisable to use protein collagen to avoid the potential of both old and modern contamination (Bradley 1992; Lowe and Walker 1997; Wilson 1993). Further, herbivores can be strongly affected by isotope fractionation resulting from different photosynthetic pathways in specific plants that they consume (Chrisholm et al. 1986; Wilson 1993).

Keeping all of these sources of contamination in mind, it is clear that ^{14}C dates retrieved from archaeological sites must be closely evaluated. It is necessary to understand, if possible, the original reservoir and potential sources of contamination. Therefore, the Agate Basin ^{14}C dates discussed in this thesis that are classified as unreliable must be addressed.

Many authors present radiocarbon dates with limited details about potential sources of contamination. Since this thesis is representing published dates, a pragmatic approach has been taken to determine if dates are either reliable or not reliable based on the evidence presented. Dates that have obvious problems, such as those based on bulk soil humates, have been designated as unreliable.

Agate Basin ^{14}C dates have also been reviewed to see if the authors discussed limitations with the dated being presented. If these limitations are addressed either directly or indirectly by the author, they are considered unreliable. Unfortunately, many of the required details needed for a thorough review of the dates in this regard are not presented.

The first date deemed unreliable in Table 3.2 is the Hell Gap date I-167 (Frison 1991; Holliday 2000). The date is based on bulk soil sample with charcoal remains. As has been discussed, younger and older sources of Carbon can easily infiltrate soil samples from bioturbation, organic decay, sources of bedrock Carbon, and reservoir effects. Due to this fact, this date is considered unreliable for use here.

Other dates that are similarly based on bulk soil samples and bulk soil humates are the Frazier date SMU-316 (Holliday 2000), and the FfQh-27 date Beta 104738 (Kulle 1998). Both of these dates are based on bulk soil samples consisting of soil humates and organic stains respectively. The Sibbald Creek date GX-8808 (Gryba 1983), the Agate Basin date O-1252 (Frison and Stanford 1982)

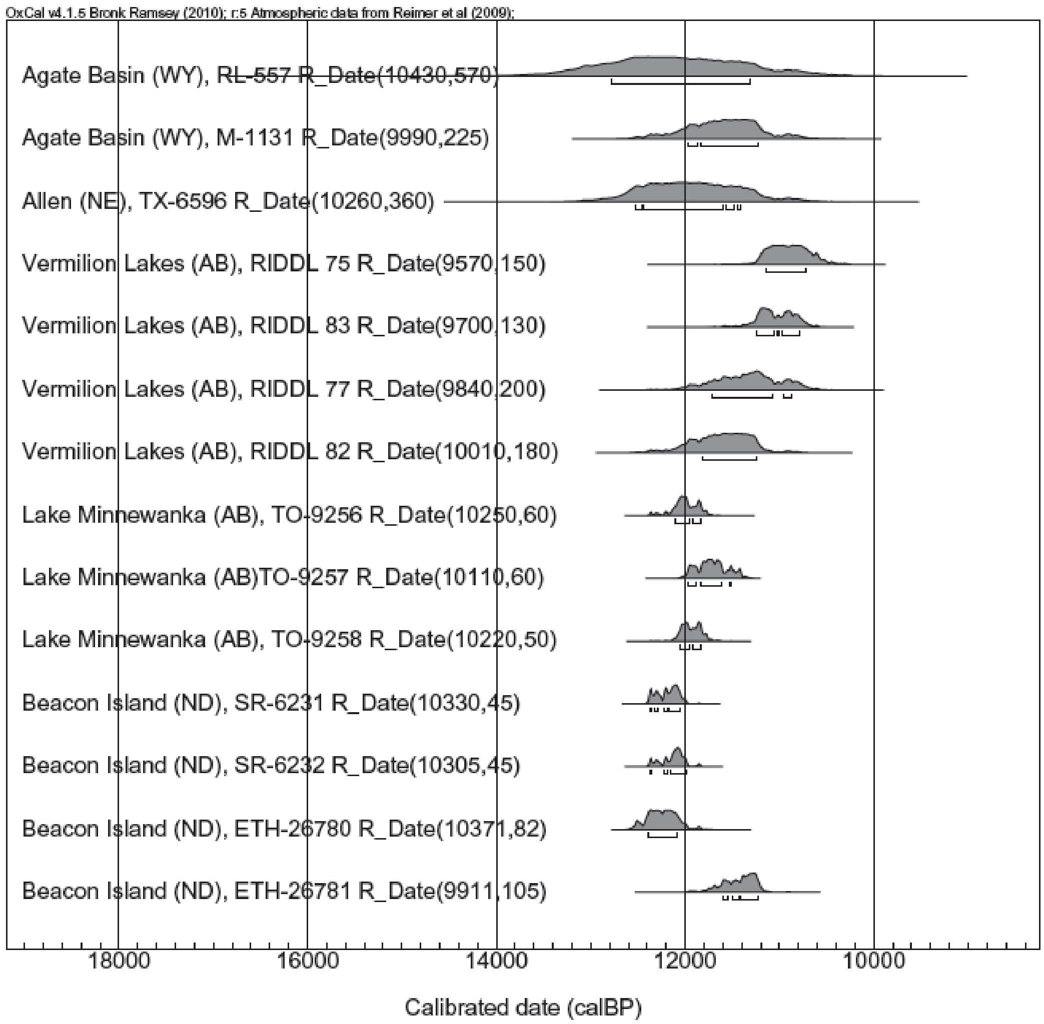


Figure 4.1 Reliable Agate Basin Calibrated Radiocarbon Dates within the Study Area and in the U.S.A. (IntCal09 calibration curve and one sigma range is shown, OxCal 4.1)

and the Allen site date TX-6594 (Bamforth 2007) are also based on bulk charcoal samples from a sediment profile, lending to the possibility of contamination and for this reason are excluded. The Sibbald Creek date is further suspect because the stratigraphic unit is considered heavily mixed as evidenced by mixed cultural materials.

With these six dates removed, the age range of Agate Basin is reduced to approximately 2000 calibrated years, from 12,800 to 10,800 cal years BP, (Figure 4.1.) This range is based on using the oldest and youngest calibrated ^{14}C ages following the methods outlined by Waters and Stafford (2007). The accuracy of the radiocarbon dates could be further increased by elimination of all ^{14}C dates not based on AMS dating techniques. The remaining dates would have a reduced age range slightly and therefore produce tighter chronologic control (see Waters and Stafford 2007, 1123). However, the lack of reliable ^{14}C dates used in this thesis makes this prospect limiting because the radiocarbon dates would be limited to only three sites (Ahler et al. 2004; Fedje et al. 1995; Landals 2000a, 2002), only one of which is from an Agate Basin site in the study area.

4.1 Distribution

Most Agate Basin sites within the study area are found in the southern half of Alberta and Saskatchewan, coincidentally in areas of infrastructure, development (largely agricultural development), and relatively high population density. This suggests a link between site discovery, population and development. However, northwest Alberta is substantially impacted by development (Figure 3.5, 3.6, 3.7) yet only one Agate Basin site is recorded from this area, IcPx-1 (Donahue 1975). It has been relayed that Agate Basin material is abundant, although little reported, in the Peace Country, mostly uncovered by private collection (Jack Ives, personal communication, May 2010). Agate Basin material has been reported in Northwest B.C. at Pink Mountain (Howe and Brolly 2008; Wilson 1996) and elsewhere in the Peace River basin in northwest B.C. (Fladmark 1975). This would also indicate, by extension, the likelihood of the presence of Agate Basin material in the Alberta Peace Country. If this is the case, there may be numerous sites yet to be discovered and/or reported in this area.

It should be noted that some sites designated as Agate Basin in the Archaeological Survey of Alberta database are found in the region that did not meet the criteria for this thesis due to the fragmentary nature of the lithic remains (see section 2.1). This also indicates the potential of this region to yield more Agate Basin discoveries in the future.

4.1.1 Addressing Related Typologies outside the Study Area

4.1.1.1 The Mesa Site

The Mesa Site is a paleoindian site located in the Central Brooks Range by the Colville River, Alaska, more than 240 km north of the Arctic Circle (Kunz et al. 2003). It lies atop a mesa-like ridge that rises approximately 60 meters above the valley below. The site produced more than 450 formal flaked stone tools, and over 120,000 artifact flakes and debitage. More than 150 of the artifacts are complete or fragmentary remains of projectile points. The site's chronology is based on 44 Accelerator Mass Spectrometry (AMS) radiocarbon dates ranging from approximately 12,100-10,500 cal years BP (10,370-9650 ^{14}C years BP). This places the Mesa site occupation clearly within the Agate Basin period.

Projectile points at the Mesa site have similarities with Agate Basin projectile points. Both are lanceolate in outline, often have parallel flake scars, tend toward a diamond to lenticular cross section, and have basal thinning and ground lateral edges (Kunz and Reanier 1994, 1995; Kunz et al. 2003). Similar projectile points have been found at the Tuluaq Hill Site, dated to a similar time frame as the Mesa site projectile points (Rasic 2000). The Mesa site projectile points tend toward concave bases with distinctive 'ears', while Agate Basin projectile points almost exclusively have straight to convex bases. This may indicate differences in hafting technology and/or hafting preferences between the two groups of manufacturers.

Kunz et al. (2003) suggest that the Mesa Site is directly related to the Agate Basin tradition to the south. The similarities between the material cultures are evident, as well as the fact that the chronologies of the occupations overlap. However, it remains debatable as to whether or not the morphological similarities between Agate Basin projectile points and those found at the Mesa site are analogous or homologous. Regardless of this, the Mesa site represents a key component of the paleoindian period and future research may give clearer indications of its relationship to other paleoindian groups.

4.1.1.2 Northern Plano

There are numerous examples of lanceolate projectile points that have come from Northern Alberta, NWT and Nunavut and appear similar to the Agate Basin projectile point typology. While there are similarities between these projectile point typologies, there are also differences in morphology and timing of occupation.

The Gardiner Lake Narrows site (HjPd-1) is a northern Alberta site located in the Birch Mountains (Ives and Hardie 1983; Sims 1974, 1980). Excavations yielded a projectile point similar in morphological form to Agate Basin projectile points. Of particular interest is the fact that the point is made of Tertiary Hills Tuffaceous Clinker, sourced to more than 1000 km to the north near Fort Norman, N.W.T. (Cinq-Mars 1973; LeBlanc 2004). This may indicate a southward movement of people from the North West Territories into northern Alberta potentially as early as 11,500 cal years BP, based on glacial reconstruction maps (Dyke 2004). Whether this projectile point is contemporaneous with an Agate Basin occupation in southern Alberta remains an open question. It is possible that an Agate Basin-like lanceolate form existed in northern Alberta, which is not contemporaneous with, but younger than, Agate Basin further to the south.

The Beaver River Quarry site (HgOv-29) is situated on the north side of an abandoned channel of the Beaver Creek, located between the McKay and Athabasca Rivers. Excavations yielded over 30,000 artifacts including a lanceolate point similar in form to an Agate Basin projectile point (Sims 1974). Because the site is an excellent source of raw material and the lanceolate point was recovered here, this site should be considered important for understanding paleoindian occupation in northern Alberta (Ives 1993; Sims 1974; Wright 1976).

It has been argued that northern Plano points found in the Canadian subarctic are related to Agate Basin cultures because of similarity of form, such as the projectile points from the Grant Lakes site (Wright 1972, 1976), or Acasta Lakes site (Noble 1971). Dates from these sites indicate that these Plano typologies are not contemporaneous with Agate Basin further to the south, but occur up to 3000 years later (Noble 1971,106; Wright 1976, 89). It is possible that Northern Plano forms are a later variant related to the Agate Basin typology and that the northern Alberta projectile points (Ives 1993; Sims 1974, 1980) may represent intermediate forms. It is also likely that this form may not be transitional typologies , but simply reflect the fact that,"…unstemmed, leaf-shaped points are the simplest form to make and the easiest to reinvent; unlike biological species, projectile point types can reoccur without necessary historical linkages" (Wilson and Burns 1999,228).

4.2 Landform Analysis

4.2.1 Landform Use and Frequency of Sites

ABPPs are generally conceived as having been communal hunters whose main subsistence activity utilized the landscape to track, trap, and hunt *Bison* (Frison 1991; Frison and Stanford 1982). However, no sites indicating communal hunting have been found in the study area. Despite this, some sites associated with different landscapes do yield detailed information about the nature of the ABPP behaviour at the sites.

4.2.1.1 Landform Categories

The shore landform category represents many of the Agate Basin sites classified here. Boyd et al. (2003) discuss how Folsom producing peoples practiced resource extraction from recently drained proglacial Lake Hind surfaces in Manitoba. This pattern of resource extraction could have operated with regard to ABPP throughout much of the northern plains as there are numerous proglacial lake basins in the north and northeast potions of the study area. Although this remains speculative, ABPP may have utilized these areas for a broad-spectrum type of resource extraction.

The Duckett site (GdOo-16), located on the northeastern shore of Ethel Lake, Alberta, and is a good representative of the shore landform category (Fedirchuk and McCullough 1986). The Agate Basin bearing component (35–40 cm, Block III) of the Duckett Site contained a discoidal biface (GdOo-16.1225), a biface fragment (GdOo-16.1226), a retouched flake (GdOo-16.1236), a chert pebble scraper (GdOo-16.1237), numerous amounts of debitage, and three Agate Basin projectile points (GdOo-16.3782, GdOo-16.13 and GdOo-16.4793[14]). The discarded flakes and tools suggest that the Agate Basin component of the Duckett site is the remains of a small campsite and lithic workshop. This represents a small, multi-function site that could reflect the type of resource extraction Boyd et al. (2003) have discussed.

The river valley landform category contains the most intact archaeological remains of the Agate Basin period within the study area. The Vermilion Lakes and Sibbald Creek sites provide the greatest degree of stratigraphic control with radiocarbon dates (site class 1). The Vermilion Lakes site is located along the Bow River Valley at the base of Mount Edith, Banff National Park. At the time of the Agate Basin occupation, the site was located near the edge of a large open lake with a prograding delta near the site (Fedje 1986; Fedje et al. 1995). A well-

[14] The projectile point GdOo-16.4793 is photographed and listed in Appendix 6.

developed stratigraphy is the result of the deposition of both sub-aqueous and aeolian silts and clays, as well as numerous debris flows from the adjacent Mount Edith. However, the frequent depositional events preclude significant soil development (Fedje 1986; Fedje et al. 1995).

Two localities within the site yielded Agate Basin projectile points and associated faunal and lithic remains. Locality A, Occupation 6b yielded approximately 500 lithic artifacts including two Agate Basin points, two hearths, faunal remains of mountain sheep (*Ovis canadensis*), and a large unidentified ungulate (Fedje 1986). Locality B, Occupation 4 yielded approximately 100 lithic artifacts including one intact Agate Basin projectile point, unidentified faunal remains, and a hearth surrounded by numerous flakes (Fedje 1986).

Fedje suggests that, "The scant faunal remains are dominated by mountain sheep (*Ovis canadensis)* which, based on our present sample, appear to have been the favoured quarry of early hunting groups at the site." (Fedje et al.1995, 91). Further, Fedje et al. suggest that the ABPP *Ovis* hunting practices may be non-analogous to the *Ovis* hunting practices in more recent periods (1995). This suggestion is based on the size difference between fossil and modern, relatively gracile, *Ovis* forms. This size difference could signal changes in mountain sheep behaviour, much as it is considered to be the case in *Bison* (Wilson 1974; Wilson and Churcher 1984). This site appears to have been a campsite for both butchering and lithic manufacturing, and therefore may have been a place that was returned to over a long period of time.

Fedje et al. does suggest that the Agate Basin points found at the site compare favourably with those of the Agate Basin complex (Fedje et al. 1995, 104). However, he later explains that the aforementioned projectile points also show similarities to other typologies, such as the stemmed point traditions defined by Bryan (1980) (Fedje et al. 1995). Further, Fedje later describes these aforementioned projectile points as part of the Banff II Eclipse phase without mention of Agate Basin (Fedje 1996). Regardless of this, the projectile points in question fit the methods used to define Agate Basin projectile points for this thesis. For this reason they are incorporated here.

Sibbald Creek (EgPr-2) is located in the Sibbald Flats, approximately 72 km due west of Calgary, in the southern Alberta foothills. Four Agate Basin projectile points of locally quarried siltstone were recovered from the site (#3427, #3570, #3731, #5922) between 35 and 40 cm below surface (Gryba 1983). Within this layer are also numerous flakes and debitage made of siltstone and quartzite, suggesting an extensive lithic workshop.

The presence of one Oxbow point and three Mt. Albion points from the same stratigraphic level indicates mixing of the archaeological remains from different periods. Gryba "… attributed [this] to natural agents, foremost of which may have been the displacement caused by plant roots during normal growth, and disturbance resulting from uprooting of trees" (1983, 37). The scant faunal remains recovered from this level indicate the presence of *Bison* and *Ovis* suggesting a campsite for lithic manufacturing and possibly hunting and butchering (Gryba 1983, 194–195).

The crest and prominence landform type and the Crest and Mid-slope category together dominate the site landscape use. However, these types of sites have yielded limited archaeological data thus far. Location of the site, and a record of finished tools, usually projectile points, is the norm. One notable exception to this is the site EePl-215, situated on a height of land between the present channel of the Sheep River and an abandoned channel, near Okotoks, Alberta (Wood 1998). EePl-215 (site class 2), displays limited soil development and little sediment deposition. Because of the compressed stratigraphy, cultural material occurs in a single horizon, including both Agate Basin and Besant. The latter type occurred many thousands of years later than Agate Basin type (Vickers 1986).

Large amounts of debitage were recovered. Together, secondary flakes (n=5), thinning flakes (n=57), and retouched flakes (n=63) account for 74% of the assemblage (Wood 1998). This suggests a lithic workshop. However, whether these remains are from the Agate Basin time period, the Besant Period, or both is unknown. One indeterminate faunal fragment from a medium large mammal was recovered.

FdOq-9 (Fedirchuk 1980a, 1980b) is similar in nature to EePl-215. FdOq-9 (site class 3) is located on Observation Point, a large stabilized sand dune in the Wainwright military base, Alberta. The hill is located in an area of numerous stabilized sand dunes. Only one paleosol horizon exists, with unstratified sands below. Excavation results indicate that the vertical stratigraphy of the site has been compressed and mixed, making it impossible to separate artifacts into discrete occupations (Fedirchuk 1980a, 1980b). Six diagnostic point typologies were found including Agate Basin, Mckean, Pelican Lake, Besant, Prairie Side-Notched, and Late Plains Triangular. In addition, numerous flakes and fire broken rock (FBR) were found at the site, indicating the presence of a lithic workshop and campsite.

Being the highest point in the region, this site offers a 360-degree view of the surrounding landform (Fedirchuk 1980a, 1980b). It likely served as an observation point for hunting, along with the evidence suggesting it was used as a lithic workshop. It would have also acted as a refuge from biting insects from spring to fall months. The fact that the site was reused over a 10,000 year period (evidenced by a succession of projectile point typologies) indicates its utility and importance.

The Flat Terrain landform category is best represented by the Napao Site (DkNv-2), Saskatchewan (site class 2) (Watson 1987). Excavations indicate this site served as a campsite. The site is on flat terrain with some gently undulating sand dunes in the area. Excavations unearthed an incomplete specimen of an Agate Basin projectile point (# DkNv-2/38) found in association with a paleosol 20–25 cm below surface. Also recovered at this level were a partial knife (# DkNv-2/23a), 204 unworked flakes, and 28 small unidentified bone fragments weighing a total of 2.8 grams. This suggests that this was a campsite where lithic manufacturing took place.

The projectile point displays use/impact damage and extensive exfoliation caused by thermal fracturing on the posterior side. Watson suggests that, "The condition of the point is another mute evidence of occupancy rather than the 'hunting loss' finds which are usually the norm" (1987, 20). Whether the fire damage was the result of human activity or natural fire cannot be determined, but considering the other evidence at the site it is probable the thermal fracturing was due to a hearth feature.

ABPP in the study area utilized a wide range of landform types. In many cases, different landforms are associated with similar use. For example, temporary campsites and lithic production are associated with all landform types. However, only certain landform types are directly associated with faunal remains, the best being the River Valley landform category. Sibbald Creek and Vermilion Lakes, both type 1 sites are associated with this landform type. The preservation and discrete stratigraphic units of this site are present due to numerous depositional events. However, site formation processes operating in the context of this landform type result in greater potential for burial and preservation. It is unlikely that this landform type was used exclusively for hunting and butchering.

The crest/prominence landform type appears to have been utilized as observation points, specifically in the plains regions. Although many of the sites associated with this landform type have scant data to offer, the sites EePl-215 and FdOq-9 suggest that the locations were used during Agate Basin and later times due to their value as lookout points.

Many flat terrain sites have little deposition and are prone to erosion, especially during arid periods. Lithic remains without clear stratigraphic context are all that is recovered. DkNv-2 is an exception as here stratigraphic context and lithic remains point to a temporary campsite associated with lithic production.

4.2.1.2 The Importance of Prominences to ABPP in the Study Area

Based on the results of the landscape analysis (Figure 3.7, 3.8) it is apparent that prominences on the landscape are of particular interest to ABPP. Approximately one-third (32%) of Agate Basin sites are located on prominences on the landscape. A further 8% of sites are located on the midslope of prominences. The majority of the remainder of sites (38%) are located close to specific water bodies (Figure 3.9, 3.10). The analysis of the relationship between Quaternary landforms and Agate basin site location in central and southern Alberta indicated a similar pattern. Approximately 62% of all Agate Basin sites in central and southern Alberta are located on some form of moraine. A further 7% of sites are located on eolian deposits, most often in the forms of stabilized sand dunes (Figure 3.8).

Three categories of Quaternary landforms: Draped Moraines, Lacustrine-coarse, and Eolian deposits were more likely to be selected for use by ABPP. Lacustrine-coarse - represents landforms close to lakes with coarse grain sediment. That this landform was selected reflects ABPPs desire for sites close to water, yet at the same time being on well-drained sediment.

A similar analysis was undertaken on fluted point distribution and Quaternary landforms in central and southern Alberta (Ives 2006). The analysis found that," The largest portion of the fluted point sample (nearly two thirds) occurs on some type of moraine deposit." (Ives 2006, 24). It is likely that this reflects a pattern of paleoindian behaviour of seeking out high ground in order to be able to see a relatively open landscape for spotting game, landmarks on the landscape, and perhaps other people.

4.2.2 Slope Facing Direction

In cold climates and during cold seasons it follows that people would choose sites that are south facing in order to utilize the maximum amount of both sunlight and heat. Further, these sites may have allowed shelter from the cold northwest winds that predominated. This behaviour is clearly exhibited by ABPP. The majority of Agate Basin sites located on slopes are south-facing (Figure 3.11). The sites on the east, west, and north-west-facing slopes may reflect summer-season sites, or may be the result of close proximity to a resource such as wood, stone, water, or plants. However, there is also the possibility that site visibility[15] is greater on south-facing slopes, making it easier to locate a site during the course of archaeological survey work. South-facing slopes throughout the study area are more likely to be covered by grasses because of the increased solar radiation and drought stress. In contrast, other slope directions are more likely to be covered by trees.

4.2.3 Landform and Water as a Limiting Factor

The majority of Agate Basin sites are located within 100m of a water source; site frequency decreases with increased distance from water sources (Figure 3.9). There does not appear to be a preference for specific water-body

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[15] Site visibility refers to the degree to which archaeologists can identify and/or access archaeological sites due to conditions such as the degree of ground cover. Archaeological sites with high visibility would have less dense ground cover.

type by ABPP, although the spring/slough category is the least favoured representing approximately 20% of Agate Basin sites in this category, while the river category appears to be the most favoured at approximately 32% of the total (Figure 3.10). The biological and resource diversity associated with larger water bodies (Osborn and Kornfeld 2003) did not appear to draw in ABPP over other water body types. Any fresh water source that was available in the area seems to have been acceptable.

4.2.4. Lake Minnewanka Site

One site of interest that is the Lake Minnewanka site (349R), originally described as a site encompassing the entire paleoindian period (Landals 2000b). This site is located along a 700 meter stretch of shoreline of the Minnewanka Reservoir in the Bow River Valley, Banff National Park (Landals 2000a, 2002). It is significant because it is within the study area, it has intact stratigraphy with lithic and faunal (*Bison* and *Ovis*) remains, and it has radiocarbon dates that fit within the time frame of ABPP occupation. Two hearth features are associated with a projectile point, along with 199 chert flakes and seven animal bone fragments. This indicates that the site was a campsite and lithic workshop of contemporaneous age to Agate Basin occupation in the region (Landals 2000a, 2002). However, there is debate as to whether the projectile point is of the Agate Basin type or some other paleoindian lanceolate type.

The projectile point in question was recovered in situ and is associated with two dates, 11,741± 131 cal. years BP (10,110 ± 60 ^{14}C years BP) (TO 9257) and 11,938 ± 114 cal years BP (10,220 ± 50 ^{14}C years BP) (TO 9258) (Landals

2002). The projectile point is similar in form to the Agate Basin type yet is stemmed in a similar fashion to Hell Gap points (Landals 2000a). Landals speculates that the in situ projectile points found in association with the radiocarbon dates are not Agate Basin, but rather Hell Gap-like or Plainview-like (Allison Landals, personal communication, 2008). However, given its close proximity in time and space to the Vermilion Lakes site that has an Agate Basin component, it should be considered related and contemporaneous.

Lake Minnewanka did yield one Agate Basin projectile point (349R12E1:1) found through a surface survey, which was incorporated into this thesis (Landals 2002). This illustrates that there is the potential for overlap of the Agate Basin and Hell Gap typologies at this location in space if not in time.

As I have stated earlier, the isomorphic relationship between Agate Basin material remains (projectile point morphology) and a specific Agate Basin Culture may not be uniform. Time frame, resource extraction, hunting practice and environmental context may be just as important in determining cultural affiliation as projectile point morphology alone. If this is the case, the Lake Minnewanka site should be considered relevant to future discussions of paleoindian occupation in this region, specifically during the time frame discussed in this thesis.

4.3 Lithic Analysis

The Agate Basin projectile points from the study area are shorter on average than those found at the Wyoming type site where there is exclusive use of cherts in point production. Differential raw material use, quartzite versus chert, may account for this (Andrefsky 1998, 54-56). To test this possibility, projectile point dimensions are compared to raw materials (Figure 4.2). The quartzite projectile points are in fact longer, wider and thicker on average than projectile points made from chert. It appears, therefore, that the fracture mechanics of different material types may not have influenced Agate Basin projectile point morphology. Because quartzite has greater tensile strength, points

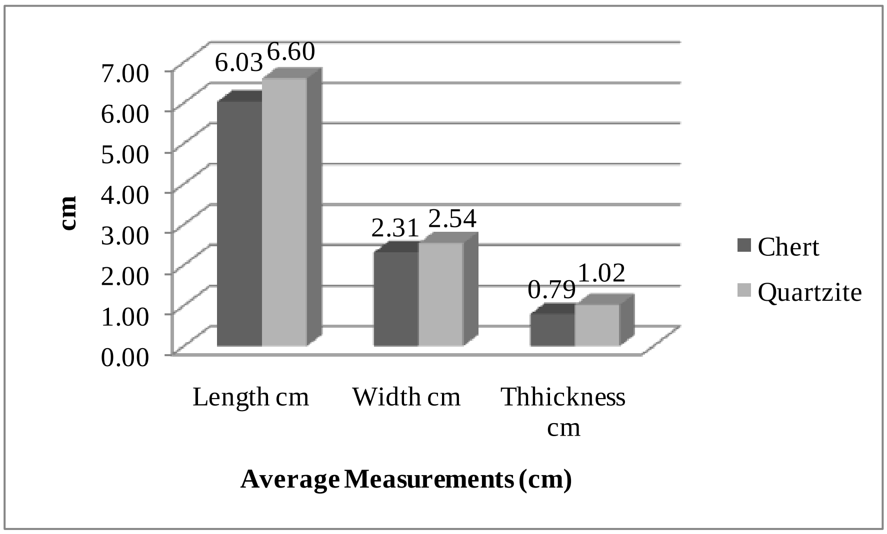

Figure 4.2 Average Length, Width, and Thickness of Agate Basin Projectile Points made from Chert and Quartzite

would tend to be more robust than their chert counterparts. All things being equal, the fracture mechanics of quartzite versus chert would suggest that chert points would be on average longer than their quartzite counterparts due to the greater tensile strength of quartzite versus chert (Andrefsky 1998). Reworking of points may account for this discrepancy.

The reworking of lithic tools represents the reality that stone tools have multiple stages of use life and are not static in appearance or function over this use life. Andrefsky makes this clear when he states," Probably the most important thing to remember when conducting lithic analysis—and perhaps the most difficult to incorporate—is that stone tools are morphologically dynamic" (1998, 38). This quote reminds us that when dealing with a large number of lithic materials from various sites, one inevitably encounters projectile points in various stages of a life cycle that includes sharpening or reworking.

In the study area, 25% of all chert projectile points were reworked whereas only 15% of quartzite projectile points exhibit reworking. It follows that the average shorter length of chert projectile points was influenced by increased frequency of reworking; and that chert may have been more valued by ABPP. Reworking projectile points may indicate a desire to reuse and maintain materials that were scarcer and/or more valued.

The study area projectile points are on average over 1.5 cm shorter than those of the Agate Basin type site (Figure 3.18). This may reflect regional stylistic differences or the higher frequency of reuse and reworking found in the study area. Many of the projectile points at the type site would have been lost or discarded immediately after their use in a large kill event and therefore represent an initial stage in the life-cycle of the Agate Basin projectile point.

Any of these possibilities could be factors that influence morphology, but reworking and reuse of projectile points is much higher in Alberta and Saskatchewan. Chert is relatively scarce in the study area. This may have led ABPPs to be more frugal with the chert they had through reworking, resulting in shorter projectile points.

4.3.1 Movement of Raw Material

Raw material studies demonstrate that during the paleoindian period, some raw materials were transported over a thousand kilometres, rather than using locally available quartzite (Tankersley 1991, 292-296). This indicates a strong preference for chert compared to other raw material types (i.e. quartzite, mudstone/siltstone) which may have been more accessible. This also appears to be the case within the study area.

Eleven Agate Basin projectile points from ten sites within the study area are made of either SRC or KRF (Figure 4.3). SRC material is sourced from the

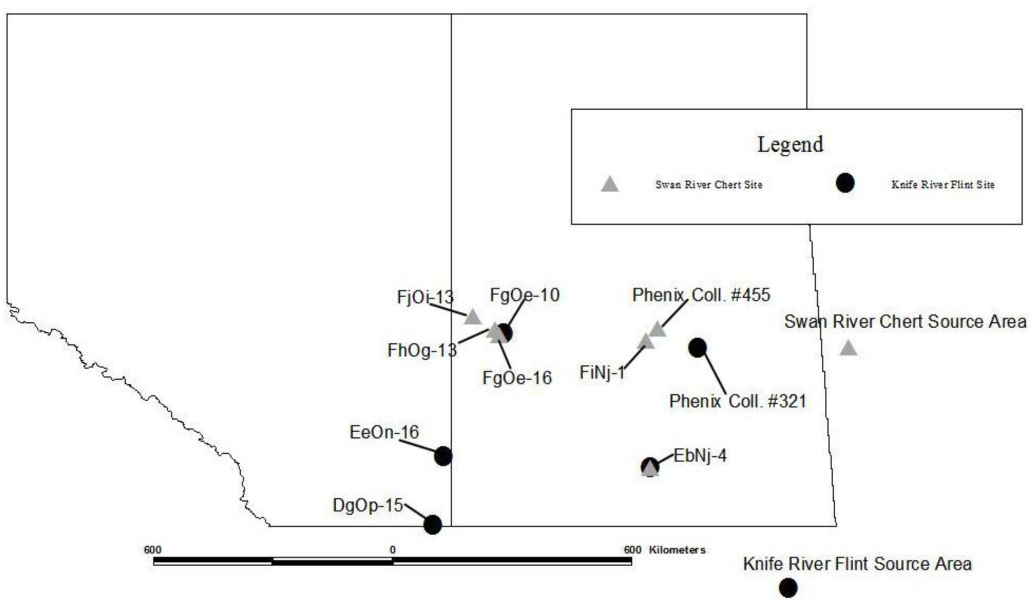

Figure 4.3 Distances from Material-Type Source Areas of Agate Basin Projectile Points Made of Knife River Flint and Swan River Chert

Swan River Valley region, in west-central Manitoba (Grasby et al. 2006; Grasby et al. 2002; Low 1996). However, the occurrence of SRC is known to extend far from its primary source in the Swan River Valley. SRC has been documented in the study area from western Manitoba, southern Saskatchewan and southern

Alberta, likely dispersed from Pleistocene glacial movement (Grasby et al. 2002; Low 1996). KRF has been sourced to the valley of the Knife River and its major tributaries, in central North Dakota (Ahler 1986; Clayton et al. 1970).

If sourced from the primary SRC source area, the Agate Basin SRC projectile points travelled 373 km from their primary source before entering the archaeological record. Although the large range of SRC in the plains makes this measurement questionable, as there is no guarantee that the Agate Basin projectile points made of SRC were sourced from the Swan River Valley Region.

Agate Basin KRF projectile points travelled an average of approximately 590 km from their source area. It is possible that this material was transported and traded indirectly to its final resting place. It is also possible that these raw materials have been transported directly by migrating people from quarrying sources. In either case, these materials would likely been highly valued by ABPP as reflected in the possible distances the material was transported.

4.3.2 Changes in the Frequency of Raw material Over Time

Raw materials are chosen by people due to preference and access. Paleoindian people were no exception in this regard. It follows that documenting a change in raw material use can reflect a change in preference for, or access to, a particular resource.

A study conducted by Ives (2006) in Alberta indicated that in a survey of fluted points, KRF, a distinctive raw material, accounted for only 2-3% of the total sample (Jack Ives, personal communication, 2009). The Agate Basin sample in this thesis found that KRF represented 8% of the total sample, almost tripling in proportion. Recently, Bob Dawe conducted a similar survey of Cody projectile points in Alberta. It was found that by the time Cody producing people inhabited Alberta, KRF represented approximately 39% of the raw material of the total Cody projectile point sample (Bob Dawe, personal communication, 2009). This is over a four-fold proportional increase in the use of KRF during the paleoindian period.

The increase in the use of KRF may reflect that it was an increasingly preferred raw material from fluted-point to Cody times. The increased usage of KRF during the paleoindian period likely reflects increased knowledge of the source of KRF and increased mobility and/or trade that resulted between the source area of KRF and the study area (Figure 4.3). These possibilities indicate an increasing trend of mobility, trade and familiarity of the KRF resource over time.

Another feature of KRF is that it is much more predominant at the Agate Basin type site in Wyoming, approximately 800 km south from its primary source area. KRF moved on average approximately 600 km north from its primary source location to the study area and shows up in relatively limited quantities. The asymmetry of KRF movement north versus south from its primary source illustrates KRF was traded and/or transported in greater quantities southward. This could be evidence for more established trade routes and movement from the KRF primary source area southward rather than northward.

4.4 Climate of the Late Pleistocene/Early Holocene

4.4.1 Milankovitch, Astronomical Forcing, and the Radiation Budget

In 1941, the Serbian engineer M. Milankovitch put forward the hypothesis that the surface temperature of the earth would go through predictable and regular changes due to perturbations of the earth's axis and orbit. These perturbations are due to the eccentricity of the orbit, the obliquity of the ecliptic, and the precession of the equinoxes (Lowe and Walker 1997, 16; Williams et al. 1998, 73). The results are shifts in the amount of incoming solar radiation that would cause changes in the surface temperature of the earth. This is called astronomical forcing.

The obliquity of the ecliptic refers to the season during which the earth is closest to the sun (the perihelion), which varies on a 21 ka (kiloannum) cycle. At 12,500 cal years BP, the perihelion occurred during the northern hemisphere summer, opposite to that of today. The obliquity of the ecliptic refers to the degree of axial tilt of the earth that shifts from 21°39' to 24°36' on a 41 ka cycle. At 10,500 cal years BP the axial tilt would have been exaggerated to 24°36' compared to roughly 23°30' today (Lowe and Walker 1997, 16-17; Williams et al. 1998, 73-78). More of the northern hemisphere would have been exposed to the summer sun 12,500 cal years BP than today. These factors combined to produce a significant change in the radiation budget at 12,500 – 9,500 cal years BP (Imbrie et al. 1993; Kaufman et al. 2004; Kutzbach and Webb 1993; Kutzbach et al.1998; Lowe and Walker 1997; Schweger and Hickman 1989; van Geel et al. 1999).

The combined effects of the obliquity of the elliptic and the precession of the equinoxes from 12,500 – 9,500 cal years BP led to a redistribution of solar radiation in the northern latitudes (Figure 4.4). The late Pleistocene/early Holocene radiation budget led to increased warmth during summer months, as well as increased cold during winter months (i.e., enhanced seasonality) (Kaufman et al. 2004; van Geel et al. 1999). The spatial and temporal pattern of peak late Pleistocene/early Holocene warmth, called the Holocene Thermal Maximum (HTM), is well documented in northwestern North America and is largely attributed to the astronomical forcing described above (Kaufman et al. 2004). Yet the HTM did not occur in all places in the northern hemisphere simultaneously. The HTM in northern Canada was time transgressive from west to east, as explained by

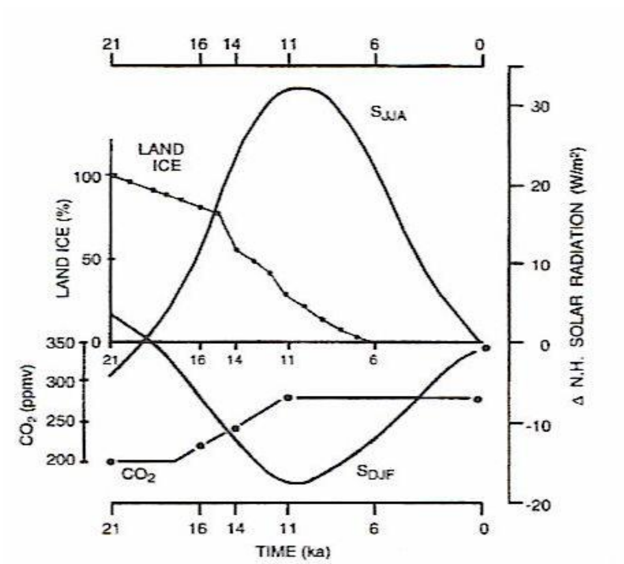

Figure 4.4 Changes in the Northern Hemisphere Insolation Budget for JJA and DJF, Percent Land Ice, and CO2 Concentration, 21,000 cal years BP to Present (Kutzbach et al. 1998)

Kaufman et al. that, "Alaska and northwest Canada experienced the HTM between ca 11 and 9 ka, about 4000 yr prior to the HTM in northeast Canada. The delayed warming in Quebec and Labrador was linked to the residual Laurentide ice sheet, which chilled the region through its impact on surface energy balance and ocean circulation" (2004, 529).

Proxy indicators of climate change during the period of 12,500 - 9,500 cal years BP show that the temperatures increased markedly in the northern hemisphere. Evidence from the Greenland Ice Sheet Project 2 (GISP2) (2004. *Greenland Ice Sheet Project 2*,

accessed August, 2005) and the Greenland Ice Core Project (GRIP) (1997. *Greenland Ice-Core Project*, accessed August, 2006) ice cores illustrate climate changes associated with changes in solar radiation in the late Pleistocene/early Holocene. For example, changes in ^{18}O and ^{10}Be isotopes and variations in the $^{14}C/^{12}C$ ratio held within these ice cores are shown to correlate directly with changes in incoming solar radiation and climate change events (Kaufman et al. 2004; van Geel et al. 1999). Other lines of evidence include proxy data from the natural archives of ocean sediments and deposits in large continental lake basins (Lowe and Walker 1997; Ritchie and Harrison 1993; Williams et al. 1998).

Intricate feedback processes operating in the global climate system means that a change in incoming solar radiation is not an accurate way to estimate the final response of the climate system. The global climate involves many interacting systems including oceanic, atmospheric, and biosphere systems. All of these systems are capable of changing the magnitude and duration of any insolation change, although the insolation change itself is controlled by orbital variation (Lowe and Walker 1997; Williams et al. 1998).

4.4.2 Climate Model

It is not surprising that added climate complexity generated by feedback processes resulted in a variable patchwork of responses to solar forcing. Further, the degree to which responses have taken place in the past is debatable. However, conceptual climate models (Kutzbach and Webb1993; Kutzbach et al. 1998) can be used to understand how these changes occurred in the past. As Kutzbach and Webb explain, “A general understanding of the climate system is therefore required to help bridge the gaps and resolve the contradictions, and this understanding can be articulated as either qualitative concepts or formal mathematical models” (1993, 5).

4.4.3 Seasonality

In the study area, the climatic response to early late Pleistocene/early Holocene solar forcing was unique. Summers would have been warmer, and winters much cooler. In fact, according to the model simulations created by Kutzbach and Webb (1993) and Kutzbach et al. (1998), the continental interiors in northern North America during the summer months would have been as much as 5°C warmer at 11,000 cal years BP (9000 ^{14}C years BP) compared to today (Kutzbach and Webb 1993, 6). Correspondingly, northern continental interior winters at this time would have been cooler (Kaufman et al. 2004; Kutzbach and Webb 1993; Kutzbach et al. 1998; Lowe and Walker 1997; Williams et al. 1998).

The result is a late Pleistocene/early Holocene period of increased seasonality and continentality.

4.4.4 Atmosphere Circulation

Significant changes in seasonality and temperature would have caused changes in atmospheric circulation over the study area. Kutzbach and Webb describe the results of this process:

> …we expect that the relatively large increase in summer temperature over northern land would cause higher air temperatures and vertical expansion of the column of air over land, outflow of air from land to ocean at high levels, lower surface pressure over land, and inflow of air from ocean to land at low levels …The increased inflow would create moister conditions along the coasts and some distance inland: *but far inland, beyond the reach of the increased influx of moisture, the climate would have been drier because of increased evaporative losses* (1993, 7 emphasis added).

The emphasis here is meant to draw attention to the fact that the study area would be considered far inland and in a rain shadow, beyond the reach of the ocean driven moisture influx. Therefore, aridity would have increased due to increased evaporative loss, particularly during summer months.

4.4.5 Glacial Ice

The retreating Laurentide glacial ice would have had a substantial impact upon the atmospheric circulation of the study area. According to Kutzbach and Webb (1993) and Kutzbach et al. (1998), increased northern summer solar radiation had warmed the region south and west of the ice sheet (central and southern Alberta and Saskatchewan), but areas near to or downwind from the ice sheet remained cold (Kutzbach and Webb 1993, 9). The atmospheric thermal gradient and the jet stream would have hugged the retreating ice sheet boundary. The ice sheet and adjacent areas would have maintained relatively high air pressure compared to surrounding regions. The time transgressive nature of the onset of the HTM corresponds directly to the position of the retreating Laurentide ice sheet (Kaufman et al. 2004; Kutzbach and Webb 1993; Kutzbach et al. 1998).

4.4.6 Precipitation/Evaporation

The model simulations by Kutzbach and Webb (1993) indicate that the precipitation and evaporation regimes would have been different in the late Pleistocene/early Holocene than today. The continental interior would be drier because of increased evaporative losses occurring during warmer summer months.

In the winter, colder air would bring less moisture from the ocean because of its reduced moisture holding capacity. An increased evaporation rate relative to precipitation would have resulted in aridity within the study area (Kutzbach and Webb 1993). However, the proximity of glacial melt-water and proglacial lakes may have mitigated this impact locally (Laird et al. 1996, 1998).

4.4.7 The Nature and Chronology of the Laurentide Glacial Retreat

Many researchers see the retreat of the Laurentide ice within the study area as becoming rapid sometime around 14,000 cal years BP (12,000 ^{14}C years BP) (Beaudoin and Oetelaar 2003; Burns 1996; Catto et al. 1996; Clayton et al.1982; Driver 1998; Dyke 2004; Jackson et al. 1996; Young et al. 1994). Contrary to this, Campbell and Campbell (1997) suggest that a gradual glacial retreat occurred starting at 20,000 cal years BP and lasting to approximately 12,000 cal years BP. However, no compelling proxy evidence supports their position except evidence from Chalmers Bog in the southwestern part of the Alberta foothills (Mott and Jackson 1982). Moss fragments dated to approximately 21,270 ± 170 cal years BP

(18,000 ^{14}C years BP) were discovered (Mott and Jackson 1982). However, it is known that dating aquatic bryophytes such as *Drepanocladus* fractionates carbon and this can lead to ^{14}C dates older than those of terrestrial macrofossils (MacDonald et al. 1987). It is most likely then, that deglaciation across the study area occurred relatively quickly starting at approximately 14,000 cal years BP (12,000 ^{14}C years BP) (Dyke 2004).

During the time frame of ABPP, the Laurentide glacial ice sheet had retreated to the northeast of Alberta, but still covered much of north and central Saskatchewan (Dyke 2004) (Figures 4.5a,b,c). Of particular interest are the nature of the proglacial lakes and their effects on the regional environment. Extensive proglacial lakes had formed along the glacial margins of the retreating Laurentide ice sheet. Some of these lakes drained very rapidly creating spillways, melt-water channels, and rapid incisions of major river channels (Evans 2000). Major incisions of the Bow River Valley of Alberta took place sometime before approximately 11,500 to 10,200 cal years BP (10,000 to 9,000 ^{14}C years BP) (Oetelaar 2002). Following the retreat and drainage of proglacial lakes, many small lakes and ponds would have been left behind in localized depressions (Beaudoin and Oetelaar 2003; Yansa et al. 2007). These water sources may have been an important resource for plants, animals, and human occupation.

The rapid creation of spillways and river channels would have created areas of landscape instability, particularly on river valley slopes. Both deposition and erosion would have resulted from these processes in relative proximity to the ice sheet, and would have had an impact on colonization by both plants and

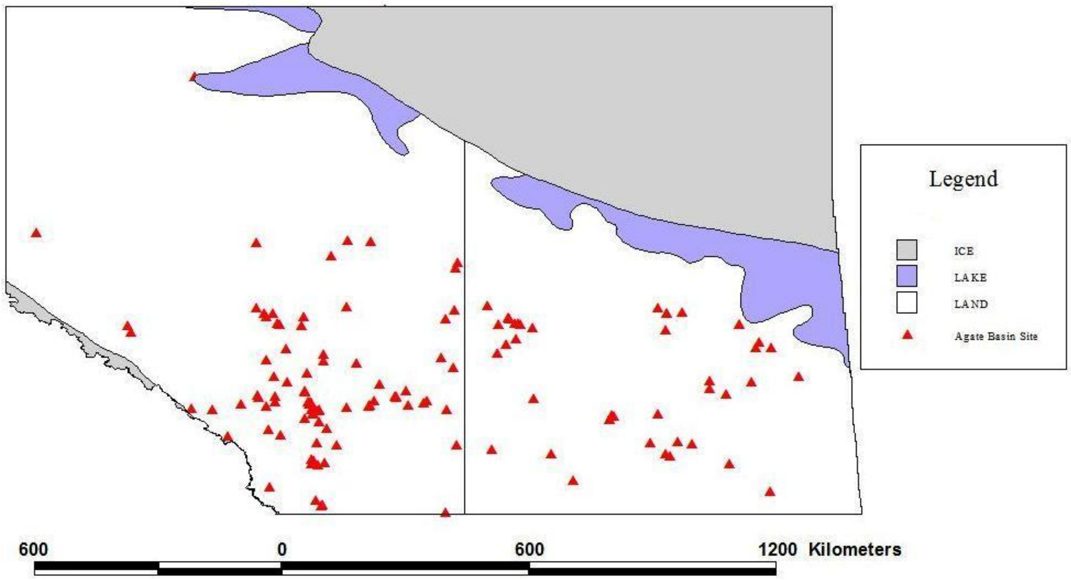

Figure 4.5a Ice sheet and Proglacial lakes in the Study Area at Approximately 12,500 cal years BP (10,500 14C years BP) (adapted from Dyke 2004)

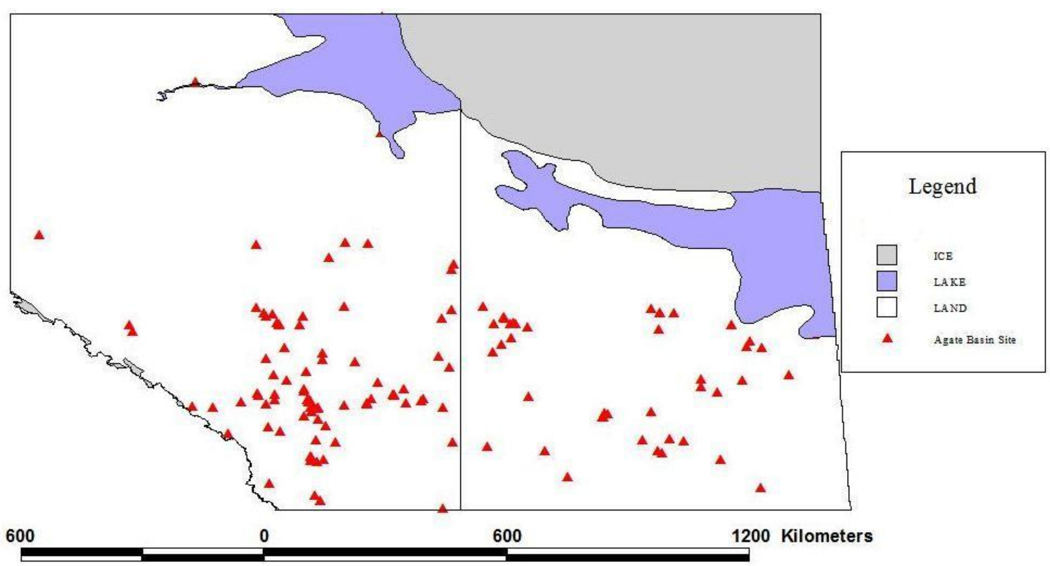

Figure 4.5b Ice sheet and Proglacial lakes in the Study Area at Approximately 11,500 cal years BP (10,000 14C years BP) (adapted from Dyke 2004)

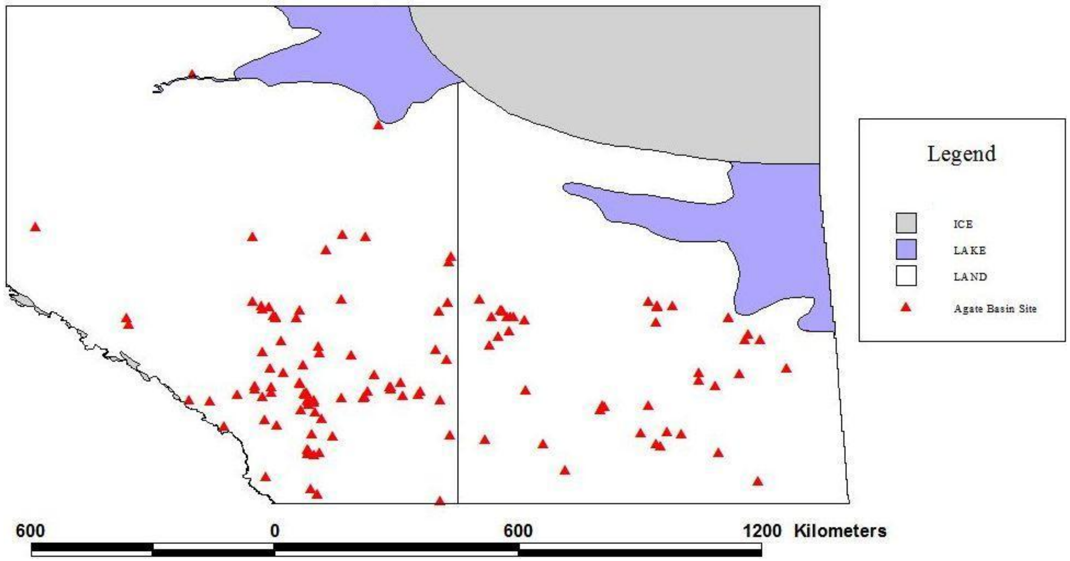

Figure 4.5c Ice sheet and Proglacial lakes in the Study Area at Approximately 10,700 cal years BP (9500 14C years BP) (adapted from Dyke 2004)

animals within the area. By the time ABPP were present in the study area, the Laurentide ice sheet would have retreated north leaving large parts of southern and central study area ice-free.

The impact of glacial retreat on human occupation of the study area would have been most dramatic in relatively close proximity to the ice sheet and proglacial lakes. Yet the entire study area would have been impacted by plant and animal migration, soil development, and landscape change. Assuming the vegetation of the study area was largely influenced by the process of deglaciation and the formation of proglacial lakes and melt-water, we may further assume that the study area contained different environments at any given time, and that these environments were in a greater state of flux than today. These environmental changes are illustrated (Figure 4.5a, b, c, Figure 4.6a, b, c, Table 3.11), respectively. As the ice sheet retreated and melt-water drained from a given area, the local climate would have changed based on new environmental conditions. This means that ABPPs occupied a landscape that was in a state of significant climatic and ecological change.

Five Agate Basin archaeological sites area (IkOs-1, IeOs-5, IlOw-7, IgOg-3 and IgOg-4) are located underneath glacial ice and proglacial lakes during the time frame of Agate Basin occupation in the study. These sites would all been uninhabitable until sometime after 9,500 cal years BP (8500 ^{14}C years BP) based on Dykes reconstructions (Dyke 2004).

These glacial reconstructions are based on geology and ^{14}C dates. However, there is a paucity of quality radiocarbon dates that can accurately depict the exact margins of glacial ice and proglacial lakes during this time frame. The approximations made by Dyke (2004) are the most accurate records to date, and the general outlines of the glaciers and proglacial lakes at this time are supported by the literature (Beaudoin and Oetelaar 2003; Burns 1996; Jackson and Pawson 1984; Jackson et al.1996; Young et al.1994).

The ^{14}C dated at this time frame are stretched at this interval, leaving some latitude to interpret the timing of glacial retreat. Regardless, these sites suggest that the Agate Basin tool producing tradition may have persisted in the far north of Alberta and Saskatchewan after it disappeared from the southern areas (Dixon 1993, 1999, 2001; Gordon 1996).

4.5 Ecological Reconstruction

Trying to recreate the ecological conditions during the ABPP occupation of the study area is a complex task. Therefore, summaries of the nature of palaeoenvironments are often helpful in order to understand environments and environmental change during the late Pleistocene/early Holocene. The work of Dyke (2005) and Dyke et al. (2004) synthesizes the palaeoenvironment at particular time-slices during the past.

Biome[16] maps spanning the interval from the last glacial maximum to modern times were created (Dyke 2005; Dyke et al. 2004), using a Geographic Information Systems (GIS) approach, largely to facilitate amendments for future research. Below are three maps (Figures 4.6a, b, c) each depicting a time slice during ABPP occupation in the study area. The three time slices represented are 12,800 cal years BP (11,000 ^{14}C years BP) (Figure 4.6a), 11,500 cal years BP (10,000 ^{14}C years BP) (Figure 4.6b), and 10,100 cal years BP (9,000 ^{14}C years

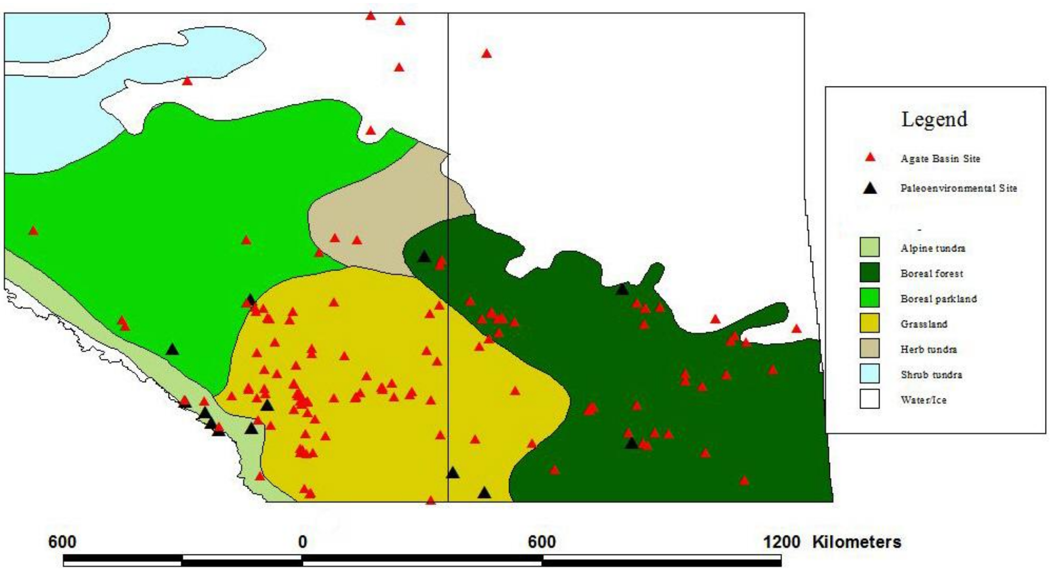

Figure 4.6a Vegetation Maps of the Study Area at Approximately 12,800 cal years BP (11,000 14C years BP) (adapted from Dyke 2005; Dyke et al. 2004)

[16] The term biome refers to a biological subdivision that reflects the ecological and physiognomic character of the vegetation. Dyke defines biomes as,"…distinctive plant and animal communities that are named for their dominant plant types." (2005, 212).

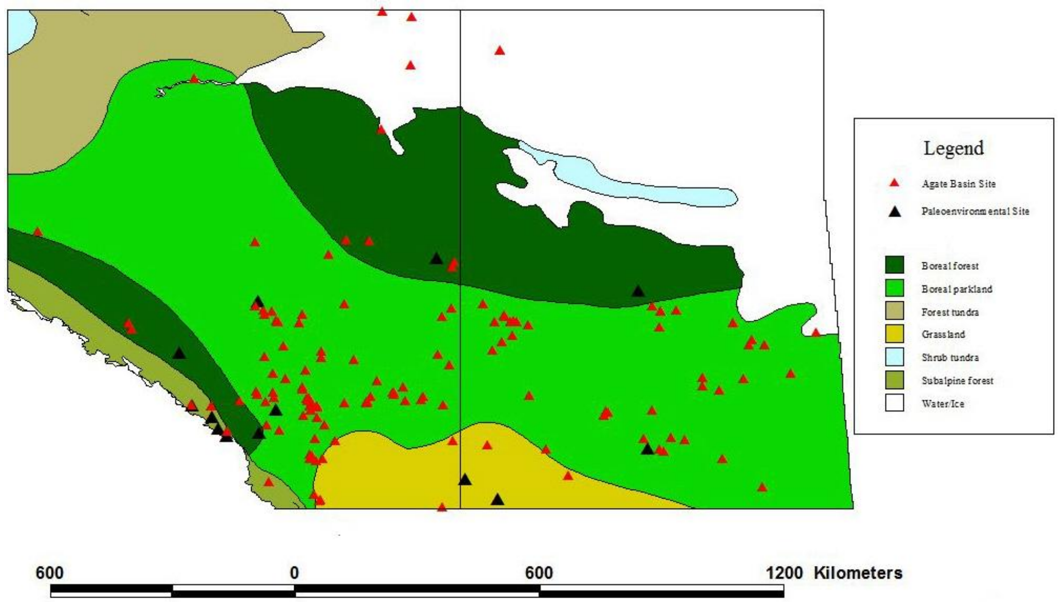

Figure 4.6b Vegetation Maps of the Study Area at Approximately 11,500 cal years BP (10,000 14C years BP) (adapted from Dyke 2005; Dyke et al. 2004)

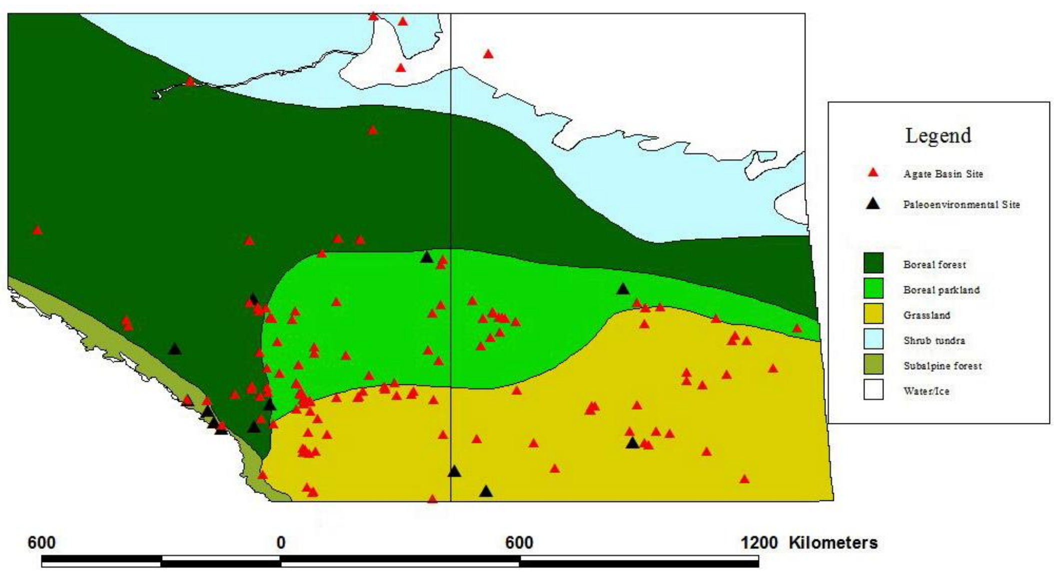

Figure 4.6c Vegetation Maps of the Study Area at Approximately 10,100 cal years BP (9,000 14C years BP) (adapted from Dyke 2005; Dyke et al. 2004)

BP) (Figure 4.6c). All three maps depict the locations of Agate Basin sites and paleoenvironmental sites used for analysis here. All of the biomes represented on these maps are described by Dyke (2005) and Dyke et al. (2004):

1. Herb tundra: A treeless area lacking shrubs other than small, prostrate willows and dominated by bare ground and herbs, typically sedge, grass, and sage with a variety of forbs.

2. Alpine tundra: Similar to herb or shrub tundra but occurring at high elevations.

3. Shrub tundra: A treeless area with a nearly continuous cover of sedge, grass, sage, and forbs along with prostrate and semi-erect willows as well as one or more additional shrubs, chiefly dwarf birch, alder, and juniper, in increasing order of required warmth.

4. Forest tundra: A zone transitional between shrub tundra and boreal forest. That is, a continuous ground cover of herb and shrub vegetation with open stands of erect trees, typically spruce, larch, and (or) poplar.

5. Boreal forest: Nearly continuous cover of trees dominated by northern conifers (mainly spruce) and northern hardwoods (mainly birch, aspen, poplar), broken by wetlands.

6. Boreal parkland: Open stands of boreal forest trees growing in ground covers dominated by herb and (or) lichen. This includes the modern aspen parkland at the southern fringe of the western boreal forest in the prairie provinces and the lichen woodland (open spruce forest) of the eastern boreal forest, which grades to forest tundra.

7. Subalpine forest: The conifer-dominated forest in mountainous terrain of the Cordillera. This is dominated by subalpine fir, spruce, mountain hemlock, lodge pole pine, and white bark pine.

8. Grassland: Treeless or nearly treeless vegetation dominated by grass, sage, or chenopods, grading to steppe with decreasing moisture; includes long- and short-grass prairie.

All of these biomes are based on the reconstructions of radiocarbon dated sites of plant macrofossils, terrestrial mammal macrofossils and pollen stratigraphic sequences (Dyke 2005). The ^{14}C dates, while giving a temporal framework for biomes and biome change, are also a source of potential error. Dyke explains that, "A major remaining source of error in late Quaternary biome reconstructions is poor radiocarbon chronology due to the preponderance of dates on bulk lake organic sediments in currently available data sets." (2005, 249). Regardless of this problem, the biome reconstructions offer a synthesis of available data in order to understand past environments and environmental change.

The maps (Figures 4.6a, b, c) illustrate a radical shift over the 3000 year period represented. Dyke states that, "Biome boundaries responded to the large climate forcing of deglaciation by shifting northward and to the ice margins at rates that were mainly in the range of 100 to 200 m/year, while slowly changing in composition" (2005, 249). The three time slices depicted in Figures 4.6 a), b), and c) illustrate this rate of change. Notable changes over the period represented by the maps are the increase in total forestation of the study area represented by the boreal forest, boreal parkland and subalpine forest biomes. Also notable is the disappearance of forest tundra, the increase of shrub tundra and the increase in grasslands by 10,100 cal years BP.

Four sites within the study area have ^{14}C dates: FfQh-27, Vermilion Lakes, Sibbald Creek and the paleoindian site of Lake Minnewanka (Table 3.2). Sibbald Creek and FfQh-27 both have problematic dates as discussed in section 4.1. However, both Lake Minnewanka and Vermilion Lakes overlap the biome time slice of 4.6 b), at approximately 11,500 cal years BP. These sites can be compared to the biome maps in order to assess what biomes they inhabited during the Agate Basin occupation.

According to the Dyke reconstructions, both sites fall within the Subalpine forest biome, composed of a conifer-dominated forest consisting of subalpine fir, spruce, mountain hemlock, lodge pole pine, and white bark pine (2005). The Vermilion Lakes palaeovegitation reconstruction reveals the presence of subalpine fir and spruce along with sage and grasses (Fedje et al. 1995, 100-101). Lake Minnewanka is close to three paleoenvironmental sites, including upper Kananaskis Lake, Lower Burstall Lake and Johnston Lake all indicate a warming period with similar paleovegetation assemblages (Beierle and Smith 1998). Although these are the only two sites with ^{14}C dates, it illustrates that paleoindians were utilizing the subalpine forest biome at approximately 11,500 cal years BP, which was capable of supporting large mammals such as *Bison* and *Ovis* species (Fedje et al. 1995; Landals 2000a, 2002).

The revised chronology of radiocarbon dates gives an age estimation of Agate Basin occupation that falls roughly between 12,800 to 10,800 cal years BP (Figure 4.1). By comparing this time slice with 4.6b) (the biome time slice that is in the middle to the revised Agate Basin time range), most sites fall within the Boreal Parkland biome (See figure 4.5b). According to Dyke, this biome consists of open stands of boreal forest trees including aspen parkland and open spruce forest environments. This association between the Boreal Parkland Biome and Agate Basin site frequency is tenuous due to the reality that these Agate Basin sites are not dated directly. It does however point to the possibility that ABPP utilized this biome extensively.

These biome maps depict a general understanding of the study area biomes during the Agate Basin occupation. A greater degree of resolution may be gained by a closer examination of each sub-region of the study area, as defined by the specific paleoenvironmental sites described in this thesis. The following sections explore this.

4.5.1 Alberta Mountains and Foothills

Cartwright Lake, Copper Lake, Johnson Lake, Lower Burstall Lake, and Upper Kananaskis Lake, all within the Rocky Mountains and Foothills indicate retreat of the Cordilleran ice sheet from roughly 12,500 to 10,000 cal years BP (10,500 to 9,500 ^{14}C years BP), suggesting a warming period (Beierle and Smith 1998). Further, Goldeye Lake indicates a warming and dry period sometime after 12,500 cal years BP (10,500 ^{14}C years BP) (Hickman and Schweger 1993). Chalmers Bog indicates that the increased temperatures and continentality resulted in spruce-dominated open-forest parkland during this same time frame (Mott and Jackson 1982).

4.5.2 Alberta Plains

The Alberta plains refer to the entirety of Alberta except for the Rocky Mountains, adjacent foothills, and the Cypress Hills region. This area is represented by Moore Lake and Lake Wabamun (Hickman and Schweger 1996) in central Alberta, along with other regional analyses (Ritchie and MacDonald 1986; Wolfe et al. 2002, 2006; Yansa 2006, 2007).

This region was populated by spruce, and became open white-spruce parkland by 11,200 cal years BP (10,000 ^{14}C years BP) (Hickman and Schweger 1996). Further, the landscape transitioned to open mixed-forest parkland after this as temperatures increased (Yansa 2007). This region highlights the rapid vegetation changes occurring within Alberta in the late Pleistocene/early Holocene.

4.5.3 Saskatchewan Plains

The Saskatchewan Plains here refers to the entirety of Saskatchewan except for the Cypress Hills region. In south-central Saskatchewan, evidence for a transition from a white spruce (*Picea glauca*) forest to a deciduous parkland environment dominated by *Populus* species and *Betula* species, along with shrubs such as *Rubus ideaus* (wild raspberry) that occurred at roughly 11,200 cal years BP (10,000 ^{14}Cyears BP) (Yansa 2007, 2006, 1998, 1995). In central Saskatchewan, Lake B is dominated by *Picea* pollen, which peaks in abundance at roughly 11,800 cal years BP (10,200 14C years BP) (Mott 1973). After this time, a closed spruce forest changes gradually to a more open spruce/shrub/pine mixed woodland environment (Mott 1973).

In southwest and central Saskatchewan, Harris Lake and Lake B indicate warmer and drier conditions during the interval falling between 12,500 to 10,200 cal years BP (10,500 to 9500 ^{14}C years BP) (Mott 1973; Porter et al. 1999; Sauchyn 1990; Sauchyn and Sauchyn 1991). Wolfe et al. (2002, 2006) indicate a trend toward greater aridity from in southeast Alberta and southwest Saskatchewan during the same time interval.

4.5.4 Cypress Hills Region

The Cypress Hills region is located in southwest Saskatchewan and southeast Alberta. It is an area of relatively high elevation compared to the surrounding plans.

This region is dominated by a unique mosaic of plants compared with the rest of the study area, likely due to its increased elevation relative to the northern plains. For example, Harris Lake indicates that prior to approximately 10,200 cal years BP (9100 ^{14}C years BP) a *Populus* forest grassland-shrub mosaic was present (Sauchyn 1990; Sauchyn and Sauchyn 1991). The Horseman site dates between 11,500 to 10,200 cal years BP (10,000 to 9000 ^{14}C years BP) (Klassen 1994). The findings here are similar to Harris Lake, yet here the pollen assemblage indicates higher frequencies of shrub versus arboreal pollen.

4.5.5 Summary of the Study Area Paleoecology

The palaeoecological reconstructions for the study area (Table 3.6) indicate the following five general conclusions. Firstly, the palaeoenvironment of the study area was greatly influenced by de-glaciation and climate change. Secondly, the climate and environment was not uniform over the study area at any given time. Thirdly, much of the vegetation lacks modern analogues (Beaudoin and Oetelaar 2003; Schweger and Hickman 1989). Fourthly, species acted individualistically in a Gleasonian[17] rather than a Clementian[18] fashion, meaning species acted with individualistic responses to the environment rather than as interdependent vegetation assemblages (climax associations). Therefore, the likelihood of non-analogous assemblages is high due to non-analogous geomorphic and climate conditions. Finally, during Agate Basin occupation in the study area, a general pattern of ecological succession is evident with initial open

[17] Proposed by H.A. Gleason in 1917, the Gleasonian hypothesis states that vegetation is continuously variable in response to a continually variable environment. Thus, no two floral communities are identical. The hypothesis also implies that vegetation cannot be classified, and that recognition of particular individual communities will be difficult.

[18] A hypothesis first proposed by Frederic Clements in 1905 which maintained that a plant community develops by constant adjustments of the relationships among species (a succession) to an optimal state (climax community) in a particular environment.

spruce parkland and spruce dominated environments. This was followed by mixed spruce/deciduous parkland environments. Finally, grassland environments were spreading by the end of Agate Basin occupation. However, the timing and nature of environmental changes would vary considerably within the study area, and this generalized succession pattern is not specific to all regions as has been shown (Beierle and Smith 1998; Hickman and Schweger 1993; Sauchyn 1990; Sauchyn and Sauchyn 1991; Wolfe et al. 2002; Wolfe et al. 2006; Yansa 2006, 2007).

4.5.6 Regional Analyses

The regional analyses summarized here indicate ecological changes coinciding with trends of warming and aridity. Table 4.1 summarizes the conditions and ecological changes observed by four regional studies in the literature.

#	Study Area Regional Analyses	Time frame - cal Years BP	Results
1	Late Pleistocene/ early Holocene Eolian Activity - (Wolfe et al. 2002, 2006)	11,300-8400	Wolf et al. explain that, "This period of eolian activity corresponds to the transition from the deglacial to more arid conditions and is most probably associated with localized drying and deflation of glaciolacustrine silts and deltaic sands under grassland vegetation cover."(2002, 223).This analysis indicates that between 10.5 and 9.5 kya, aridity was increasing which caused eolian activity and localized landscape instability. The causes of this may include one or any combination of the following: 1. decreased precipitation, 2. increased temperatures, and 3. increased evapotranspiration rate.
2	Post Glacial Spread of White Spruce - (David 1981; Ritchie and MacDonald 1986)	12,100-10,500	The spread of white spruce was extremely rapid in the western interior, and that was a time transgressive process directly related to glacial retreat. The rapid spread of white spruce over the study area is further supported by the study of fossil dunes in northwestern Saskatchewan (David 1981) which indicates strong unidirectional winds that would have aided in seed dispersal. Increasing summer temperatures during this time would have aided in seedling establishment. Thus Ritchie and MacDonald argue that white spruce would have been established throughout central Alberta and Saskatchewan by 12,100 cal years BP (10,500 ^{14}C years BP) and would have colonized new habitats as quickly as 2 km/^{14}C year, or 2000 km over 1000 years.

3	Post Glacial Spread of White Spruce - (Yansa 2006)	12,100–11,500	The post-glacial spread of white spruce was rapid and was a time transgressive process directly related to glacial retreat. The arrival of white spruce is 1500 years later than originally thought. This would also slow the rate of the spread of white spruce to 0.38 km/14C year. In addition, Yansa argues that the white spruce spread less uniformly, and that it likely occupied lake shorelines and river valleys, while prairie, parkland, and boreal plants occupied both lowlands and uplands, forming more of an open white spruce parkland.
4	Lake Records of the Northern Plains - (Yansa 2007)	12,900-9000	In North Dakota and southern Alberta and Saskatchewan from roughly 12,900 to 11,500 cal years BP (11,000 to 10,000 ^{14}C years BP) aridity was counterbalanced by glacial melt water saturating areas of the landscape that supported white spruce parkland. After this time, aridity increased drying up some areas while creating scattered oases based on melt water inputs from the retreating glacier (see Yansa et al. 2007). The result being a deciduous parkland environment between 11,500 to 10,200 cal years BP (10,000 to 9000 ^{14}C years BP). As the glacial ice retreated further, grassland would have increased by 10,200 cal years BP (9000 ^{14}C years BP).

Table 4.1 Summary of four Regional Analyses (David 1981; Ritchie and MacDonald 1986; Wolfe et al. 2002; Yansa 2006, 2007).

4.5.6.1 The Spread of White Spruce

Ritchie and MacDonald (1986) argue that the spread of white spruce across the plains was rapid in the western interior, and that it was a time transgressive process directly related to glacial retreat. They claim that the rapid spread of white spruce over the study area is supported by the evidence from fossil dunes in northwestern Saskatchewan (David 1981). The dunes provide evidence of strong unidirectional winds that could have aided in seed dispersal to the northwest. Further, they suggest that increasing summer temperatures during this time would have aided in seedling establishment (Ritchie and MacDonald 1986, 537). Ritchie and MacDonald argue that white spruce would have been established throughout central Alberta and Saskatchewan by 12,100 cal years BP (10,500 ^{14}C years BP), and would have colonized new habitats as quickly as 2 km/^{14}C year, or 2000 km over 1000 years (1986, 537).

Yansa also interprets the post glacial spread of white spruce as a rapid and time transgressive process directly related to glacial retreat (2006, 263). Based on macrofossil remains, Yansa (2006) argues that the arrival of white spruce is 1500 years later than originally proposed by Ritchie and MacDonald (1986). Further, the rate of the spread of white spruce is 0.38 km/^{14}C year with the white spruce spreading less uniformly. Spruce likely occupied lake shorelines and river valleys, while prairie, parkland, and boreal plants occupied both lowlands and uplands, forming more open white spruce parkland (Yansa 2006, 263). Her conclusions on the timing and complexity of the spread of white spruce agrees with many of the sites reviewed here (Hickman and Schweger 1996; Klassen 1994; Mott 1973; Sauchyn 1990; Sauchyn and Sauchyn 1991; Yansa 1998).

4.5.6.2 Late Pleistocene/early Holocene Eolian Activity

A regional chronology of early late Pleistocene/early Holocene eolian activity was compiled by Wolfe et al. (2002). The area analyzed includes southwestern Alberta and south and central Saskatchewan. Both optical stimulated luminescence (OLS) and radiocarbon dates were compiled from many dune sites across the Canadian prairies.[19] These sites indicate eolian activity as well as periods of stability, indicated by the presence of paleosols. Wolf et al. explain that the period from 11,300 to 8,400 cal years BP, "… corresponds to the transition from the deglacial to more arid conditions and is most probably associated with localized drying and deflation of glaciolacustrine silts and deltaic sands under grassland vegetation cover" (2002, 223).

This analysis indicates that between 12,500 to 10,200 cal years BP (10,500 to 9000 ^{14}C years BP), aridity was increasing leading to eolian activity and

[19] See Wolfe et al. 2002 for a list of sites.

localized landscape instability. The increased aridity may be caused by one or any combination of decreased precipitation, increased temperatures, and increased evapotranspiration rate.

4.5.7 Environment South of the Study Area

Paleoecological records from Moon Lake (Laird et al. 1996, 1998) and Guardipee Lake, Montana (Barnosky 1989) indicate increased temperatures and aridity between 12,500 and 10,200 cal years BP (10,500 and 9000 ^{14}C years BP). The Guardipee Lake pollen assemblage is dominated by *Pinus, Artemisia,* and Chenopodiaceae/ Amaranthaceae (Barnosky 1989). High non-arboreal percentages and small amounts of *Juniperus, Salix,* and *Populus* pollen in sediments deposited during this time frame suggest temperate grassland with shrubs and some trees.

Moon Lake indicates diatom-inferred salinity at roughly 12,500 to 10,700 cal years BP (10,500 to 9500 ^{14}C years BP) (Laird et al. 1996, 1998). Pollen records indicate that the area was relatively cool and moist until approximately 12,100 cal years BP (10,300 ^{14}C years BP), evidenced by spruce forest. After this, deciduous parkland and increased water salinity indicate a changing climate and ecology of the area, from wetter and cooler conditions to warmer and drier conditions, with maximum aridity reached sometime after 10,300 cal years BP (9200 ^{14}C years BP) (Laird et al. 1996; Laird et al. 1998).

4.5.8 Faunal Resources

Faunal remains help us to reconstruct a fuller paleoecological picture of the late Pleistocene/early Holocene. As the environment changed from spruce dominated forest to an open forest parkland environment, the presence and frequency of many animals likely changed as well although *Bison* appears to have been dominant throughout (Table 3.7).

It is hard to discuss late Pleistocene/early Holocene fauna without mentioning the Wally's Beach site (DhPg-8), St. Mary's Reservoir, Alberta, which is established as an important site for interpretation of late Pleistocene and early Holocene fauna. The site is an alluvial[20] deposit of Pleistocene age (12,930–12100 cal years BP), deposited by the St. Mary's River in southern Alberta (McNiel et al. 2004). Skeletal remains and footprints indicate a rich animal assemblage. Skeletal remains include: *Equus conversidens* (Mexican half ass), *Bootherium bombifrons* (helmeted musk ox), *Bison antiquus* (bison), *Rangifer tarandus* (caribou), *Taxidia taxus* (badger), *Ursus* (bear), *Canis lupus* (wolf), *Vulpes* (fox), *Lepus* (hare), *Ondatra* (muskrat) and ground squirrel species. Trace fossils in the form of preserved animal tracks include *Equus* (horse), *Camelops* (camel), *Mammuthus* (mammoth), *Bison* (bison), and *Rangifer* (caribou) (McNeil et al. 2004). It is fair to assume that species found at this site were present during the Agate Basin time frame. This listing of mammals illustrates the rich in variety of fauna species during Agate Basin times. However, it is important to note that deflation of Wally's Beach sediments may have mixed extinct fauna with the material remains from the Agate Basin occupation.

[20] Alluvial is a term applied to environments, processes, and products of rivers and streams. Alluvial deposits refer to the deposition of clastic and or detrial materials deposited by rivers or streams.

Table 3.7 (Appendix 3) illustrates that beaver, mammoth, wapati, caribou, camel and horse are notably present. However, various *Bison sp.* dominate the assemblage, representing approximately 62% of all the faunal records here.

The most frequent faunal remains found in association with Agate Basin archaeological sites include *Ovis canadensis* within the Rocky Mountains and foothills (Fedje et al. 1995; Gryba 1983) and *Bison* within and outside the study area (Ebell 1980; Frison 1991; Frison and Stanford 1982; Gryba 1983; Vickers 1986). Bison, deer, pronghorn, jackrabbit, cottontail, prairie dog and fresh water mussels have been found at the Allen site in Nebraska, indicating a large dietary breadth of ABPP not reported elsewhere (Bamforth 2007).

4.5.9 Plant Resource Use

One example within the study area does shed some light on paleoindian plant use despite the difficulty of obtaining such information. A hearth feature at Saskatoon Mountain in northwest Alberta (GhQt-4) dating to 9380 ± 360 cal years BP (AECV-1474) produced the remains of carbonized seeds (Beaudoin et al. 1996). The taxa identified were *Rubus* sp. (raspberry), *Prunus* sp. (cherry), *Rosa* sp. (rose), *Fragaria* sp. (strawberry) and *Arctostaphylos uva-ursi* (bearberry). Because these are all edible berries, this indicates the possibility that paleoindian people relied on berries to supplement their diet.

4.6 Agate Basin Resource Use

One of the key issues in determining Agate Basin adaptation is how they organized themselves in order to acquire resources and sustain themselves from generation to generation. Based on the work of numerous archaeologists

(Agogino et al. 1964; Agogino and Frankforter 1960; Frison 1991; Frison and Stanford 1982; Roberts 1961), it has become the standard interpretation that ABPP were communal hunters using natural traps to procure more meat than was immediately usable (Dixon 1999; Frison 1991, 1992, 2004; Frison and Stanford 1982; Reeves 1990). Further, many researchers have suggested that bison and mountain sheep hunting by Agate Basin groups represent communally organized activity involving numerous cooperating hunters (Frison 1991, 1992, 1994; Reeves 1990). This reconstruction does not reflect the nature and significance of the numerous small-scale sites found within the study area. Excavations at the Allen site, located along the Medicine Creek in south-central Nebraska, have shown that ABPP utilized a variety of animal resources including bison, deer, pronghorn, jackrabbit, cottontail, prairie dog and fresh water mussels (Bamforth 2007). Bamforth states that the ABPP at the site,"…appear to have hunted, trapped and otherwise procured a wide variety of animals in the area around the site and carried all or parts of the animals back to the site for processing." (Bamforth 2007, 231). This indicates a broad-based resource procurement strategy, with smaller groups occupying the Allen site relative to the type site in Wyoming. The Allen site does not appear to represent communal hunting of bison, although bison were an important part of resource procurement on a smaller and more intermittent scale (Bamforth 2007).

4.6.1 Communal Hunting

Communal hunting must be defined because this concept is fundamental to the discussion of paleoindian adaptation. Yet the definition of communal hunting varies from one researcher to another. Driver (1990) defines communal hunting as all hunting activity not undertaken by an individual or pair of hunters:

> a) Participation by more than two hunters (usually more than this);
> b) Active cooperation between hunters such that they work together, as opposed to passive cooperation in which hunters agree not to interfere with each other's activities;
> c) A system of hunting that requires all hunters to participate in a previously conceived plan (1990, 12).

Hoffman states that," active cooperative hunting by several individuals by the same family group does not represent a communal venture, rather a cooperative one" (1994, 348).

The difference between these two definitions of communal hunting is slight, yet important when 'communal hunting' is used to describe the 75 bison killed at the Agate Basin type site. In most cases communal hunting is thought to mean a large multi-group venture rather than a small group of hunters. Combining Drivers' and Hoffmans' definitions leads me to the following definition of communal hunting:

> a) Participation by more than one family group,
> b) Active cooperation between hunters such that they work together, as opposed to passive cooperation in which hunters agree not to interfere with each other's activities;
> c) A system of hunting that requires all hunters to participate in a previously conceived plan.

I will apply this definition when considering the Agate Basin adaptations in the study area.

4.6.2 Conflicting Ideas about Social Organization

Based on the evidence from the type site, many have argued that ABPP were predominantly involved in the capture of numerous animals in a communal venture (Frison 1991; Frison and Stanford 1982; Reeves 1990; Robertson 2004). If communal hunting is the most common model of social organization of ABPP, the following four features should be evident. Firstly, there should be evidence of the presence of large-scale kill and butchery sites. Secondly, there should be evidence of food storage. Thirdly, evidence of extensive butchery should be present. Finally, there should be evidence of the use of natural or artificial features used to direct, corral and trap numerous animals.

Agate Basin sites with high Minimum Number of Individuals (MNI) of bison and mountain sheep have been documented and interpreted as the outcome of a single large-scale communal hunt (Frison 1991; Frison and Stanford 1982; Reeves 1990). There is the assumption that communal hunting characterizes Agate Basin hunting practice in general. However, others have argued that small groups of people moving across an under-populated landscape would not necessitate large communal hunting ventures. Instead, subsistence might have been based on single family or small group opportunistic hunting that emphasized a broad-spectrum diet (Bamforth 2007; Hoffman 1994; Kelly and Todd 1988; Kornfeld 2003).

The High-Technology Forager Hypothesis describes paleoindian social organization as made up of small communities that were rarely able to organize large communal hunting events (Kelly and Todd 1988). These groups focused on smaller-scale opportunistic hunting encounters, utilizing an intricate knowledge of animal behaviour. The main features of the High-Technology Forager Hypothesis put forth by Kelly and Todd are as follows:

1. A reliance on hunting, and a detailed knowledge of animal behaviour,
2. High residential, logistical and range mobility,
3. A focus on subsistence technology that is not based on a particular environment,
4. A reliance on high quality lithic raw materials from large quarry sources, and
5. Low level processing of food (lack of full butchery and long-term preservation) (1988, 231).

Some aspects of the adaptations mentioned above are observed in this study. First, the high mobility of ABPPs is illustrated by evidence of highly valued raw material movement from distant sources for tool production, which also indicates a desire, if not reliance, on high quality lithic material. Second, there is no evidence for the reuse of kill sites or for communal hunting by ABBP's in the study area. Rather, there is only the presence of small-scale kill and butchery sites. The variety of environments that characterized the landscape in the study area suggests a focus on subsistence technology that is not reliant on a particular environment.

During the Agate Basin occupation of the study area, relatively dense bison populations would have been concentrated on grasslands, which became more widespread during the latter period of ABPP occupation in the southern portion of the study area. Greater bison density would increase the potential for communal hunting ventures. Success would have lead to the potential for larger human populations, longer human aggregations, and require complex planning needed for large-scale communal hunting ventures (Bamforth 2002, 2007).

The numerous small-scale sites that exist within the study area likely indicate small groups of people moving through the landscape. Hill (2008) argues that the small-scale camps evident through the study area represent the full variety of resources used by paleoindians, rather than the large kill sites found elsewhere. If this is true, the hunting practices, both in scope and strategy, would have differed based on the context of the environment and the density of the animal populations that inhabited them.

For permanent occupation to occur in a particular area, the area must be as productive as surrounding areas (Hill 2008; Kornfeld 2003). Areas in Wyoming have produced communal hunting sites with large numbers of bison killed. The environmental context of these sites would have been open grasslands (Dyke 2004, 2005; Frison and Stanford 1982).

The majority of environments that characterized the study area during the Agate Basin occupation would have been quite different, including boreal and deciduous forests and parklands, and shrub tundra environments. It is less likely that relatively large groups of people needed for a communal hunting event like that at the type site would have existed within the study area. Diverse environments would have provided habitats for diverse fauna. It has been argued that the more variable the environment, the more variable the resources exploited by paleoindians (Cannon and Meltzer 2008; Hill 2008).

To expand on this idea, it has been argued that the significant and rapid environmental changes that occurred in the late Pleistocene/early Holocene led to patchwork environments. This in turn led to an increase in diet breadth related directly to these environmental changes and patchwork environments. Thus, where the environment was more uniform (grasslands) bison would have been more abundant and the preferred prey, whereas patchwork environments (open mixed forests) would have necessitated a greater reliance on a diversity of prey species (Bamforth 2007; Cannon and Meltzer 2008; Hill 2008).

This comes full circle to the idea of communal hunting. As Bamforth explains, "…larger, more regular and longer human aggregations should have been held when herds of large ungulates were larger, less mobile, and more regular in their migration and aggregation patterns" (1988, 185). Bamforth (1988) proposes that social structure is more complex when larger groups of people come together more regularly and stay together longer. Larger and longer-term human aggregations occur when resources are abundant and concentrated predictably at a small set of locations within a region. The increased social complexity and long-term aggregations can result in the complex organization needed for large-scale communal hunts. This type of complexity is evident at the type site (Frison and Stanford 1982).

The ecological conditions of the study area likely led to short-term aggregations and smaller groups than what the type site suggests. This may explain the lack of large-scale communal hunting sites within the study area. Agate Basin people would have had less time and less need to undertake communal hunting activities. Agate Basin people within the study area would have been more likely to travel in smaller groups and hunt a greater variety of animals in response to the ecological conditions. The small-scale, short-term Agate Basin sites within the study area indicate this.

The emphasis on bone beds in the archaeological record also influences how people view paleoindian hunter-gatherers. Bone beds account for only a small portion of the total number of sites documented in the archaeological record. One study found that approximately 98% of all paleoindian sites on the Great Plains and Rocky Mountains are not bone beds (Kornfeld and Larson 2008). Because of the disproportionate focus on bone beds, it becomes clearer as to why there is an assumption that communal hunting events are more common for paleoindian hunter-gatherers, even though this activity may be relatively rare.

It is important to remember that environmental factors such as those considered here did not determine but rather influenced Agate Basin people's responses or actions. Yet it appears clear that Agate Basin adaptations are interconnected with the variability of the environments they inhabited. Therefore the environmental context of Agate Basin sites provides one source for interpreting the adaptations of ABPP.

Chapter 5 – Conclusions

5.0 Introduction

This thesis documents the presence of Agate Basin culture in Saskatchewan and Alberta, and documents the context of the late Pleistocene/early Holocene climate and environment on ABPP in the study area. This thesis has also illustrated a relationship between organizational variability of Agate Basin people (i.e. movement, resource extraction, and hunting practice) and the nature of the environments they inhabited. It appears that Agate Basin producing people within the study area practiced a predominantly broad-based strategy for procuring resources. If variability exists between Agate Basin people's behaviour inside and outside of the study area, the strongest influence of this difference may be summarized as environmental. Cultural-ecological relationships are relevant and illuminate much about past peoples. Agate Basin producing people are no exception. This chapter summarizes the conclusions made throughout this thesis and suggests avenues for possible future research.

5.1 Climate and Environment in the Late Pleistocene/Early Holocene

The unique radiation budget of the late Pleistocene/early Holocene resulted in greater seasonality and continentality. This was mitigated by the retreating Laurentide ice sheet, which led to a time transgressive east-west temperature gradient. Climate, ice retreat, plant and animal introductions, and topography led to variable local environments for ABBP.

During this time, spruce forests initially dominated the landscape, and probably existed close to the margins of the retreating Laurentide ice sheet and proglacial lakes. However, these environments likely changed as glacial retreat progressed and temperatures increased. Non-analogous patchworks of vegetation would have been present and subject to relatively rapid change. These would also be influenced by landscape change and glacial melt waters. During the occupation of ABPP, spruce forest, tundra-steppe, open spruce parkland, deciduous parkland, open spruce/shrub/pine mixed woodland environments, and eventually grassland environments came and went as glacial melt water disappeared and aridity continued to increase. Glacial melt water and groundwater hydrology were significant factors in influencing the environment at this time (Beaudoin and Oetelaar 2003; Yansa et al. 2007).

5.2 Landform Use

Agate Basin sites are associated with a number of landform features. Landform Types 3 and 4 (crests and prominences) account for 40% of the recorded sites. The comparison of Quaternary landforms and Agate Basin sites found similar results in that the majority of sites used were found to exist on a prominence (Figure 3.8). The likely explanation for use of this landform type use is that these sites were used extensively as observation points for finding and monitoring animals, observing the surrounding landscape, or as meeting points and reference points on the landscape. Further, during the spring to fall months, elevated areas can offer relief from dense clouds of biting insects due to increased exposure to winds and greater distance from wet insect breeding areas.

The site aspect was mostly south facing (81%). This direction maximizes the amount of heat and sunlight received. This is especially important during winters that were longer and colder than those at present are.

5.3 Faunal Resource Use

Bison, mountain sheep, beaver, elk, caribou, deer, hare, and waterfowl were likely the most common and numerous animals available for exploitation. The predominant animal associated with Agate Basin sites in the Rocky Mountains was *Ovis* (Fedje 1986; Fedje et al. 1995), whereas *Bison* are associated with Agate Basin sites on the plains (Ebell 1980; Frison and Stanford 1982; Gryba 1983). This indicates variability between regions in the hunting practices of Agate Basin people, although the foothills have shown to be an intermediary zone for procurement of both species (Gryba 1983).

Communal hunting remains undocumented in the study area. Agate Basin bison bone beds in Wyoming (Frison 1991, 1992, 1999, 2004; Frison and Stanford 1982) have been interpreted as communal hunting events. However, Agate Basin sites in the study area where identifiable faunal remains have been found (Ebell 1980; Fedje 1986; Fedje et al. 1995; Gryba 198; Krozner and Playfield 2000) do not represent the type of communal hunting events documented elsewhere.

The environmental context of ABPPs in the study area indicates that they had a highly adaptable culture. They must have been able to adjust to various environments as they moved through the landscape. This includes a reliance on a variety of prey species that would have used different habitats in the patchwork of environments at this time. The ecological context would indicate that ABPPs within the study area utilized *Bison* and *Ovis,* but also hunted other species. Likely ABPP were focused on a broad-spectrum diet within the study area and did not commit to communal hunting as a primary hunting adaptation.

5.4 Water Resource Use

The data collected here demonstrates that close proximity to water was important for determining activities and site selection. Proxy evidence clearly points to increasing aridity in the late Pleistocene/early Holocene with occasional drought conditions likely. Access to water is important for any culture but given the warmer summers at this time it may have especially important for ABPP. They appear not to have focused on any particular type of water source (Figure 3.10).

5.5 Lithic Analysis

Agate Basin projectile points vary in dimension; Saskatchewan projectile points tend to be marginally longer, wider and thicker on average than those from Alberta; study area projectile points are shorter, wider and thicker on average than those of the type site. These differences can be explained by the differences in material type frequencies and the increased frequency of reworking of projectile points. The results have shown a correlation between shorter average length in projectile points and high frequency of reworking in the study area projectile point sample. The reworking of Agate Basin projectile points within the study area represents the repair, reuse or an expedient new purpose for the projectile point in question showing that many projectile points found in the study area are at the end of use life (Frison 1991; Frison and Stanford 1982; Joyes 1997).

The distance that certain raw material types (KRF) have moved from their source indicates they were highly valued (see section 4.3.1). Chert materials were reworked at almost the same frequency that they represent in the total sample, while KRF, SRC and Mudstone were reworked at a much greater frequency than their occurrence in the total sample (Table 3.17). ABPP relied heavily on locally available raw materials such as quartzite, mudstone, and siltstone, yet traveled and/or traded over great distances to acquire specific raw material types, such as KRF and Tertiary Hills Tuffaceous Clinker.

5.6 Integration of Grey Literature and Private Collections

Private collections and grey literature were incorporated in this thesis. The larger data set provided better and more site locational data, a more complete inventory of lithic raw material use, evidence of migration, regional Agate Basin point morphology differences, landform use, and proximity to resources. The use of these data allowed for a general comparative analysis of lithic remains within the study area and between the study area and the type site. Limitations with these data are the variability in detail and accuracy. However, the quality of CRM reports improved with time. Many of the recent reports give quality, high resolution data that can more easily be incorporated into academic research. If the consistency and quality of reporting is maintained into the future, grey literature should provide an invaluable resource to all future analyses.

5.7 Suggestions for Future Research

This thesis raises significant questions about the nature of ABPP within and without the study area and how they fit into the larger paleoindian context. Future questions regarding ABPP should relate to the variability of ABPP's through space and time. Some questions that should be addressed in the future are as follows.

Lithic analysis here is focused on a few select variables of Agate Basin projectile points. An analysis focused on detailed multivariate metric measurements could shed more light on the nature of the morphological variations of Agate Basin projectile point technology. In addition, a more in-depth analysis of trade and mobility of lithic raw materials across the northern plains would be of importance. To what extent can lithic procurement tell us about mobility and/or trade of ABPPs?

Another interesting possibility for future research is the impact of former water bodies on human movement across the landscape. Springs, creeks, and streams no longer present must have had an impact on human occupation and movement. Detailed on-site examination of many of these sites could indicate potential past water sources. This detail may shed light about the specific resource extraction techniques used by ABPP's in specific environments (see Boyd and Havholm 2003).

Already mentioned, the Peace country in northwest Alberta is an area of high potential recovery of Agate Basin material that is thus far unreported (Jack Ives, personal communication, May 2010). An excellent opportunity exists to document the paleoindian material in general and Agate Basin material in particular. If this can be done, perhaps a more accurate picture of human occupation in the study area can be made. Particularly with regards to how ABPP in the study area relate to Agate Basin and paleoindian occupations in northeast B.C. and Alaska, regarding aspects such as seasonal movement, migration and regionally specific adaptations.

Still relatively unknown is an analysis of plant resources and faunal remains other than *Bison* and *Ovis* used by ABPPs in the study area. Following the analysis conducted by Bamforth (2007) at the Allen site, or the hearth analysis excavated by Beaudoin et al. (1996), perhaps further evidence can be gained as to the variability of Agate Basin resource use in the study area. Unfortunately, it will take new site discoveries with high preservation potential to yield these data.

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APPENDICES

Appendix One –Agate Basin Projectile Point Measurements

#	Site/ Collection	Accession #	Province / State	Length (cm)	Width (cm)	Thickness (cm)	Material Type	Reference to Photograph	Reference
1	GfPd-100 (GfPd-1)	99.5	AB	5.93	2.08	0.73	Chert	This Study	R.A.M.
2	DhPh-87	87.3	AB	6.6	2.36	0.78	Argillite	This Study	Meyer 2001
3	GfPa-6	92	AB	7.15	2.19	0.79	Quartzite	This Study	Ball 2006
4	FiPo-264	1	AB	5.15	1.82	0.61	Chert	This Study	Anonymous 1976
5	IlOw-7	1	AB	6.4	2.45	0.84	Chert	This Study	Pollock 1977
6	FiPp-27	995	AB	11.8	3.86	1.36	Quartzite	Wright 1979	Wright 1979
7	FiPp-27	1200	AB	7.78	3.17	0.97	Mudstone	Wright 1979	Wright 1979
8	IkOs-1	113	AB	5.9	2.1	1	Quartzite	This Study	Pollock 1977
9	IeOs-5	18	AB	10.1	3.24	1.14	Quartzite	Bereziuk 2007	Bereziuk 2007
10	IeOs-5	7	AB	9.09	5.41	1.43	Quartzite	Bereziuk 2007	Bereziuk 2007
11	EhPu-1, Surface Find	349R12E1.1	AB	6.77	1.95	0.76	Chert	Landals 2002	Landals 2000a, 2002
12	EgPr-2	7717	AB	4.1	2.03	0.59	Siltstone	Gryba 1983	Gryba 1983
13	Vermilion Lakes	153Rd	AB	7.4	2.2	0.9	Chert	Fedje 1986, Fedje et al. 1995	Fedje 1986; Fedje et al. 1995
14	Vermilion Lakes	153Re	AB	5.35	1.9	0.6	Chert	Fedje 1986, Fedje et al. 1995	Fedje 1986; Fedje et al. 1995
15	Vermilion Lakes	520Ra	AB	4.75	2.21	0.6	Chert	Fedje 1986, Fedje et al. 1995	Fedje 1986; Fedje et al. 1995
16	GdOo-16	4793	AB	5.3	2.21	0.61	Chert	This Study	R.A.M.
17	Derdrich Collection	H97.89.55	AB	4.05	1.75	0.6	Mudstone	This Study	R.A.M.
18	Derdrich Collection	H97.89.19	AB	3.99	2.24	0.68	Quartzite	This Study	R.A.M.
19	Scriver Collection	H90.142.10	AB	3.9	1.96	0.87	Chert	This Study	R.A.M.
20	Light Collection	H88.118.2	AB	3.9	1.97	0.81	Mudstone	This Study	R.A.M.
21	Johnson Collection	60.2.561	AB	5.39	2.17	0.73	KRF	This Study	R.A.M.
22	Wichender Collection	56.2.45	AB	7.79	2.32	0.95	Mudstone	This Study	R.A.M.
23	Unnamed Collection (Tray E-22)	H67.354.347	AB	7.09	2.38	1.18	Quartzite	This Study	R.A.M.
24	Unnamed Collection (Tray D-22)	H67.354.1	AB	7.08	2.32	1.05	Quartzite	This Study	R.A.M.

25	Unnamed Collection (Tray G-22)	H73.13.22	AB	6.01	2.02	0.58	Mudstone	This Study	R.A.M.
26	Unnamed Collection (Tray W26)	H03.15.216	AB	4.8	2.06	0.6	Quartzite	This Study	R.A.M.
27	Unnamed Collection (Tray W26)	H03.15.197	AB	6.23	1.74	0.73	Mudstone	This Study	R.A.M.
28	Unnamed Collection (Tray G-22)	H.68.4.73	AB	6.11	2.48	0.86	Quartzite	This Study	R.A.M.
29	Dzurko Collection	H05.78.27	AB	5.8	2.3	0.55	Quartzite	This Study	R.A.M.
30	Dzurko Collection	H05.78.43	AB	6.4	0.94	0.46	Mudstone	This Study	R.A.M.
31	Dzurko Collection	H05.78.46	AB	5.42	1.89	0.8	Siltstone	This Study	R.A.M.
32	Dzurko Collection	H05.78.91	AB	4.26	1.9	0.79	Chert	This Study	R.A.M.
33	Robinson Collection	H78.24.3	AB	6.12	1.88	0.96	Quartzite	This Study	R.A.M.
34	Howard Collection	61.1.26	AB	5.99	2.38	0.99	Quartzite	This Study	R.A.M.
35	Howard Collection	61.4.658	AB	4.25	2.2	0.61	Sandstone	This Study	R.A.M.
36	Howard Collection	61.4.785	AB	5.56	1.9	0.69	Quartzite	This Study	R.A.M.
37	McKay Collection	H88.139.58	AB	6.09	2.23	0.9	Chert	This Study	R.A.M.
38	McKay Collection	H88.139.60	AB	4.76	2.22	0.58	Chert	This Study	R.A.M.
39	FgOe-10	1	SK	6.35	2.6	1.8	Quartzite	This Study	Carlson 1993
40	FgOe-16	2	SK	4.35	2	0.7	SRC	This Study	Carlson 1993
41	FjOi-13	5	SK	6	2.2	0.9	SRC	This Study	Carlson 1993
42	FgOc-6,	2	SK	6.1	2.4	1.9	Quartzite	This Study	Carlson 1993
43	FgOe-10	1	SK	5.4	1.9	0.6	KRF	This Study	Carlson 1993
44	FhOg-14	1	SK	4.4	1.9	0.8	SRC	This Study	Carlson 1993
45	FhOg-4	5	SK	8.1	2.85	0.9	Quartzite	This Study	Carlson 1993
46	EgNo-41	3	SK	6.5	2.2	0.9	Quartzite	This Study	Saylor 1993
47	EbNj-4	2	SK	7.65	2.45	0.8	Chert	Ebell 1980	Ebell 1980
48	EbNj-4	3	SK	6.4	2.7	0.85	KRF	Ebell 1980	Ebell 1980
49	EbNj-4	6	SK	8.5	2.65	0.7	Chert	Ebell 1980	Ebell 1980
50	EbNj-4	7	SK	5.75	2.2	0.65	Chert	Ebell 1980	Ebell 1980
51	EbNj-4	12	SK	5.76	2.11	0.7	Chert	Ebell 1980	Ebell 1980
52	EbNj-4	604	SK	4.01	1.96	0.96	SRC	This Study, Ebell 1980	Ebell 1980
53	EbNj-4	431	SK	5.21	2.12	0.51	KRF	This Study	Ebell 1980
54	Phenix Collection	AS2	SK	6.9	2.82	0.93	Quartzite	This Study	University of Sask.

55	Phenix Collection	COA	SK	5.26	2.39	0.93	Sandstone	This Study	University of SK
56	Phenix Collection	321	SK	6.33	2.51	0.74	KRF	This Study	University of Sask.
57	Phenix Collection	633	SK	5.56	2.55	0.73	Chert	This Study	University of Sask.
58	Phenix Collection	470	SK	6.81	2.79	1.11	Chert	This Study	University of Sask.
59	Phenix Collection	No # (a)	SK	5.59	2.19	0.82	Chert	This Study	University of Sask.
60	Phenix Collection	No # (b)	SK	5.83	2.41	0.9	Chert	This Study	University of Sask.
61	Phenix Collection	No # (c)	SK	6.51	2.52	0.82	Chert	This Study	University of Sask.
62	Phenix Collection	636	SK	7.4	2.81	0.98	Chert	This Study	University of Sask.
63	Phenix Collection	637	SK	5.45	2.39	0.92	Chert	This Study	University of Sask.
64	Phenix Collection	320	SK	5.41	2.52	0.76	Chert	This Study	University of Sask.
65	Phenix Collection	459	SK	6.31	2.41	0.9	Chert	This Study	University of Sask.
66	Phenix Collection	497	SK	7.56	2.98	0.99	Chert	This Study	University of Sask.
67	Phenix Collection	455	SK	13.31	3.6	0.92	Chert	This Study	University of Sask.
68	Agate Basin Site Collection	2.48a	WY	11.15	2	0.62	KNF	Frison and Stanford 1982	Frison and Stanford 1982
69	Agate Basin Site Collection	2.48b	WY	10.5	2.2	0.6	KNF	Frison and Stanford 1982	Frison and Stanford 1982
70	Agate Basin Site Collection	2.48c	WY	11.9	2.6	0.68	KNF	Frison and Stanford 1982	Frison and Stanford 1982
71	Agate Basin Site Collection	2.48e	WY	7.8	2.4	0.87	KNF	Frison and Stanford 1982	Frison and Stanford 1982
72	Agate Basin Site Collection	2.48f	WY	8.8	2.2	0.7	KNF	Frison and Stanford 1982	Frison and Stanford 1982
73	Agate Basin Site Collection	2.48g	WY	6.7	1.8	0.6	KNF	Frison and Stanford 1982	Frison and Stanford 1982
74	Agate Basin Site Collection	2.48h	WY	5.5	2	0.62	KNF	Frison and Stanford 1982	Frison and Stanford 1982
75	Agate Basin Site Collection	2.48i	WY	8.4	1.9	0.7	KNF	Frison and Stanford 1982	Frison and Stanford 1982
76	Agate Basin Site Collection	2.48j	WY	7.8	1.9	0.59	KNF	Frison and Stanford 1982	Frison and Stanford 1982
77	Agate Basin Site Collection	2.48k	WY	7	2	0.69	KNF	Frison and Stanford 1982	Frison and Stanford 1982
78	Agate Basin Site Collection	2.48l	WY	2	5.75	0.61	KNF	Frison and Stanford 1982	Frison and Stanford 1982
79	Agate Basin Site Collection	2.48m	WY	5.9	2.5	0.74	KNF	Frison and Stanford 1982	Frison and Stanford 1982

80	Agate Basin Site Collection	2.49d	WY	6.7	2.4	0.87	KNF	Frison and Stanford 1982	Frison and Stanford 1982
81	Agate Basin Site Collection	2.49e	WY	6.3	1.5	0.62	KNF	Frison and Stanford 1982	Frison and Stanford 1982
82	Agate Basin Site Collection	2.49f	WY	5.7	1.6	0.61	KNF	Frison and Stanford 1982	Frison and Stanford 1982
83	Agate Basin Site Collection	2.49k	WY	6.8	2.4	0.71	Chert	Frison and Stanford 1982	Frison and Stanford 1982
84	Agate Basin Site Collection	2.49m	WY	10.3	2.4	0.89	Chert	Frison and Stanford 1982	Frison and Stanford 1982
85	Agate Basin Site Collection	2.50a	WY	7.1	1.8	0.82	Chert	Frison and Stanford 1982	Frison and Stanford 1982
86	Agate Basin Site Collection	2.50g	WY	4.2	1.75	0.69	Chert	Frison and Stanford 1982	Frison and Stanford 1982
87	Agate Basin Site Collection	2.50i	WY	9.5	2.5	0.81	Quartzite	Frison and Stanford 1982	Frison and Stanford 1982
88	Agate Basin Site Collection	2.50p	WY	4.95	1.7	0.59	Quartzite	Frison and Stanford 1982	Frison and Stanford 1982
89	Agate Basin Site Collection	2.51a	WY	8	2.4	0.76	KNF	Frison and Stanford 1982	Frison and Stanford 1982
90	Agate Basin Site Collection	2.51b	WY	9.6	2.3	0.61	KNF	Frison and Stanford 1982	Frison and Stanford 1982
91	Agate Basin Site Collection	2.51e	WY	7.9	2.6	0.74	Quartzite	Frison and Stanford 1982	Frison and Stanford 1982
92	Agate Basin Site Collection	2.51g	WY	13.9	2.1	0.7	KNF	Frison and Stanford 1982	Frison and Stanford 1982
93	Agate Basin Site Collection	2.51h	WY	5.4	1.9	0.73	Chert	Frison and Stanford 1982	Frison and Stanford 1982
94	Agate Basin Site Collection	2.51i	WY	8.4	2.5	0.73	Porcelanit e	Frison and Stanford 1982	Frison and Stanford 1982
95	Agate Basin Site Collection	2.51l	WY	5.5	1.7	0.54	Chert	Frison and Stanford 1982	Frison and Stanford 1982
96	Agate Basin Site Collection	2.51m	WY	7.8	2.45	0.9	Quartzite	Frison and Stanford 1982	Frison and Stanford 1982
97	Agate Basin Site Collection	2.52b	WY	11.0 5	2.5	0.8	KNF	Frison and Stanford 1982	Frison and Stanford 1982
98	Agate Basin Site Collection	2.52d	WY	8.3	2.3	0.78	KNF	Frison and Stanford 1982	Frison and Stanford 1982
99	Agate Basin Site Collection	2.52f	WY	5.75	2	0.69	KNF	Frison and Stanford 1982	Frison and Stanford 1982

100	Agate Basin Site Collection	2.52h	WY	7	1.6	0.61	KNF	Frison and Stanford 1982	Frison and Stanford 1982
101	Agate Basin Site Collection	2.52i	WY	7.4	1.8	0.61	KNF	Frison and Stanford 1982	Frison and Stanford 1982
102	Agate Basin Site Collection	2.52k	WY	8.95	2.7	0.75	KNF	Frison and Stanford 1982	Frison and Stanford 1982
103	Agate Basin Site Collection	2.53c	WY	6.5	1.6	0.55	KNF	Frison and Stanford 1982	Frison and Stanford 1982
104	Agate Basin Site Collection	2.53n	WY	7.82	2.31	0.78	chert	Frison and Stanford 1982	Frison and Stanford 1982
105	Agate Basin Site Collection	2.53o	WY	8.43	2.2	0.88	Chert	Frison and Stanford 1982	Frison and Stanford 1982
106	Agate Basin Site Collection	2.56a	WY	10.11	2.52	0.75	KNF	Frison and Stanford 1982	Frison and Stanford 1982
107	Agate Basin Site Collection	2.56j	WY	10.03	2.35	0.69	Chert	Frison and Stanford 1982	Frison and Stanford 1982
108	Agate Basin Site Collection	2.56k	WY	7.91	2.11	0.71	KNF	Frison and Stanford 1982	Frison and Stanford 1982

Appendix Two - Archaeological Site Radiocarbon Dates

#	Site	LAB #	Material Dated	Uncorrected Age (^{14}C)	Range of Calibrated Ages (Cal BP) *	Cultural Association	Reference
1	Agate Basin (WY)	RL-557	Charcoal	10430 ± 570	12785-11310	Agate Basin	Frison and Stanford 1982; Holliday 2000
2	Agate Basin (WY)	O-1252	Charcoal	9300 ± 450	11203-9917	Agate Basin	Frison and Stanford 1982; Holliday 2000
3	Agate Basin (WY)	M-1131	Charcoal	9990 ± 225	11965-11220	Agate Basin	Frison and Stanford 1982; Holliday 2000
4	Hell Gap (WY)	I-167	Charcoal (burned soil)	10850 ± 550	13353-11999	Agate Basin	Frison 1991; Holliday 2000

5	Frazier (CO)	SMU-316	Soil Humates	9550 ± 130	11101-10706	Agate Basin	Holliday 2000
6	Allen (NE)	TX-6596	Charcoal	10260 ± 360	12526-11406	Agate Basin	Holliday 2000
7	Allen (NE)	TX-6594	Charcoal	10600 ± 620	13119-11410	Agate Basin	Holliday 2000
8	Vermilion Lakes (AB)	RIDDL 75	Charred Wood	9570 ± 150	11137-10715	Agate Basin	Fedje et al. 1995
9	Vermilion Lakes (AB)	RIDDL 83	Bone Collagen	9700 ± 130	11237-10792	Agate Basin	Fedje et al. 1995
10	Vermilion Lakes (AB)	RIDDL 77	Bone Collagen	9840 ± 200	11709-10872	Agate Basin	Fedje et al. 1995
11	Vermilion Lakes (AB)	RIDDL 82	Charred Wood	10010 ± 180	11823-11244	Agate Basin	Fedje et al. 1995
12	Sibbald Creek (AB)	GX-8808	Charcoal	9570 ± 320	11313-10311	Agate Basin	Gryba 1983
13	FfQh-27 (AB)	Beta - 104738	Organic Stain Sediment	11270± 50	13234-13115	Agate Basin	Kulle 1998
14	Lake Minnewanka (AB)	TO-9256	Mountain Sheep bone	10250 ± 60	12105-11826	Plano	Landals 2002
15	Lake Minnewanka (AB)	TO-9257	Bison incisor	10110 ± 60	11961-11506	Plano	Landals 2002
16	Lake Minnewanka (AB)	TO-9258	Mountain Sheep bone	10220 ± 50	12049-11825	Plano	Landals 2002
17	Allen Site (NE)	TX-6596	Charcoal	10280 ± 360	12545-11410	Agate Basin	Bamforth 2007
18	Allen Site (NE)	TX-6594	Charcoal	10610 ± 620	13130-11411	Agate Basin	Bamforth 2007
19	Beacon Island (ND)	SR-6231	*Bison antiquus* Bone fragment	10330 ± 45	12375-12049	Agate Basin	Ahler et al. 2004
20	Beacon Island (ND)	SR-6232	*Bison antiquus* M1	10305 ± 45	12370-11989	Agate Basin	Ahler et al. 2004
21	Beacon Island (ND)	ETH-26780	charred wood, *Salix sp.*	10371 ± 82	12390-12093	Agate Basin	Ahler et al. 2004
22	Beacon Island (ND)	ETH-26781	charred wood, *Salix sp.*	9911 ± 105	11602-11218	Agate Basin	Ahler et al. 2004

* (1 sigma, IntCal09 calibration curve, OxCal 4.1)

Appendix Three - Radiocarbon Dates on or Associated with Faunal Remains

#	Species	Lab #	Material Dated	Uncorrected Age	Range of Calibrated Ages (cal years BP) *	Reference
1	*Castor sp.* (beaver)	AECV-1620C	beaver-gnawed wood	9730 ± 110	11252-10806	Beaudoin et al. 1996
2	*Castor sp.* (beaver)	AECV-1596C	Wood	10,150 ± 140	12055-11408	Harington 2003
3	*Mammuthus imperator* (Mammoth)	S-232	Femur	10,600 ± 140	12670-12223	Agenbroad 1984; Morlan 1999
4	*Mammuthus sp.* (Mammoth)	GX-2918-D	Tibia	10,240 ± 325	12418-11405	Graham et al. 1987
5	*Cervus elaphus* (wapati)	AECV-272C	Rib	9920 ± 220	11995-11163	Churcher 1984
6	*Bison priscus*(steppe bison)	GSC-2865	2 tibiae	9880 ± 130	11607-11186	Driver 1998
7	*Bison occidentalis* (western Bison)	GSC-612	not reported	10,760 ± 160	12875-12545	Wilson and Churcher 1984
8	*Bison occidentalis* (western Bison)	I-8579	Ribs	9670 ± 160	11219-10780	Shackelton and Hills 1977
9	*Bison occidentalis* (western Bison)	GSC-1894	Bison bone Collagen	9630 ± 300	11395-10502	Lowdon and Blake 1979; Shackelton and Hills 1977
10	*Bison sp.*(unknown species)	I-3118	not reported	10,210 ± 100	12108-11652	Morlan 1993
11	*Bison sp.*(unknown species)	GSC-3065	Skull	10,200 ± 280	12378-11404	Jackson and Pawson 1984
12	*Bison sp.*(unknown species)	AECV-439C	not reported	10,080 ± 150	11965-11358	Beaudoin 1988
13	*Bison sp.*(unknown species)	GSC-1205	2 tibiae	10,000 ± 160	11767-11246	Lowdon and Blake 1979

14	*Bison sp*.(unknown species)	CAMS-13192	not reported	9990 ± 150	11750-11250	Harington 2003
15	*Bison sp*.(unknown species)	CAMS-12913	not reported	9930 ± 60	11593-11240	Harington 2003
16	*Bison sp*.(unknown species)	I-8483	Tibia, Metatarsal, Metacarpal	9860 ± 140	11613-11156	Westgate et al.1978
17	*Bison sp*.(unknown species)	TO-2999	Metacarpal	9750 ± 80	11250-10901	Beaudoin et al. 1996
18	*Castor sp*. (beaver)	AECV-1620C	beaver-gnawed wood	9730 ± 110	11252-10806	Harington 2003
19	*Castor sp*. (beaver)	AECV-1596C	Tibia	10,150 ± 140	12005-11408	Harington 2003
20	*Cervus elaphus* (wapiti)	AECV-272C	Rib	9920 ± 220	11955-11163	Harington 2003
21	*Bison priscus* (steppe bison)	GSC-2865	2 tibiae	9880 ± 130	11607-11186	Harington 2003
22	*Bison occidentalis* (western bison)	I-8579	Rib	9670 ± 160	11389-10787	Harington 2003
23	*Bison occidentalis* (western bison)	GSC-1894	Rib	9630 ± 300	11395-10502	Harington 2003
24	*Bison sp*.(unknown species)	CAMS-12913	Rib	9930 ± 60	11593-11240	Harington 2003
25	*Bison sp*.(unknown species)	I-8483	Tibia, Metatarsal, Metacarpal	9860 ± 140	11613-11156	Harington 2003
26	*Bison sp*.(unknown species)	TO-2999	Metacarpal	9750 ± 80	11250-10901	Harington 2003
27	*Bootherium bombifrons*	TO-7691	3rd Cervical Vertebrae	10,980 ± 80	12955-12709	Tolman 2001
28	*Bison bison antiquus*	TO-7693	Maxilla fragment	11,130 ± 90	13133-12897	Tolman 2001
29	*Equus conversidens*	TO-7696	Rib Fragment	11,330 ± 70	13279-13144	Tolman 2001
30	*Rangifer tarandus*	TO-8972	Antler	11,350 ± 80	13299-13148	Tolman 2001
31	*Unidentified Bone Fragment*	GSC-613	Unidentified Bone Fragment	11,370 ± 170	13417-13095	Stalker 1968

32	*Bison sp.(unknown species)*	RL-757	Tibia	11,300 ± 290	13445-12852	Wilson and Churcher 1984
33	*Bison sp.(unknown species)*	TO-7694	Cranium	11,290 ± 280	13430-12859	Wilson et al. 2008
34	*Unidentified Bone Fragment*	GSC-989	Unidentified Bone Fragment	11,100 ± 160	13136-12786	Stalker 1968
35	*Unidentified Bone Fragment*	GSC-612	Unidentified Bone Fragment	10,760 ± 160	12875-12545	Lowdon and Blake 1979
36	*Bison sp.(unknown species)*	GSC-3065	Cranium	10,200 ± 280	12378-11585	Wilson 1983
37	*Bison sp.(unknown species)*	TO-7695	Cranium	10090 ± 70	11944-11406	Wilson et al. 2008
38	*Camelops hesternus*	BGS-2143	not reported	10708 ± 100	12708-12550	Burns 2009
39	*Mammuthus sp.*	BGS-2141	not reported	10743 ± 100	12728-12565	Burns 2009

* (1 sigma, IntCal09 calibration curve, OxCal 4.1)

Appendix Four - Palaeoenvironmental Site Radiocarbon Dates

#	Site	Lab#	Material Dated	Uncorrected Age	Range of Calibrated Ages (Cal years BP) *	Reference
1	Moore Lake	GSC-2921	plant fragment	10,200 ± 160	12371-11411	Hickman and Schweger 1996, 1993; Schweger and Hickman 1989
2	Moore Lake	GSC-2858	plant fragment	9250 ± 80	10515-10219	Hickman and Schweger 1996, 1993; Schweger and Hickman 1989
3	Goldeye Lake	AECV-1325C	wood fragment	9380 ± 100	10747-10429	Hickman and Schweger 1993
4	Goldeye Lake	GSC 3546	plant fragment	11400 ± 170	13429-13110	Hickman and Schweger 1993
5	Lake Wabamun	S-2051	plant fragment	9780 ± 265	11686-10742	Hickman and Schweger 1991; Schweger and Hickman 1989
6	Harris Lake	TO-2745	plant fragment	9240 ± 260	11067-10158	Last and Sauchyn 1993; Porter et al. 1999; Sauchyn 1990; Sauchyn and Sauchyn 1991
7	Harris Lake	S-2908	plant fragment	9120 ± 250	10652-9910	Last and Sauchyn 1993; Porter et al. 1999; Sauchyn 1990; Sauchyn and Sauchyn 1991
8	Johnson Lake	TO-5186	wood fragment	9440 ± 230	11097-10431	Beierle and Smith 1998
9	Lower Burstall Lake	CAMS20358	pine needle	9180 ± 60	10404-10250	Beierle and Smith 1998
10	Copper Lake	RIDDL-664	wood fragment	10490 ± 160	12572-12144	Beierle and Smith 1998
11	Copper Lake	RIDDL-88	spruce needle	9650 ± 150	11201-10781	Beierle and Smith 1998
12	Copper Lake	RIDDL-665	monocot	9740 ± 140	11276-10789	Beierle and Smith 1998
13	Lake B	GSC-647	wood fragments	10,260 ± 170	12390-11719	Mott 1973
14	Horseman Site	GSC-4266	wood fragment	10,200 ± 140	12208-11417	Klassen 1994
15	Horseman Site	GSC-4098	peat sample	9500 ± 80	11070-10608	Klassen 1994

16	Horseman Site	GSC-4270	wood fragment	10,000 ± 130	11711-11265	Klassen 1994
17	Andrews Site	AECV-2047C	wood root	10,230 ± 140	12375-11630	Yansa 2007, 2006
18	Andrews Site	GSC-5822	wood fragment	10,200 ± 80	12063-11755	Yansa 2007, 2006
19	Andrews Site	AECV-2048C	wood fragment	10,200 ± 140	12208-11417	Yansa 2007, 2006
20	Moon Lake	CAMS-6827	wood fragment	10,780 ± 100	12759-12580	Laird et al. 1998; Laird et al. 1996
21	Moon Lake	CAMS-6826	wood fragment	9530 ± 130	11092-10683	Laird et al. 1998; Laird et al. 1996
22	Guardipee Lake	WIS-1769	unid. plant debris	10,360 ± 100	12402-12054	Barnosky 1989
23	Guardipee Lake	AA-1823	unid. plant debris	9220 ± 290	11065-9938	Barnosky 1989

* (1 Sigma, IntCal09 Calibration Curve, OxCal 4.1)

Appendix Five – Listing of Agate Basin Projectile Point Photographs in the Study Area*

#	Site/Collection	Accession Number	Reference to Photograph	Reference
1	GfPd-100 (GfPd-1)	99.5	This Study	R.A.M.
2	DhPh-87	87.3	This Study	Meyer 2001
3	GfPa-6	92	This Study	Ball 2006
4	FiPo-264	1	This Study	Anonymous 1976
5	IlOw-7	1	This Study	Pollock 1977
6	IkOs-1	113	This Study	Pollock 1977
7	GdOo-16	4793	This Study	R.A.M.
8	Derdrich Collection	H97.89.55	This Study	R.A.M.
9	Derdrich Collection	H97.89.19	This Study	R.A.M.
10	Scriver Collection	H90.142.10	This Study	R.A.M.
11	Light Collection	H88.118.2	This Study	R.A.M.
12	Johnson Collection	60.2.561	This Study	R.A.M.
13	Wichender Collection	56.2.45	This Study	R.A.M.
14	Unnamed Collection (Tray E-22)	H67.354.347	This Study	R.A.M.
15	Unnamed Collection (Tray D-22)	H67.354.1	This Study	R.A.M.
16	Unnamed Collection (Tray G-22)	H73.13.22	This Study	R.A.M.
17	Unnamed Collection (Tray W26)	H03.15.216	This Study	R.A.M.
18	Unnamed Collection (Tray W26)	H03.15.197	This Study	R.A.M.
19	Unnamed Collection (Tray G-22)	H.68.4.73	This Study	R.A.M.
20	Dzurko Collection	H05.78.27	This Study	R.A.M.
21	Dzurko Collection	H05.78.43	This Study	R.A.M.
22	Dzurko Collection	H05.78.46	This Study	R.A.M.
23	Dzurko Collection	H05.78.91	This Study	R.A.M.
24	Robinson Collection	H78.24.3	This Study	R.A.M.

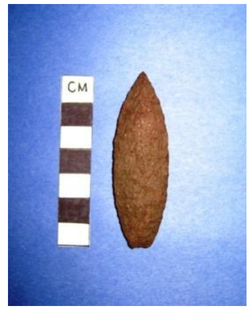
25	Howard Collection	61.1.26	This Study	R.A.M.
26	Howard Collection	61.4.658	This Study	R.A.M.
27	Howard Collection	61.4.785	This Study	R.A.M.
28	McKay Collection	H88.139.58	This Study	R.A.M.
29	McKay Collection	H88.139.60	This Study	R.A.M.
30	FgOe-10	1	This Study	Carlson 1993
31	FgOe-16	2	This Study	Carlson 1993
32	FjOi-13	5	This Study	Carlson 1993
33	FgOc-6, Larry Iverson Collection	2	This Study	Carlson 1993
34	FgOe-10, Leclare Collection	1	This Study	Carlson 1993
35	FhOg-13, Furman Collection	1	This Study	Carlson 1993
36	FhOg-4, Cooper Collection	5	This Study	Carlson 1993
37	EgNo-41	3	This Study	Saylor 1993
38	EbNj-4, Parkhill Site	604	This Study	Ebell 1980
39	EbNj-4, Parkhill Site	431	This Study	Ebell 1980
40	Phenix Collection	AS2	This Study	University of Saskatchewan
41	Phenix Collection	COA	This Study	University of Saskatchewan
42	Phenix Collection	321	This Study	University of Saskatchewan
43	Phenix Collection	633	This Study	University of Saskatchewan
44	Phenix Collection	470	This Study	University of Saskatchewan
45	Phenix Collection	No # (a)	This Study	University of Saskatchewan
46	Phenix Collection	No # (b)	This Study	University of Saskatchewan
47	Phenix Collection	No # (c)	This Study	University of Saskatchewan
48	Phenix Collection	636	This Study	University of Saskatchewan
49	Phenix Collection	637	This Study	University of Saskatchewan
50	Phenix Collection	320	This Study	University of Saskatchewan
51	Phenix Collection	459	This Study	University of Saskatchewan
52	Phenix Collection	497	This Study	University of Saskatchewan
53	Phenix Collection	455	This Study	University of Saskatchewan

***67 Agate Basin projectile points measurements from the study area were used for the data collection in this thesis. Only 53 were accessible for photography. The remainder of the data are sourced from publications. See Appendix 1 for sources.**

Appendix 6 – Agate Basin Projectile Point photographs from the study Area

1. GfPd-1 (99.5)

2. DhPh-87 (87.3)



3. GfPa-6 (92)

4. FiPo-264 (1)

5. IlOw-7 (1)

6. IkOs-1 (113)

7. GdOo-16 (4793)

8. Deirdrich (H97.89.55)

9. Deirdrich (H97.89.19)

10. Scriver (H90.142.10)

11. Light (H88.118.2)

12. Johnson (60.2.561)

13. Wichender (56.2.45)

14. Unnamed (H67.354.347)

15. Unnamed (H67.354.1)

16. Unnamed (H73.13.22)

17. Unnamed (H03.15.216)

18. Unnamed (H03.15.197)

19. Unnamed (H68.4.73)

20. Dzurko (H05.78.27)

21. Dzurko (H05.78.43)

22. Dzurko (H05.78.46)

23. Dzurko (H05.78.91)

24. Robinson (H78.24.3)

25. Howard (61.1.26)

26. Howard (61.4.658)

27. Howard (61.4.785)

28. McKay (H88.139.58)

29. McKay (H88.139.60)

30. FgOe-14 (1)

31. FgOe-16 (2)

32. FjOi-13 (5)

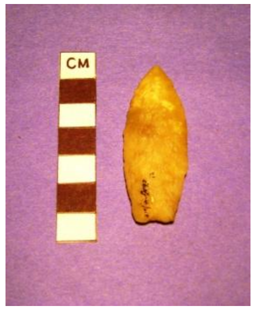
33. FgOc-6 (2)

34. FgOe-10 (1)

35. FhOg-13 (1)

36. FhOg-4 (5)

37. EgNo-41 (3)



38. EbNj-4 (604)

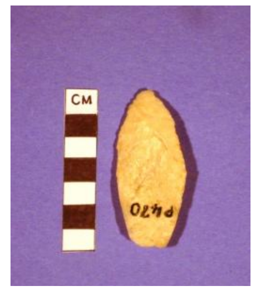
39. EbNj-4 (431)

40. Phenix (AS2)

41. Phenix (COA)

42. Phenix (321)

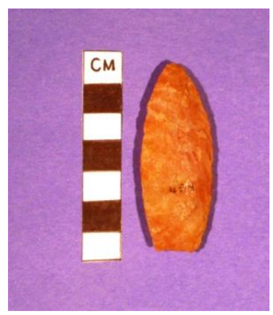
43. Phenix (633)



44. Phenix (470)

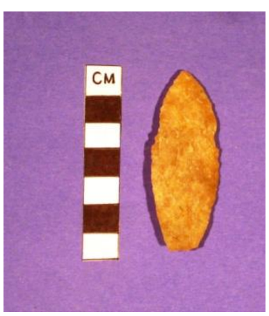
45. Phenix (no # A)

46. Phenix (no # B)



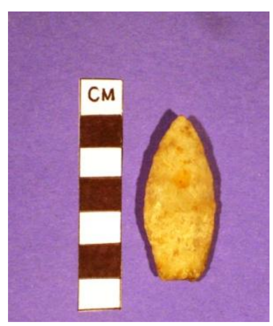
47. Phenix (no # C)

48. Phenix (636)



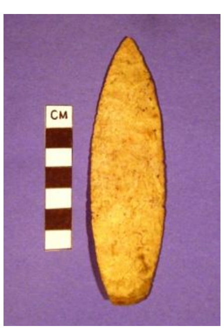
49. Phenix (637)

50. Phenix (320)



51. Phenix (459)

52. Phenix (497)



53. Phenix (455)

Appendix Seven –Sites Designated as Agate Basin through the Alberta and Saskatchewan Surveys not used for this thesis and the Reason for this Rejection

#	Borden	Site Name	Province	Reason for Site Rejection
1	DiOo-88		AB	Did not meet thesis methodological criteria for Agate Basin Designation for this thesis (see methods section 2.1)
2	DgPm-1	Red Rock Canyon	AB	Did not meet thesis methodological criteria for Agate Basin Designation for this thesis (see methods section 2.1)
3	DjPo-81	North Bellevue	AB	Unable to gain access to, or visually verify, the collection.
4	DjPp-8	Crowsnest Valley Campsite	AB	Did not meet thesis methodological criteria for Agate Basin Designation for this thesis (see methods section 2.1)
5	DkPh-15		AB	Unable to gain access to, or visually verify, the collection.
6	DkPn-11		AB	Did not meet thesis methodological criteria for Agate Basin Designation for this thesis (see methods section 2.1)
7	DkPn-22		AB	Unable to gain access to, or visually verify, the collection.
8	DlPh-17	Chanticlear	AB	Did not meet thesis methodological criteria for Agate Basin Designation for this thesis (see methods section 2.1)
9	DlPh-20		AB	Did not meet thesis methodological criteria for Agate Basin Designation for this thesis (see methods section 2.1)
10	DlPh-23	Old Toboggan Blow	AB	Did not meet thesis methodological criteria for Agate Basin Designation for this thesis (see methods section 2.1)
11	EaOp-2		AB	Did not meet thesis methodological criteria for Agate Basin Designation for this thesis (see methods section 2.1)
12	EhOm-2	Circle 8	AB	Did not meet thesis methodological criteria for Agate Basin Designation for this thesis (see methods section 2.1)
13	EiOq-4		AB	Unable to gain access to, or visually verify, the collection.
14	EjOr-1	Johnston Locality 3	AB	Unable to gain access to, or visually verify, the collection.
15	EjOu-14		AB	Did not meet thesis methodological criteria for Agate Basin Designation for this thesis (see methods section 2.1)
16	EePh-15	Roy's Goldmine	AB	Did not meet thesis methodological criteria for Agate Basin Designation for this thesis (see methods section 2.1)
17	EePj-59		AB	Unable to gain access to, or visually verify, the collection.
18	FaPd-1		AB	Unable to gain access to, or visually verify, the collection.

19	FbPe-1	Wilfort	AB	Unable to gain access to, or visually verify, the collection.
20	FcPb-5		AB	Did not meet thesis methodological criteria for Agate Basin Designation for this thesis (see methods section 2.1)
21	FcPc-1	Red Willow	AB	Did not meet thesis methodological criteria for Agate Basin Designation for this thesis (see methods section 2.1)
22	FdPe-4	Boss Hill; Boss Hill Locality 1 and 2	AB	Did not meet thesis methodological criteria for Agate Basin Designation for this thesis (see methods section 2.1)
23	FlPg-24		AB	Did not meet thesis methodological criteria for Agate Basin Designation for this thesis (see methods section 2.1)
24	GhQo-1		AB	Did not meet thesis methodological criteria for Agate Basin Designation for this thesis (see methods section 2.1)
25	DhMl-1		SK	Unable to gain access to, or visually verify, the collection.
26	ElMj-29	MD 400	SK	Unable to gain access to, or visually verify, the collection.
27	ElMj-32	SR87-21	SK	Unable to gain access to, or visually verify, the collection.
28	DgNa-3	Weedy Hilltop Site	SK	Unable to gain access to, or visually verify, the collection.
29	DhMn-5		SK	Unable to gain access to, or visually verify, the collection.
30	DhMn-6	Double D Burial	SK	Unable to gain access to, or visually verify, the collection.
31	DjMo-6		SK	Unable to gain access to, or visually verify, the collection.
32	DjMq-4		SK	Unable to gain access to, or visually verify, the collection.
33	DkMq-4		SK	Unable to gain access to, or visually verify, the collection.
34	DjMq-3	Curtis-Moat/Kisbey Burial	SK	Unable to gain access to, or visually verify, the collection.
35	DkMq-7		SK	Unable to gain access to, or visually verify, the collection.
36	DjNf-4		SK	Unable to gain access to, or visually verify, the collection.
37	EbNj-21	Carter's	SK	Unable to gain access to, or visually verify, the collection.
38	EcNc-2		SK	Unable to gain access to, or visually verify, the collection.
39	EdNg-9		SK	Unable to gain access to, or visually verify, the collection.
40	EdNh-9	Johnston Flats	SK	Unable to gain access to, or visually verify, the collection.
41	EdNh-10	Stony Beach II	SK	Unable to gain access to, or visually verify, the collection.
42	EdMr-6		SK	Unable to gain access to, or visually verify, the collection.
43	EeMr-1		SK	Unable to gain access to, or visually verify, the

				collection.
44	EeNk-4	Flynn 3	SK	Unable to gain access to, or visually verify, the collection.
45	EeNk-6	Small Site	SK	Unable to gain access to, or visually verify, the collection.
46	EeNk-7	Pit Site	SK	Unable to gain access to, or visually verify, the collection.
47	EfMo-3		SK	Unable to gain access to, or visually verify, the collection.
48	EfMo-1		SK	Did not meet thesis methodological criteria for Agate Basin Designation for this thesis (see methods section 2.1)
49	EgMo-3		SK	Unable to gain access to, or visually verify, the collection.
50	EgNk-9	Strange Site	SK	Unable to gain access to, or visually verify, the collection.
51	EhNk-1	Gust Site #4	SK	Unable to gain access to, or visually verify, the collection.
52	EhNl-4	Barlow #2, Morrison #2	SK	Unable to gain access to, or visually verify, the collection.
53	EhNl-22	Sherlock II, Gust #7	SK	Unable to gain access to, or visually verify, the collection.
54	EhNl-3	Barlow #1, Dolan #5, Sherlock, Gust #1	SK	Unable to gain access to, or visually verify, the collection.
55	EhNl-2	Barlow #11, LEE (Righetti #2), Gust #4	SK	Unable to gain access to, or visually verify, the collection.
56	EhNl-18	Barlow #18	SK	Unable to gain access to, or visually verify, the collection.
57	EiNk-4	Barlow #23	SK	Unable to gain access to, or visually verify, the collection.
58	EiNl-5	Barlow #24, Gust #14, Righetti #11	SK	Unable to gain access to, or visually verify, the collection.
59	EiNl-13		SK	Did not meet thesis methodological criteria for Agate Basin Designation for this thesis (see methods section 2. 2.1)
60	EiMo-2		SK	Did not meet thesis methodological criteria for Agate Basin Designation for this thesis (see methods section 2.1)
61	EkMn-1		SK	Unable to gain access to, or visually verify, the collection.
62	EkNg-21	Neufeld\Stephan\ Lanigan Creek #18	SK	Unable to gain access to, or visually verify, the collection.
63	FcMu-2		SK	Unable to gain access to, or visually verify, the collection.
64	FdMw-3	Trembley	SK	Unable to gain access to, or visually verify, the collection.
65	FdMs-1		SK	Unable to gain access to, or visually verify, the collection.

66	FeMw-9	A2	SK	Unable to gain access to, or visually verify, the collection.
67	FeMw-3	A1, S, K, A, A:2	SK	Did not meet thesis methodological criteria for Agate Basin Designation for this thesis (see methods section 2.1)
68	FeMw-4	John Popp Site (JP)	SK	Did not meet thesis methodological criteria for Agate Basin Designation for this thesis (see methods section 2.1)
69	FeNg-1	McCloy Creek	SK	Unable to gain access to, or visually verify, the collection.
70	FgNb-4	Green-Ridgedale Site	SK	Unable to gain access to, or visually verify, the collection.
71	FgNe-1	South of Brockingtown	SK	Unable to gain access to, or visually verify, the collection.
72	FgNi-50		SK	Unable to gain access to, or visually verify, the collection.
73	FhNa-11	Bill Martin site	SK	Unable to gain access to, or visually verify, the collection.
74	FgNb-2	Issaacson	SK	Unable to gain access to, or visually verify, the collection.
75	FhNi-96	Stankowski	SK	Unable to gain access to, or visually verify, the collection.
76	FiNa-8	Boughen 1	SK	Unable to gain access to, or visually verify, the collection.
77	FjNa-1		SK	Unable to gain access to, or visually verify, the collection.
78	FiNa-6		SK	Unable to gain access to, or visually verify, the collection.
79	DhOa-6		SK	Unable to gain access to, or visually verify, the collection.
80	DjNr-1	McCord	SK	Unable to gain access to, or visually verify, the collection.
81	DjNr-25		SK	Unable to gain access to, or visually verify, the collection.
82	DkNr-2		SK	Unable to gain access to, or visually verify, the collection.
83	DkNt-1		SK	Unable to gain access to, or visually verify, the collection.
84	DkNu-37	Bambino Site	SK	Unable to gain access to, or visually verify, the collection.
85	DkNv-8		SK	Unable to gain access to, or visually verify, the collection.
86	EeOi-3		SK	Unable to gain access to, or visually verify, the collection.
87	EeNt-1		SK	Unable to gain access to, or visually verify, the collection.
88	EeOi-6	The Prelate Gap site	SK	Unable to gain access to, or visually verify, the collection.
89	EgNo-28	DP-9S	SK	Unable to gain access to, or visually verify, the collection.
90	EgNp-57	DP-2N, Draw #4	SK	Unable to gain access to, or visually verify, the collection.
91	EgNp-50	DP-3N	SK	Unable to gain access to, or visually verify, the collection.

92	EgNp-16	SSR #62	SK	Unable to gain access to, or visually verify, the collection.
93	EgNp-27	SSR #73	SK	Unable to gain access to, or visually verify, the collection.
94	ElOa-4	Knorr	SK	Unable to gain access to, or visually verify, the collection.
95	ElOc-17		SK	Unable to gain access to, or visually verify, the collection.
96	FbNr-10	Ewen Site	SK	Unable to gain access to, or visually verify, the collection.
97	FbNs-14	The Gate Site	SK	Unable to gain access to, or visually verify, the collection.
98	FcNn-35		SK	Unable to gain access to, or visually verify, the collection.
99	FcNr-15		SK	Did not meet thesis methodological criteria for Agate Basin Designation for this thesis (see methods section 2.1)
100	FdNu-23		SK	Unable to gain access to, or visually verify, the collection.
101	FdNt-31		SK	Unable to gain access to, or visually verify, the collection.
102	FdNu-8		SK	Unable to gain access to, or visually verify, the collection.
103	FdNm-78	Doug Site	SK	Unable to gain access to, or visually verify, the collection.
104	FdNm-90	Zarry Site 1	SK	Unable to gain access to, or visually verify, the collection.
105	FeNo-1		SK	Unable to gain access to, or visually verify, the collection.

Appendix Eight – Agate Basin Sites in the Study Area Listed by Decimal Latitude and Longitude*

#	Borden	Site Name	Latitude	Longitude	Permit #	Reference
1	FiPo-200		53.3	114.3	ASA 82-062	Ronaghan 1982
2	DhPg-8	Wally's Beach	49.2	113.1	ASA CRM 128	Tolman 2001
3	FgQj-7		53.1	117.3	ASA 98-121; ASA CRM 266	Reeves 2001; Wondrasek 1998
4	DhPh-51	St Mary's Reservoir	49.3	113.2	ASA 01-027	Meyer 2001
5	DhPh-87	St Mary's Reservoir	49.2	113.1	ASA 01-027	Meyer 2001
6	DgOp-15	Bad Waters	49	110.4	ASA 76-044	Reeves 1976
7	FiPp-26		53.3	114.3	ASA 78-031	Wright 1979
8	GdOo-16	Duckett	54.3	110.2	ASA 86-034	Fedirchuk and McCullough 1986
9	IkOs-1	Leland Lake	59.8	111.1	ASA 77-030	Pollock 1977
10	IcPx-1		58.5	115.9	ASA 75-008	Donahue 1975
11	GcOm-18		54.4	110.2	ASA 80-100; ASA 80-123	Fedirchuk 1980a, 1980b
12	FdOq-9		52.4	110.5	ASA 80-100; ASA 80-123	Fedirchuk 1980a, 1980b
13	EePl-215		50.7	114	ASA 79-032; ASA 98-081	Rogers 1979; Wood 1998
14	GfPp-2		54.9	114.5	05-378	Cloutier 2006
15	FkOo-8		53.4	110.2	N/A	Gruhn 1965
16	FiPn-36		53.3	114.2	ASA 81-067	Damp 1981
17	EkPj-4	Kievers Lake; Kiever Lake	51.4	113.3	N/A	Hjermstad 1991
18	EhPj-2	Hutterite Colony	51.2	113.3	N/A	Hjermstad 1991
19	EhPi-4	Goose Track Hill	51.2	113.3	N/A	Hjermstad 1991

20	EeOn-16	Project Past	50.5	110.2	N/A	Boag 1989
21	ElOw-3	Project Past	51.5	111.5	N/A	Boag 1989
22	ElOw-4	Project Past	51.6	111.5	N/A	Boag 1989
23	ElOx-7	Project Past	51.6	111.5	N/A	Boag 1989
24	FiOq-17	Project Past	53.2	110.4	N/A	Boag 1989
25	FcPd-2	Project Past	52.3	112.3	N/A	Boag 1989
26	FdPg-23	Project Past	52.3	113.1	N/A	Boag 1989
27	FdPr-5	Project Past	52.3	114.3	N/A	Boag 1989
28	FePg-19	Project Past	52.5	113.1	N/A	Boag 1989
29	FgPl-4	Project Past	53.1	113.6	N/A	Boag 1989
30	FhPm-9	Project Past	53.1	114	N/A	Boag 1989
31	FhPm-10	Project Past	53.1	114.1	N/A	Boag 1989
32	FhPm-24	Project Past	53.1	114	N/A	Boag 1989
33	EjPo-135	Project Trace	51.3	114.3	N/A	Hjermstad 1991
34	EfPi-9	Three Boulder Blow (PT)	50.5	113.2	N/A	Hjermstad 1991
35	EhPi-9	Sandhill (PT)	51.2	113.2	N/A	Hjermstad 1991
36	EiPi-10	Pointed Knife Blow (PT)	51.3	113.3	N/A	Hjermstad 1991
37	EiPh-6	Gas Cap Hill (PT)	51.2	113.2	N/A	Hjermstad 1991
38	EiPi-16	Rooster Blow (PT)	51.3	113.2	N/A	Hjermstad 1991
39	EkPj-10	Allingham Highway (PT)	51.4	113.4	N/A	Hjermstad 1991
40	EiPj-5	Spike Blow (PT)	51.3	113.3	N/A	Hjermstad 1991
41	EjPj-19	Walking Crow (PT)	51.4	113.4	N/A	Hjermstad 1991
42	FaPk-11	Headless Mouse (PT)	52.1	113.4	N/A	Hjermstad 1991

43	ElPn-5	Moose Blowout (PT)	51.6	114.1	N/A	Hjermstad 1991
44	EgPh-19	Milnesand Blowout (PT)	51	113.2	N/A	Hjermstad 1991
45	EjPj-23	Blue Nitro Hill (PT)	51.4	113.4	N/A	Hjermstad 1991
46	FiPl-19	Project Trace	53.3	113.5	N/A	Hjermstad 1991
47	FlPf-26	Project Trace	53.5	112.6	N/A	Hjermstad 1991
48	EjPa-8	Project Trace	51.4	112.1	N/A	Hjermstad 1991
49	EkPn-6	Project Trace	51.4	114.1	N/A	Hjermstad 1991
50	EjOu-7	Project Trace	51.4	111.2	N/A	Hjermstad 1991
51	FbOo-2	Project Trace	52.2	110.2	N/A	Hjermstad 1991
52	EjPa-9	Project Trace	51.4	112.1	N/A	Hjermstad 1991
53	EjPa-14	Project Trace	51.3	112.1	N/A	Hjermstad 1991
54	EjPf-52	Project Trace	51.3	112.6	N/A	Hjermstad 1991
55	EkPi-1	Project Trace	51.7	113.5	N/A	Hjermstad 1991
56	EjPj-32	Project Trace	51.6	113.5	N/A	Hjermstad 1991
57	EdPk-45	Project Trace	50.5	112.8	N/A	Hjermstad 1991
58	ElPl-10	Rosebud Hill, East (PT)	51.9	113.9	N/A	Hjermstad 1991
59	FdPl-14	Project Trace	52.6	113.9	N/A	Hjermstad 1991
60	ElPm-8	Project Trace	52	114.1	N/A	Hjermstad 1991
61	EjPo-141	Project Trace	51.5	114.5	N/A	Hjermstad 1991
62	EjPo-144	Project Trace	51.6	114.5	N/A	Hjermstad 1991
63	EhOo-2	Project Trace	51.3	110.4	N/A	Hjermstad 1991
64	EiOr-2	Project Trace	51.4	110.9	N/A	Hjermstad 1991
65	EiOx-11	Project Trace	51.5	112	N/A	Hjermstad 1991
66	EkOt-6	Project Trace	51.7	111.3	N/A	Hjermstad 1991

67	EkOx-19	Project Trace	51.8	111.8	N/A	Hjermstad 1991
68	EaPg-30	Project Trace	50.1	113	N/A	Hjermstad 1991
69	EaPh-13	Trail Hill Blowout (PT)	50.1	113.3	N/A	Hjermstad 1991
70	EaPh-24	Project Trace	50.1	113.2	N/A	Hjermstad 1991
71	EbPh-5	Big Rock Blowout (PT)	50.2	113.3	N/A	Hjermstad 1991
72	EbPh-7	Project Trace	50.2	113.3	N/A	Hjermstad 1991
73	EgPi-9	Caruso Hill (PT)	51.1	113.5	N/A	Hjermstad 1991
74	EfPf-15	Project Trace	50.8	113	N/A	Hjermstad 1991
75	GdPf-3	Project Trace	54.6	112.9	N/A	Hjermstad 1991
76	EfPn-7	Project Trace	50.8	114.3	N/A	Hjermstad 1991
77	EdPc-219		51.7	113.8	ASA 02-039	Green 2002
78	EgPr-2	Sibbald Creek	51.4	114.9	N/A	Gryba 1983
79	GfPd-1		54.9	112.5	N/A	Stored at University of Alberta, no Report
80	DjPn-50		49.6	114.2	ASA 85-043	Reeves 1985
81	EiOq-1	Johnston Locality 19	51.5	110.8	N/A	Wormington and Forbis 1965
82	EePs-25	Orchid Creek	50.7	115.2	ASA 78-015	Brink 1978
83	EhPu-1	Lake Minnewanka	51.3	115.5	349R	Landals 2000a, 2002
84	FiPo-264		53.4	114.3	ASA 82-062	Gryba 1982
85	FiPp-27		53.5	114.5	ASA 77-058	Gryba 1977
86	FfQh-27		52.9	117.3	ASA 96-056 ASA 97-115	Fedirchuk and McCullough 1998; Kulle 1998
87	GfPa-6		54.9	112	ASA-06-205	Ball 2006
88	GgQt-10		55.1	119.3	ASA 96-063	Gorham 1996
89	HiOw-38		57.4	111.7	ASA 01-248	Clarke 2001

90	IeOs-5		58.8	111.1	ASA 07-437	Bereziuk 2007
91	IlOw-7	Projectile Find Spot	59.9	111.7	ASA 77-030	Pollock 1977
92	EhPv-8	Vermilion Lakes	51.3	115.9	N/A	Fedje 1986; Fedje et al. 1995
93	DkNv-2	Napao Site	49.7	107.6	85-005	Watson 1987
94	DiMu-3		49.5	103.3	98-102	Light 1998
95	FiNk-8	Forest Shatilla Site (PA8)	53.5	105.8	99-014	Krozner and Playfield 2000
96	FiNh-4	Kosowan II	53.4	105.3	94-017	Frey 1994
97	EgNq-18	Coteau Beach D	51.1	106.8	89-40	Stevenson 1989
98	FeOf-2		52.7	109.1	89-10	Carlson 1993
99	FeOf-3	Gibbon	52.8	108.9	89-10	Carlson 1993
100	FgOc-6	Tait Site A	53	108.5	89-10	Carlson 1993
101	FgOe-10	La Clare A	53.1	108.8	89-10	Carlson 1993
102	FgOh-8	Foster B	53.1	109.3	89-10	Carlson 1993
103	FhOg-13	Furman B	53.2	109	89-10	Carlson 1993
104	FhOg-4		53.2	109	89-10	Carlson 1993
105	IgOg-4		59.1	109.1	60-13	Site Form
106	IgOg-3		59.1	109.1	60-12	Site Form
107	FiNj-5	Bachur #2	53.3	105.6	N/A	Meyer and Freeman 2006
108	FiNj-6	Bachur #1	53.3	105.6	N/A	Meyer and Freeman 2006
109	FiNj-10	Bachur Collection	53.3	105.6	N/A	Meyer and Freeman 2006
110	FgMx-3	Armley Site	53.1	104	83-03	Spurling 1983
111	FgMx-4	Allchin (Campbell A-4)	53.1	104	83-03	Spurling 1983
112	EgNq-7	Coteau Pasture #2	51.1	106.7	84-11	Johnson 1984
113	EgNo-41	Debra's Walk	50.5	106	92-01	Saylor 1993
114	EdNi-6		50.6	105.4	90-73	Balcom 1990
115	EdNg-10		50.5	105	O1-84	Hjermstad and Paquin 2002
116	FgOe-14		53.1	108.8	89-10	Carlson 1993
117	FgOe-16		53.1	108.9	89-10	Carlson 1993
118	FhOd-2		51.5	108.5	89-10	Carlson 1993
119	FjOi-13		53.5	109.5	89-10	Carlson 1993

120	FgOg-4		53.2	109	89-10	Carlson 1993
121	EgNk-7	Righetti #4	51.2	105.8	98-102	Light 1998
122	EkNd-3	Lorienz Site	51.9	104.7	99-023	Novekosky 2002
123	EkNd-4	Burt Pumford Site	51.7	104.6	99-023	Novekosky 2002
124	EbNj-4	Parkhill Site	50.3	105.5	N/A	Ebell 1980
125	EaNb-3		50.1	104.2	85-005	German 1985
126	EbNj-9	Ernie Doyle	50.3	105.6	89-020	David 1990
127	EjNb-1	Blue Hill	51.6	104.3	99-023	Novecosky 2002
128	ElMw-8	Bill Kereluke	51.9	103.8	99-023	Novecosky 2002
129	ElMq-1	Riverside Farm Site	52	102.7	85-005	German 1985
130	FdMt-9	Aron Site	52.6	103.3	96-093	Finnegan and Gibson 1997
131	FdMv-25	Base Site	52.6	103.6	96-093	Finnegan and Gibson 1997
132	FeMv-14	John McCormack Site	52.7	103.6	96-093	Finnegan, J. and T. Gibson, 1997
133	FfMv-13		52.9	102.2	96-093	Finnegan and Gibson 1997
134	FfNj-1	Fenton Ferry	53	105.6	N/A	Meyer and Freeman 2006
135	EbOa-19		50.3	108.1	88-020	Thomas and German 1991
136	EcOi-2	Jean Wilk	50.4	109.4	89-056	Anonymous 1989
137	EgNr-8	Girl Guides' Camp Site	51	106.8	89-040	Stevenson 1989
138	EgNr-2	Camp Rayner	51	106.8	89-040	Stevenson 1989
139	FcOh-3	Anna Site	52.5	109.3	04-107	Hanson and Weinbender 2004

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